CITY OF VANCOUVER

NORTHEAST FALSE CREEK TRANSPORTATION STUDY

PHASE 4 – OPERATIONAL ASSESSMENT

PARSONS

SW1261

August 2018

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EXECUTIVE SUMMARY

Since the conclusion of the Phase 2 Multi-Modal Transportation Assessment Report (2015), the design of the Viaducts replacement network has undergone significant changes based on previous recommendations as well as from continued engagement with various stakeholders. As a result, a combination of macro and micro-scopic level traffic analysis tools have been applied to provide an updated operational assessment of the refined multi-modal Northeast False Creek replacement network as detailed in this Phase 4 Operational Assessment Report.

Major changes to the network since the 2015 Phase 2 Transportation Multi-Modal Network Report include:

- Conversion of the entirety of new Pacific Boulevard to two-way operations. Two-way Pacific Boulevard provides improved network and point-to-point travel times, improved block accessibility, reduced circulation requirements, better traffic distribution between parallel network links, and safer and reduced travel speeds.
- New signalized crossings for pedestrians at Georgia / Pacific, mid-block on the Georgia Ramp, Site 6C access, Expo Boulevard slip-lane, and mid-block on Pacific Boulevard between Georgia Ramp and Smithe Mews all serve to enhance the safety and convenience of the pedestrian network, allowing for more direct walking trips between adjacent land uses.
- Additional protected only signal phases for cyclists and pedestrians at select intersections to further support the City's initiative of encouraging active mode share and increase safety.
- Eastbound and westbound left-turn signal phases and dedicated turn bays added to the intersection of Main Street at Prior Street and eastbound and westbound left-turns banned at Quebec Street at Pacific Boulevard.
- Reallocation of concept cycling facility along Georgia Street ramp for pedestrian crush space requirements with the high forecast demand to and from the stadia.
- Recessed bus bays at applicable locations to reduce the impact to through traffic caused by passenger boarding and alighting.
- Refinement of intersection geometries to accommodate adequate turning radii for vehicles as well as sufficiently sized dwell areas for pedestrians and cyclists.

Based on the results of the updated analysis, the following are the study's key findings:

i. The Viaducts replacement network can accommodate today's traffic volumes with minor increases in travel time of approximately one to five minutes during the peak periods, depending on the route. These travel time increases can be mitigated through the future implementation of Intelligent Transportation Systems. Minor vehicle volume increases to parallel streets are forecast; however, these diversionary trips are within the capacity of the existing roadways.

ii. Given the City's ongoing success in reducing vehicular volumes while accommodating increased density and active mode share, the no net traffic growth scenario is deemed appropriate for the modelling and design of the replacement network.

iii. The Viaducts replacement network will enable increased accessibility to new developments due to the reduction in circuitous routing (caused by the existing one-way couplet arrangement) which better distributes local traffic.

iv. Significant walking and cycling improvements as part of the Viaducts replacement network will further support the City's initiative of reducing automobile usage and shift trips to alternative modes of transportation. These multi-modal network improvements are essential towards meeting the City's Transportation 2040 goals of increased mode split for active transportation and transit and no net increase to vehicular volumes on City streets.

v. A number of optimization strategies identified in the previous Phase 2 report have been incorporated including the management of left-turn movements from New Pacific Boulevard and the Georgia Street extension, additional pedestrian crossing opportunities, two-way vehicle flow on Pacific Boulevard, and reviewing locations for active facilities including exclusion of cycle tracks along the Georgia Street extension to accommodate pedestrian crush space requirements. These alterations were further tested to determine their full benefits and if the physical changes required at the street level were feasible.

vi. Events occurring at the stadia shall continue to be accommodated by providing comparable on-street staging capacity to what is currently available. In addition, improvements to pedestrian permeability in the network from the introduction of the Georgia Ramp connection between Beatty Street and Pacific Boulevard will result in better utilization of stadia accesses. The Viaducts replacement network will also maintain acceptable traffic operations in the local and overall road network through the careful use of appropriate traffic management plans, well positioned advisory signage, targeted media communications, and continued traffic monitoring before, during, and after events. The full event management strategies report is covered in a separate Phase 3 Event Management Strategies report.

1.0 BACKGROUND AND STUDY CONTEXT

The City of Vancouver has continued to advance planning and design components for the Northeast False Creek (NEFC) area. As the proposed Viaducts replacement network has progressed from conceptual plans and ideas to the detailed design, it is important to understand how proposed changes will influence transportation within the study area and how input from area stakeholders, City staff, and designers have been incorporated. As a result, modelling analysis has been revised to reflect the current design elements and study findings and observations supplemented accordingly. The previous three technical reports summarized findings for interrelated phases of study, as described below:

- **Phase 1** – Existing Conditions provided a summary of Baseline (2014/2015) conditions within the NEFC multi-modal network. Current vehicle volume and capacity relationships were assessed, along with historic trends regarding vehicle growth within the area. Safety and operational issues were identified, as well as opportunities and constraints for the pedestrian, cycling, transit, and goods movement network.
- **Phase 2** – Transportation Multi-Modal Assessment generated forecast travel demands for the NEFC network based on local development assumptions and the expected use of various modes of travel. A travel demand model and micro-simulation model were developed and applied to test alternative travel demand and network configuration scenarios. The assessment concluded that the proposed replacement network accommodates a range of potential development and traffic scenarios and could be further enhanced with supplemental physical and operational changes as well as new walking, cycling and transit infrastructure.
- **Phase 3** – Event Management Strategies reviewed the range of special events occurring in and around the NEFC area on a regular basis. This included load-in, load-out, and traffic management plans for the two stadia, as well as recurrent mass participation running events. The impacts to existing operations as a result of the replacement network were quantified and proposed refinements to the traffic management plans developed.

This document represents Phase 4, which provides an operational assessment of the resulting design and identifies key changes incorporated from the end of the Phase 2 Transportation Multi-Modal Assessment report issued in 2015.

2.0 KEY PLANNING AND DESIGN REFINEMENTS

Following the conclusion of the Phase 2 Multi-Modal Transportation Assessment report (2015) where several opportunities and constraints were identified, refinements to the transportation network have been made as a result of supplementary analysis and further consultations with City of Vancouver staff and stakeholders and the detailed design process. This section discusses the key multi-modal changes to the NEFC transportation network.

2.1 Development Assumptions

The NEFC development blocks consist of 11 distinct area blocks with a potential for up to 5.4 M ft^2 of residential development and 2.3 M ft^2 of non-residential development. To generate the forecast trips for the NEFC development scenarios, a number of assumptions were reviewed pertaining to typical trip rates per unit of development, as well as the proportion of trips by mode for analogous City neighbourhoods. These assumptions are detailed fully in the Phase 2 Multi-Modal Transportation Assessment report. While it is acknowledged that there may be minor changes to build-out development assumptions over-time with refinements in the planning process, the estimates provided in the Phase 2 report are still valid as these were conservative and are consistent with the NEFC area plan.

NEFC development blocks are forecast to generate up to 3,300 vehicles per hour in the PM peak hour with a significant proportion of overall trips anticipated to be walking trips given the mix and density of land uses and the convenience of making local trips between individual blocks. ***Figure 1*** provides the projected traffic volumes within the viaducts replacement network based on these assumptions.

The proposed new St. Paul's Hospital situated just outside the eastern extent of the NEFC study area will feature up to 3.2 M ft^2 of additional development. The impacts of this development have been considered within multiple traffic modelling scenarios and is accounted for in the analysis.

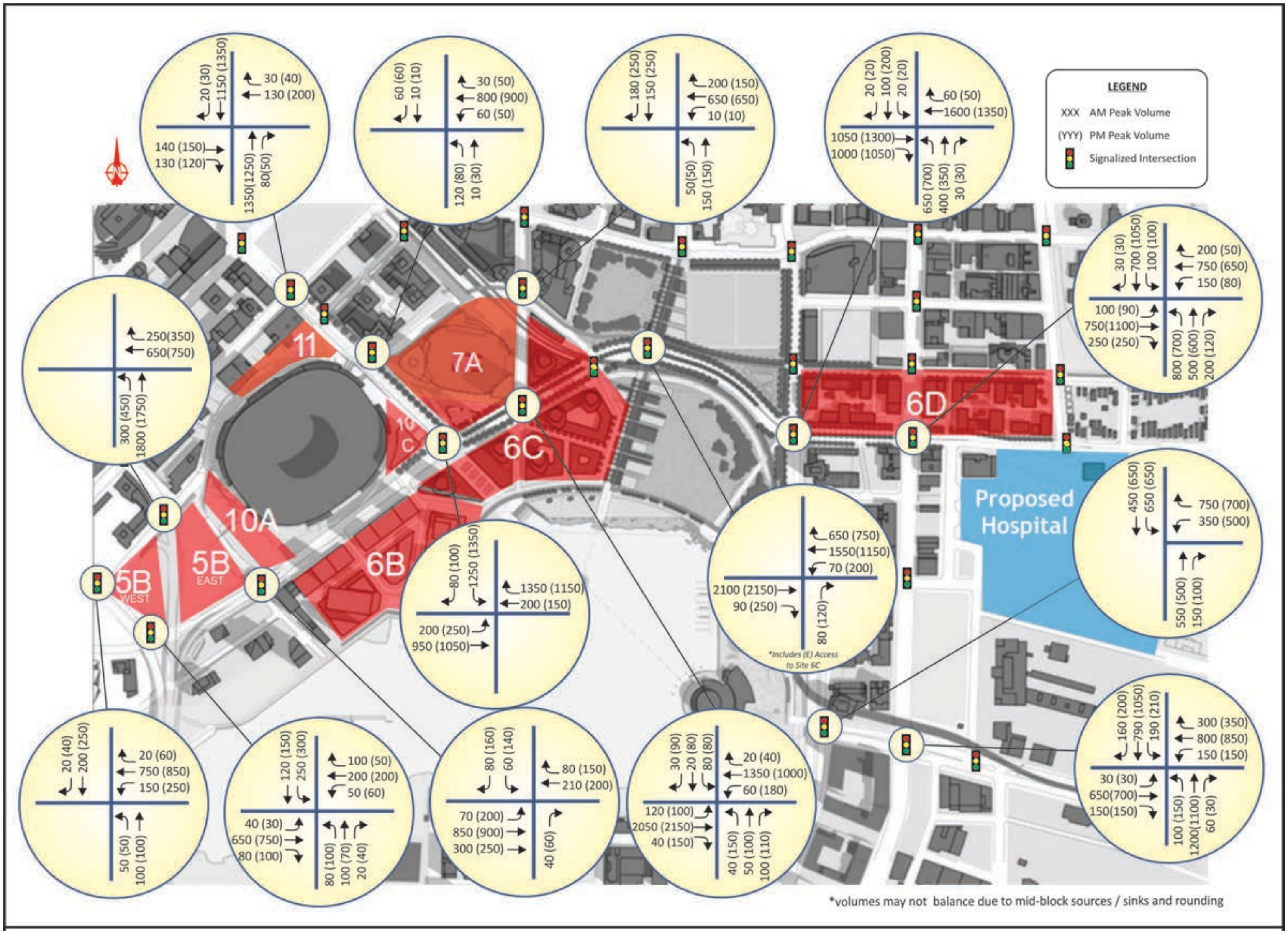


Figure 1: NEFC Replacement Network Traffic Volumes

2.2 Network Configuration

In the intervening period between the Phase Two Multi-Modal Transportation Assessment report (September 2015) and the current Phase Four Operational Assessment report, opportunities and constraints which were previously identified have been considered and incorporated into the latest network and subsequent detailed design. This section provides a summary of major network changes, descriptions of key intersections, and proposed improvements to active transportation and transit within the NEFC.

2.2.1 Summary of Vehicle Network Updates

Two-Way Pacific Boulevard

The most significant change to the NEFC transportation network is the presence of two-way vehicular traffic along the entire length of Pacific Boulevard. During the previous Phase 2 report, it was assumed that Pacific Boulevard would operate as a one-way couplet, with two-way flow only between Quebec Street and Georgia Street. However, as the study progressed, it was determined that there are significant benefits to two-way flow along the entire length of Pacific Boulevard (extending to Cambie Street to the west) and as a result, this refined two-way concept was incorporated at the preliminary design stage.

A full assessment comparing two-way Pacific Boulevard with the one-way couplet configuration was conducted with the results detailed in the supplemental ***Appendix A*** of the Phase 2 Transportation Multi-Modal Assessment report. In summary, the findings suggest that the 2045 Viaducts replacement Two-way Pacific Boulevard network showed improved point-to-point travel times relative to the one-way couplet configuration. Average network travel times in the modelled Two-way Pacific Boulevard network are also lower than the one-way couplet network, particularly in the more congested PM peak. ***Table* 1** provides a high-level comparison between the one-way and two-way Pacific Boulevard networks.

Table 1: Comparison of One-Way and Two-Way Pacific Boulevard Network

Metric	One-way Pacific Boulevard	Two-way Pacific Boulevard
Pedestrian / Cyclist Connectivity	Prioritizes through traffic mobility over local accessibility. Higher vehicle volume on Expo Blvd increases pedestrian and cyclist exposure.	Potential for slower vehicle speeds provides a more inviting atmosphere for pedestrians.
		Offers a more pleasant experience to cyclists and pedestrians and is easier to implement a complete street approach.
Vehicle Throughput on Pacific Blvd	Achieves higher capacity for eastbound through traffic but increases delays at downstream traffic signals such as at Quebec / Pacific and Main / Terminal. No westbound route along Pacific Blvd.	Lower eastbound throughput west of Pacific Blvd / Georgia Street. Provision for westbound traffic on Pacific Blvd provides improved network resiliency.
Traffic Operations	Increase in "Vehicle Kilometres Travelled" from prioritization of through movements resulting in additional distance traveled needed to reach localized destinations. May also contribute to increased vehicle emissions.	Better traffic distribution between parallel network links leading to a decrease in "Vehicle Kilometres Traveled" by eliminating indirect routes (driving around the block to get to your destination). Lower volumes on Expo Blvd due to additional westbound Pacific Blvd link.
	Uni-directional operations may reduce the number of signalized phases required at intersections.	Bi-directional operations may increase the number of signalized phases required at intersections.
Local Access	Reduced accessibility and egress for vehicles along Pacific Blvd.	Improved block accessibility and increased access / egress to and from businesses.
	Greater wayfinding confusion among infrequent travelers to the NEFC area in the one-way couplet system.	Better visibility of businesses / storefronts, less focus on just passing through NEFC area.
Transit Network Performance	Similar to general vehicle traffic, increase in average vehicle travel time between 15-20% relative to the two-way network operations.	Similar to general vehicle traffic, decrease in average vehicle travel time between 15-20% relative to the one-way network operations. Also offers increased flexibility of bus routes with less circuitous route choice.
Bus Stop Placement	Stops on the same route (i.e. along Pacific Blvd) for opposite directions are forced to be located on two different streets (westbound on Expo Blvd and eastbound on Pacific Blvd).	Bus routes on Pacific Blvd will be able to accommodate stops on either side of the street for the same route in opposite directions therefore minimizing passenger confusion.

As shown in the above table, benefits of the two-way conversion include improved block accessibility, reduced circulation requirements, better traffic distribution between parallel network links, and safer and reduced travel speeds. Benefits to active transportation users are also derived by allowing remaining road space to be converted to protected cycle tracks.

In contrast, the one-way couplet system presents significant constraints within the NEFC network, especially at either end of the Stadium blocks as the one-way couplet restricts local block access and requires circuitous and overlapping directional traffic flows, particularly evident at the following locations and highlighted in ***Figure 2***:

- Expo Boulevard westbound left-turn at Nelson Street;
- Nelson Street southbound left-turn at Pacific Boulevard;
- Smithe Mews southbound left-turn at Pacific Boulevard;
- Pacific Boulevard eastbound left-turn to Griffiths Way; and
- Griffiths Way northbound left-turn to Expo Boulevard.

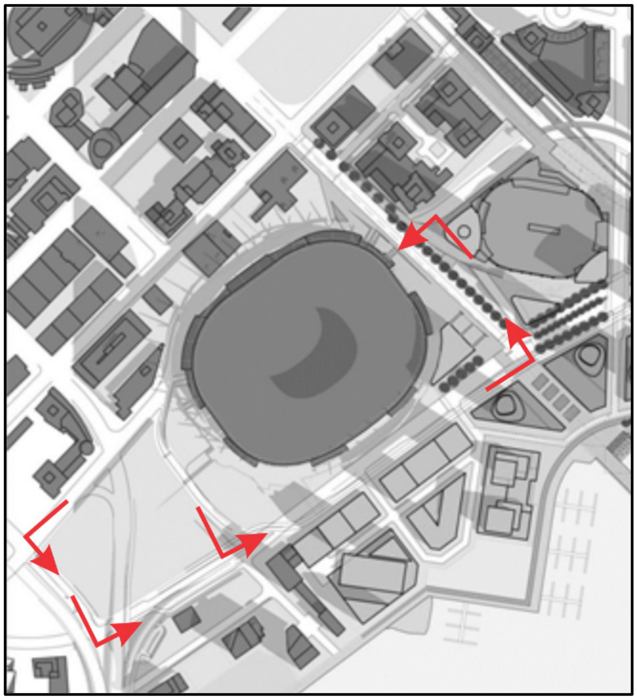


Figure 2: One-Way Pair Local Circulation Issues

As shown in ***Figure 3***, provision of a two-way street network between Nelson Street and Abbott Street improves local access / egress options for all blocks along this segment and eliminates the need for an eastbound Pacific Boulevard to northbound Griffiths Way local circulation movement at the Pacific / Georgia signalized intersection. As this intersection is forecast to carry the highest volumes, any redirection of traffic or operational flexibility achieved by removing conflicting turning movements would reduce delays for all users and increase vehicular capacity.

Based on these findings and comparing the operational impacts between a one-way couplet configuration and a two-way Pacific Boulevard network, the latter was advanced and has been incorporated into the detailed design due to its superior traffic operational characteristics.

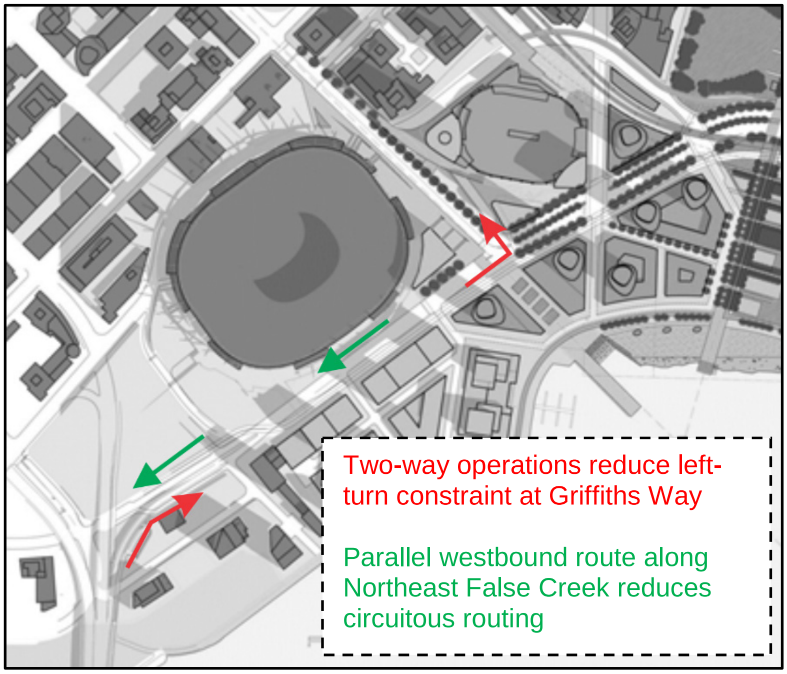


Figure 3: Two-Way Pacific Operations

Refined Intersection Configuration

Refined intersection configurations including laning and traffic signal phasing have been developed as part of the detailed design process that has progressed in the period between the conclusion of the Phase 2 report and the Phase 4 report. The latest design incorporates several of the recommendations proposed in the previous report as well as from continued input for various stakeholders and City staff.

For the full details regarding intersection specific improvements within the NEFC, refer to ***Appendix A***. It is acknowledged that the proposed intersection configurations within the Northeast False Creek Area are subject to change as design and development plans advance and therefore the observations presented within only reflect the layout available at the time this document was created (90% milestone for the detailed design). ***Figure 4*** provides an overview map showing the key intersections within the study area.

The main driver in the development of the detailed roadway design was to balance the needs for all modes while advancing the detailed design. Signal timing and signal phasing plans evolved to incorporate protected only movements for cyclists where possible; as well as a reduction to the assumed pedestrian walking speed to 1.0 m/s to ensure increased comfort for pedestrians.

Several new intersections were also added within the NEFC network which mainly provide additional development access/egress points and increase pedestrian and cyclist connectivity. These intersections service the development parcels to the south side of Pacific Boulevard and were collaboratively designed in discussion with City Staff and the developer's transportation consultant.

Along Pacific Boulevard, the provision for westbound flow stemming from two-way Pacific Boulevard operations resulted in changes to the intersections at Nelson Street, Expo Boulevard (W), and Georgia Street. These changes included the design of an east approach for vehicles including turning bays and revised signal phasing.

To future-proof the network for potential street car operations, right-of-way space was allocated for future implementation of streetcar plans along Pacific Boulevard, in addition to the strategic placement of street infrastructure to accommodate a potential future streetcar infrastructure.

Georgia Street from Howe Street to the Georgia Street ramp was also included within the scope of the detailed design process that has progressed since the Phase 2 report in 2015. A significant analysis effort was made to determine the impact of the replacement network on the downtown streets. In summary, the City has chosen a design whereby the central lane is converted to opposing left-turn bays at applicable intersections. This design increases the local block access and reduces circulation issues prevalent in the downtown network. In addition, this design offers a consistent lane alignment which can be maintained along the entire length of Georgia Street, such that vehicle lane-changing maneuvers are minimized for through traffic. This design leads to an increase to safety and overall vehicle capacity.

Overall, refinement to all intersection geometries were made to accommodate sufficient turning radii for vehicles as well as to provide adequately sized dwell areas for pedestrians and cyclists. Additional protected only signal phasing was incorporated at several locations where the need for increased safety was deemed necessary.

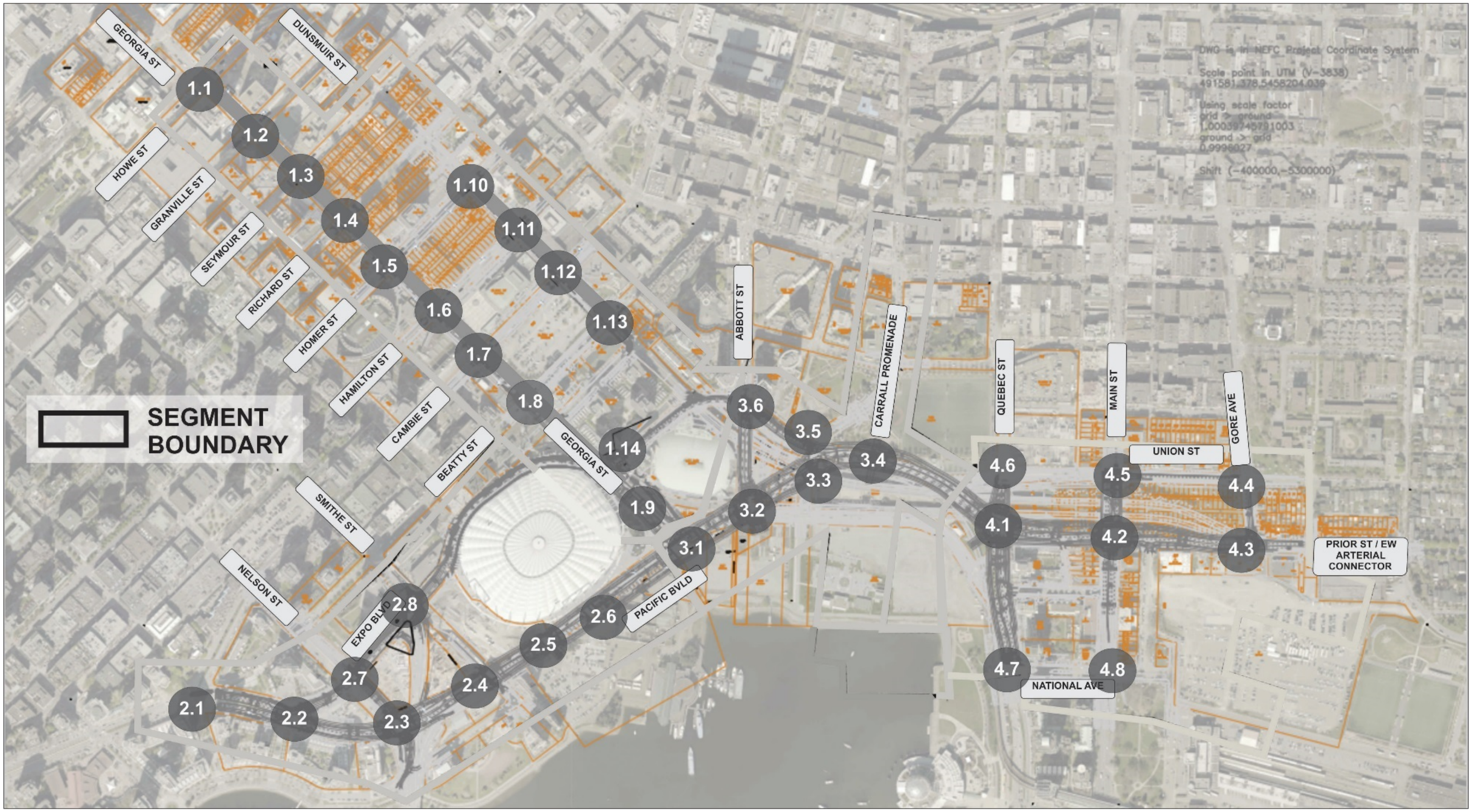


Figure 4: Northeast False Creek Overview Map of Key Intersections

2.2.2 ACTIVE TRANSPORTATION NETWORK

Enhancements to the active transportation network have been made to further encourage walking and cycling and shift trips away from automobile usage. These changes are based on consultation with City of Vancouver staff as well as supplemental analysis as described below.

Pedestrian Network

Existing pedestrian facilities on the Viaducts provide limited connections to the NEFC area, parks, and future developments due to their grade separation. Furthermore, their clear width of approximately 1.2 m do not meet current sidewalk requirements, resulting in overcrowding and posing issues for opposing wheelchair or stroller users. The proposed Viaducts replacement network will offer more direct pedestrian access to the NEFC and waterfront area and provide fully accessible pedestrian facilities that meet current best practices.

With the introduction of the New Pacific Boulevard and Georgia Ramp modifications to the NEFC network, there are several changes that will affect area walkability including the introduction of new crossing points along Pacific Boulevard. The proposed crossing point at the Georgia Ramp / New Pacific Boulevard intersection will allow for a protected crossing, providing a new convenient crossing point between the Smithe Mews and Pat Quinn Way intersections. This intersection will also allow for pedestrian travel along the new Georgia Ramp which will connect Pacific Boulevard and the NEFC area directly to the downtown core. A signalized mid-block pedestrian crossing will also be provided on the Georgia Ramp to improve accessibility between Rogers Arena and the east gate of BC Place. Additional signalized crossings will also be implemented at the Expo Boulevard slip-lane and at the new eastern access points to the future Concord Pacific development and future Plaza of Nations development site across Pacific Boulevard. Refer to ***Table 2*** for a list of the current pedestrian network design practices.

The proposed conversion of Carrall Street between Pacific Boulevard and Keefer Street includes a new and straighter alignment which restricts vehicle access and only permits pedestrians and cyclists. This allows Andy Livingstone Park to be experienced as a safer and more enjoyable space, as it reconnects the eastern and western portions into a single contiguous area. Where Carrall Street crosses new Pacific Boulevard, an at-grade signalized pedestrian crossing will be provided.

Given the importance of the five-minute walk in overall walkability, a contributing factor is the spacing of protected pedestrian crossings along the new NEFC road network. Currently, along the Pacific Boulevard segment between Nelson Street and Quebec Street, there are a total of seven signalized pedestrian crossings along a one kilometre stretch for an average pedestrian crossing spacing of one per 200 m. Note that this segment includes a 450 m segment between Smithe Mews and Abbott Street where twin overpass structures cross between BC Place Stadium and the Plaza of Nations site. Although these structures provide for a protected crossing, given the required diversion from a straight walking path and the additional distance and elevation change, these overpasses are not convenient for trips across Pacific Boulevard and presents a greater impediment to accessibility challenged persons. Due to design constraints, the future replacement network will feature the removal of the two overpasses and will be supplemented with at-grade crossings in close proximity. This will assist in increasing the permeability across Pacific Boulevard, especially with the significant proposed development to the south which will further drive crossing demands.

A similar spacing of pedestrian crossings (six crossings over 1,200 m or an average of one per 200 m) is provided on the Expo Boulevard segment between Quebec Street and Nelson Street. A 400 m segment under the BC Place plaza between Griffiths Way and Smithe Street is noted to be less comfortable for pedestrians due to the noise, vibration, and air quality effects of adjacent traffic in the tunnel. The future network will provide crossings at the same locations as noted above; however, there will be enhancements to street level crossings including improved lighting and increased greenery making the walking environment more attractive.

As the transportation network evolves, design criteria have been established to guide minimum and desirable standards for pedestrian amenities. A number of these criteria have been emerged after discussion with City of Vancouver staff and were finalized by the design team. ***Table 2*** summarizes the criteria the pedestrian network. By following the criteria, a high-quality walking environment can be implemented for usage by all ages and abilities, and non-auto modal split targets may be met or exceeded.

Table 2: NEFC Pedestrian Network Design Criteria

Item / Design Classification	BC / TAC Guidelines Criteria	City of Vancouver Standard	Project Design Criteria	Comments / Notes
Sidewalk Width	Min. 1.5 m	Min: 1.8 m Desired: 3.0 m	Min: 1.8 m Desired: 3.0 m	-
Front Boulevard Width	Min: 1.5 m Desired: 3.0 m	Min: 0.91 m Min. for Trees: 1.35 m	Min: 0.91 m Min. for Trees: 1.35 m Desired: 3.0 m	-
Back Boulevard Width	Min: 0.3 m Desired: 1.0 m	Min. Desired: 0.35m	Varies	-

Cycling Network

One of the key changes to proposed cycling infrastructure that has taken place since 2015 is the reallocation of the concept cycle facility along Georgia Street ramp to better accommodate pedestrian crush space requirements with the high forecast demand from the stadia. The remaining network throughout NEFC and the proposed Dunsmuir active bridge (connecting the grade-separated downtown network to Pacific Boulevard for pedestrians and cyclists) provides ample route options for cyclists travelling through and within NEFC. Further analysis of anticipated pedestrian volumes on the Georgia Ramp and a progression of the City's requirements for AAA bike facilities resulted in insufficient space to appropriately dedicate right-of-way for both pedestrians and cyclists (given the street width constraints created by BC Place and Rogers Arena). Based on recommendation from the Detailed Design team, City of Vancouver staff determined that sidewalk space between these two stadia is of greater importance given its safety and public realm advantages and as such have removed the sub-optimal cycling facility on the Georgia Street extension between Beatty Street and Pacific Boulevard.

With the removal of the Dunsmuir Viaduct, a replacement cycle track is necessary given the forecasted cycling travel demands and the need for separation from high vehicle volumes and speeds. Analysis was undertaken to assess that viability of a variety of options for the replacement cycle track and pedestrian link. Utilizing a Multiple Account Evaluation, options were compared for both qualitative and quantitative aspects of three separate alignments as part of a screening process with the City of Vancouver. Based on that analysis, the most likely alignment of the combined cycling and pedestrian facility, referred to as the Active Bridge, connects at the east end of Dunsmuir Street at Rogers Arena plaza and follows the south side of the SkyTrain guideway to land at grade east of Carrall Street, south of Pacific Boulevard. An extension to Quebec Street / Science World pathway and False Creek pathway will also be provided and will be incorporated with the replacement and straightening of Carrall Street north of Pacific Boulevard. A sample of the proposed alignment that was carried forward is shown in ***Figure 5***.

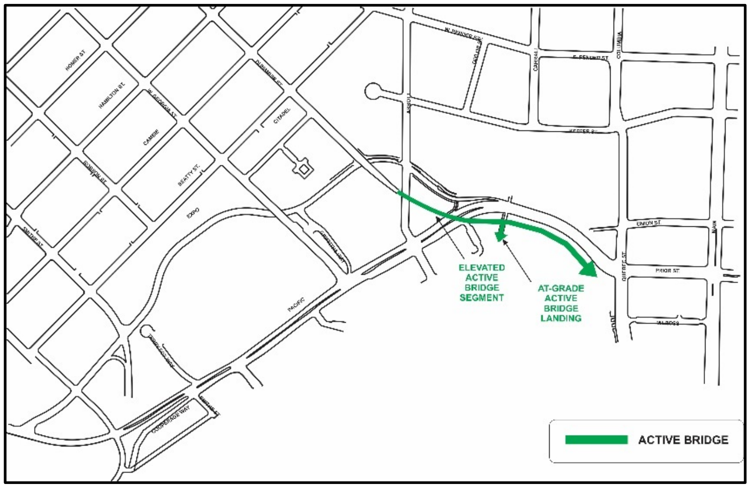


Figure 5: Conceptual Active Bridge Alignment

As with the pedestrian network, design criteria have evolved and have been established to guide minimum and desirable standards for cycling infrastructure. A number of these criteria were established in discussions with City of Vancouver staff and were finalized by the design team including WSP-MMM and Urbans Systems Ltd. The criteria are summarized in ***Table 3*** below. By following the criteria, a high-quality cycling environment can be implemented for all ages usage.

Table 3: NEFC Cycling Network Design Criteria

Item Design Classification	BC / TAC Guidelines Criteria	City of Vancouver Standard	Project Design Criteria	Comments / Notes
Design Speed	15-30 km/hr	-	15-30 km/hr	TAC 3.4.5.3 (Abs. min. 15 km/hr)
Bike Lane / Cycle Track Width	2.5-3.5	Abs Min: 2.7m Min: 3.5m Desired: 4.0m	Abs Min: 2.7m Min: 3.5m Desired: 4.5m	-
Minimum Radius	15 - 24 m	-	Min: 5m >20 m (main route) >10m (connection)	CROW (2016) 3.4 referenced for min at constrained areas
Stopping Sight Distance	9 - 35 m	-	9 - 35 m	TAC Table 3.4.5.1
Vertical Clearance	2.5 m	3.6 m	Min: 2.5m Desired: 3.6m	TAC pg. 2.1.3.13
Clearance to Lateral Obstructions	0.6 m (wall) 0.3 m (fixed objects)	-	0.6 m (wall) 0.3 m (fixed objects)	TAC Table 3.4.6.1 Crow (2016) 3.3

Overall Assessment

The pedestrian and cycling network elements incorporated into the Viaducts replacement network design provide a significant safety and connectivity enhancement to the existing network. Specifically, the following enhancements are included:

- New signalized crossings for pedestrians at Georgia / Pacific, mid-block on the Georgia Ramp, Site 6C access, Expo Boulevard slip-lane, and mid-block on Pacific Boulevard between Georgia Ramp and Smithe Mews will all serve to enhance the safety and convenience of the pedestrian network, allowing for more direct walking trips between adjacent land uses.
- Additional protected only signal phases at select intersections where increased safety and comfort for active road users was deemed necessary.
- Updated design criteria for the pedestrian network.
- A new and more direct pedestrian / cyclist connection along Carrall Street to False Creek, along with a closure of Carrall Street to vehicular traffic.
- Reallocation of concept cycle facility along Georgia Street ramp to better accommodate pedestrian crush space requirements with the high forecast demand from the stadia.
- An active bridge with wider, higher active mode capacity, and more aesthetically pleasing linkage between downtown, the NEFC and existing historic neighbourhoods.
- New AAA infrastructure and protected bicycle facilities along Quebec Street from Union Street to Terminal Avenue, Pacific Boulevard – Prior Street from Cambie Street to Gore Ave, and Expo Boulevard from Carrall Promenade to Cambie Street.
- Lays the groundwork to further extend the AAA network to connect False Creek and the Waterfront, Southeast Vancouver to the Central Business District and Union / Adanac Street to Helmcken Street.

2.2.3 TRANSIT NETWORK

Similar to the active transportation network, several enhancements to transit will be realized with the Viaducts replacement network. These improvements are detailed below.

Bus Network

As described in the Phase 2 report, transit trips are anticipated to account for over 10% of the trips to / from NEFC development blocks. The resultant peak hour passenger demand is forecast to exceed 1,000 passengers per hour two-way. At a capacity of 40 passengers per full size bus, a total of 25 buses per hour would be required to service peak demand. Split into inbound and outbound trips, this would imply 12 to 13 full size buses per hour per direction and a schedule headway of 5 minutes.

Increased future densification of adjacent development parcels will increase the demand for trips destined to and originating from the Northeast False Creek. The replacement network will allow for bus route adjustments to consolidate split routes along the two-way network (bi-directional Pacific Boulevard) and better service adjacent activity and development centres which are concentrated to the south side of Pacific. The provision for recessed bus bays where applicable also allows for bus boarding and alighting to be made without impact to through traffic. Bus passenger dwell areas are also separated from the dedicated cycle tracks and any potential conflict areas between bus bound pedestrians and crossing cyclists will have clear sign and paint markings.

Skytrain Network

Millennium Line Extension to Arbutus

Completion of TransLink's Phase 2 report on the evaluation of potential alternative transit scenarios between Commercial-Broadway SkyTrain station and the UBC campus has yielded several potential options for improved transit along the corridor. ***Figure 6*** shows the latest concept that proposes approximately 6 km of SkyTrain track extending from VCC-Clark to Arbutus under Broadway. Six stations are proposed along the route with additional B-line bus service linking Arbutus with UBC.

Figure 6: Millennium Line Extension to Arbutus (source: TransLink)

The new connection between the Millennium Line and the Canada Line at Cambie d/ Broadway provides a more robust and resilient transit network that will help to further increase the active / transit mode share and shift trips away from automobile usage.

Although specific alignments and technology have yet to be assessed, both the Hastings Street and Main / Fraser transit priority corridors will provide additional transit options to future NEFC residents and employees and provide options for existing and future background vehicle trips. To maintain service frequency and efficiency as ridership builds and background congestion increases, additional transit priority measures such as enhanced signal priority have been considered as part of the City's strategy to upgrade the existing traffic signal infrastructure.

Overall Assessment

The Viaducts replacement network will offer a number of benefits to existing and future transit users, including:

- New westbound bus routes along Pacific Boulevard accommodated by the two-way Pacific Boulevard network, west of Georgia Street.
- Recessed bus bays will reduce the impact to through traffic caused by boarding and alighting.
- Sufficiently sized bus passenger dwell facilities and increased signage and paint marking are incorporated at locations where there are conflicts between protected cycling facilities and pedestrians.
- Ongoing investigations into new traffic signal infrastructure are being made to further optimize transit flows.
- Bus route adjustments will consolidate split routes along the two-way network (bi-directional Pacific Boulevard) and better service adjacent activity and development centres which are concentrated to the south side of Pacific.
- Progression of design of the Broadway Line spur.

3.0 ANALYSIS SCENARIOS

Operational testing of the proposed changes to the NEFC transportation network was accommodated using the PARAMICS microsimulation software. Four distinct travel demand scenarios were run for comparative purposes. The scenarios were selected to isolate the incremental effects of the Viaducts replacement network and the forecast growth within NEFC development parcels. These are described as follows and summarized in ***Table 4***.

- **2014 existing network** represents modelled existing conditions using the 2011 RTM background volumes and adjustments based on traffic counts conducted in 2014. This serves as a reference point for all future scenarios.
- **2045 Viaducts replacement network no net traffic growth** represents conditions in the absence of any net vehicular traffic growth between the current base and the future horizon of 2045. The only major difference is the replacement of the Viaducts network. NEFC vehicular traffic volumes are assumed to either displace an equivalent number of existing trips on the network or be converted to transit, walk or bike trips as per Transportation 2040 objectives. This scenario represents the best estimate of future forecast traffic demands on the replacement network.
- **2045 existing network full traffic growth** is a hypothetical scenario whereby the equivalent level of development forecast within the NEFC blocks is accommodated without any change to the existing transportation network. As retention of the Viaducts would likely conflict with the space required to achieve forecast densities, this scenario is intended for comparative testing in the model environment only. The more conservative full traffic growth impacts have been included.
- **2045 Viaducts replacement network full traffic growth** is a scenario which evaluates the effects of all the contemplated changes to the NEFC transportation and land use networks. This would represent achievement of all potential development totals and implementation of all aspects of the Viaducts replacement network. The more conservative full traffic growth impacts have been included.

Table 4: NEFC PARAMICS Model Analysis Scenarios

Scenario	Run ID	Horizon Year	NEFC Development?	Viaducts in Place?
2014 existing network	AMEX PMEX	2014	×	✓
2045 Viaducts replacement network with no net traffic growth	AM2045NoGrowth PM2045NoGrowth	2045	✓ - assumes no resultant net vehicular traffic growth	×
2045 existing network full traffic growth	AM2045Full PM2045Full	2045	✓	✓
2045 Viaducts replacement network full traffic growth	AM2045FullNew PM2045FullNew	2045	✓	×

To assess the latest Viaducts replacement network scenarios, the geometrics for the road network as described in ***Appendix A*** were coded into the PARAMICS model environment. An overview of the assumed network is shown in ***Figure 7***.

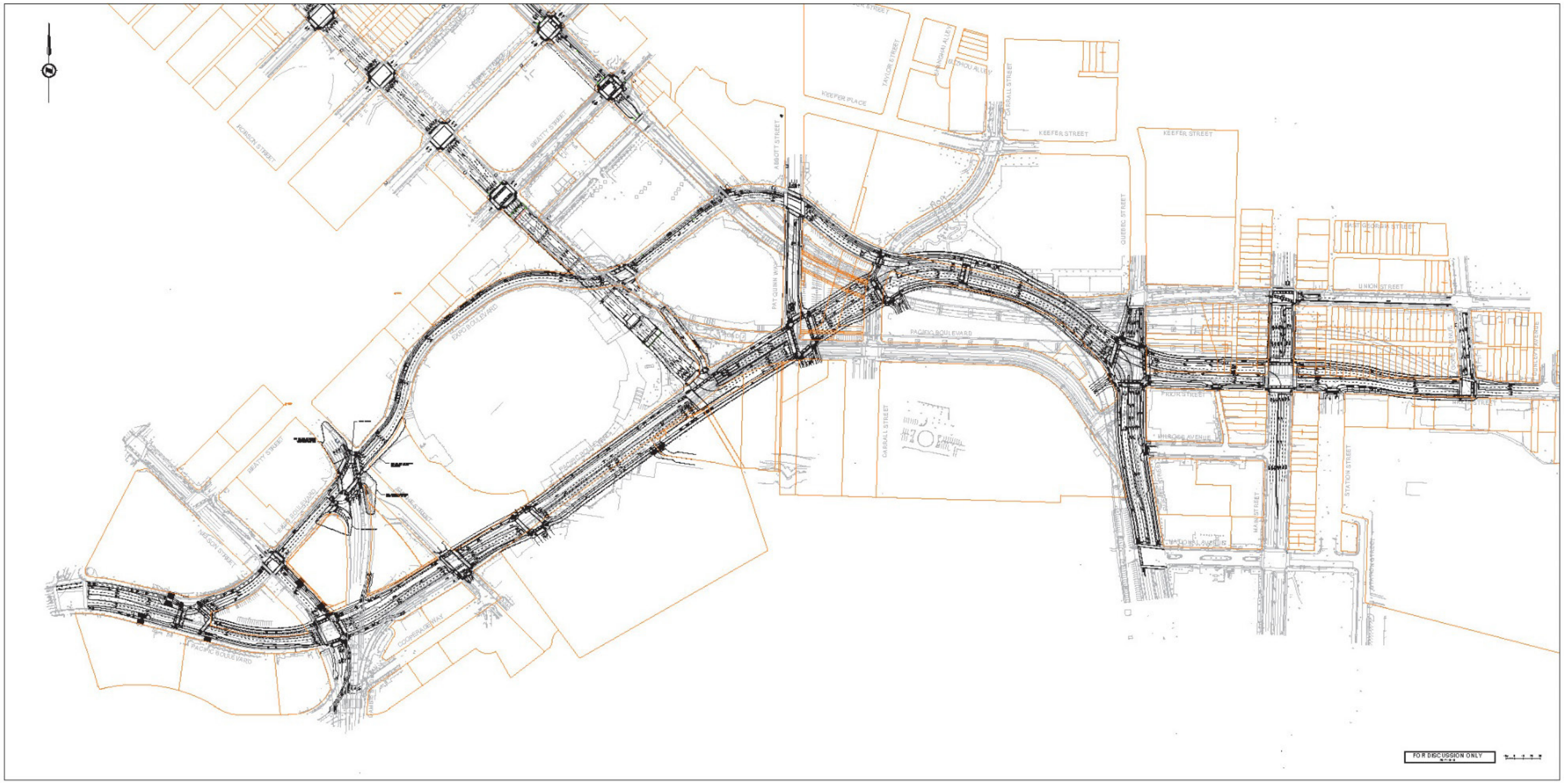


Figure 7: NEFC Replacement Network Overview

4.0 REPLACEMENT NETWORK ASSESSMENT RESULTS

Using the updated transportation network and development scenario assumptions described in the previous sections, the microsimulation PARAMICS model was run to generate a variety of descriptive traffic performance statistics. Of particular interest were the following performance metrics.

4.1 Total Vehicles Processed

The volume of total vehicles processed is a metric used to confirm that the full travel demand is capable of being accommodated by the transportation network as coded within the model. If congestion results in blockage to intersections or traffic loading zones, the processed model volume will fall below the total applied demand. Models with blocking issues can result in unreliable comparative metrics due to excessive delay imposed on selected vehicles and exaggerated route diversion effects. The metric is also useful for gauging the total level of traffic activity in each scenario.

Figures 8 and ***9*** show the total model demand plotted against the actual processed demand for each of the three scenarios in the AM and PM peak, respectively. Note that each model was run using seven randomly generated "seeds" to ensure consistency and avoid statistical outliers in the reporting.

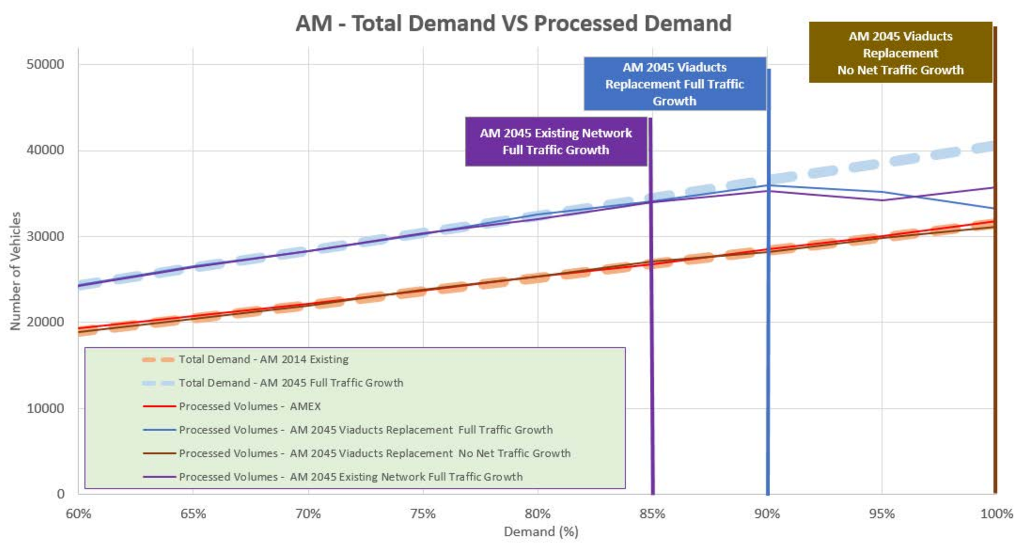


Figure 8: AM Peak Scenarios Vehicle Processing Comparison

As shown, for the AM peak period, the 2045 Viaducts replacement network no net traffic growth and 2045 Viaducts replacement network full traffic growth models are capable of processing between 100% and 90% of assigned demand, respectively, before divergence between assigned and processed demand is evident. The AM 2045 existing network full traffic growth model processes between 5% and 15% less traffic than the other scenarios.

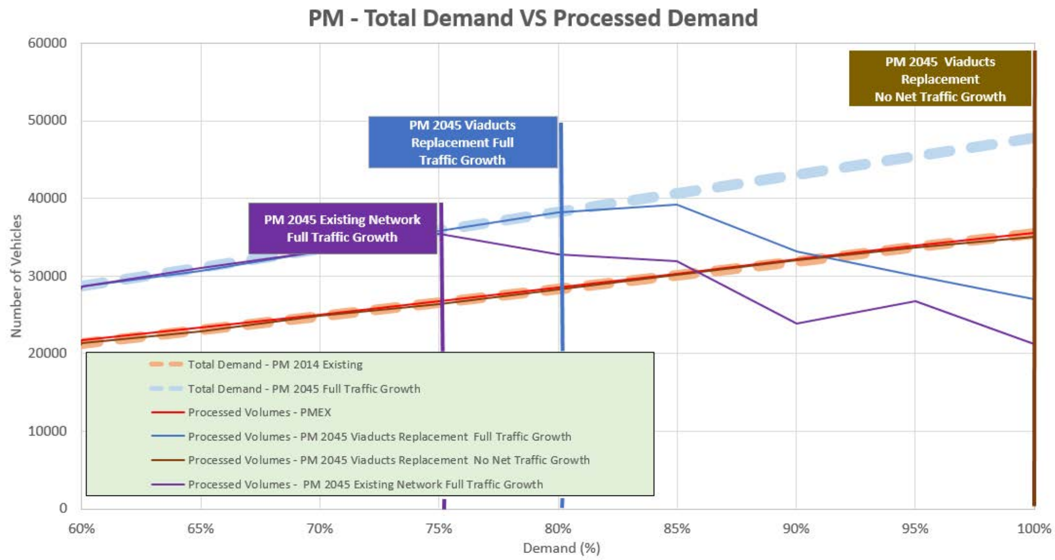


Figure 9: PM Peak Scenarios Vehicle Processing Comparison

For the PM peak period, the 2045 Viaducts replacement no net traffic growth and 2045 Viaducts replacement network full traffic growth models are capable of processing between 100% and 80% of assigned demand, respectively. The PM 2045 existing network full traffic growth processes 5% to 25% less traffic than the other scenarios.

In both the AM and PM peak periods, the existing network operates worse than the viaducts replacement network due to the compromised distribution of new development traffic and limited accessibility within the Viaducts footprint. Of particular note is that new development traffic distributed to / from the east does not have a viable option to utilize the future False Creek Flats arterial due to the location of the Viaducts ramp footprint in the vicinity of Main Street / Union Street. The Viaducts replacement scenarios allow this easterly oriented traffic to distribute more equally between Terminal Avenue and the future False Creek Flats arterial thereby reducing network delays. Results for the 2045 no net traffic growth and the constrained 2045 full traffic growth demand scenarios are presented separately in greater detail in the following sections.

In both the AM and PM models, the replacement network is able to accommodate increased 2045 traffic demand compared to the existing road network, which demonstrates that the existing grade separated network is less compatible with attaining build out of the NEFC development blocks.

4.2 Scenario A – 2045 No Net Traffic Growth

The summary of results and statistics for the 2045 no net traffic growth travel demand scenarios are presented below with full details regarding point-to-point travel times and detailed operational assessments for each intersection found ***Appendix B***.

4.2.1 Average Network Travel Time

Average network travel time represents the aggregate time that all vehicles spend within the model network between their origin and destination. This global statistic is divided by the total number of vehicles processed to create a measure of average travel time per vehicle. It is a single network-wide statistic and allows for easy comparison across scenarios by capturing all possible trip types, origins and destinations. The results of the average network travel time statistics are shown in ***Tables 5*** and ***6***. Of interest is the change relative to the calibrated model base. For each scenario, the maximum stable processing capacity was used as the reference point, acknowledging that the more vehicles added to the network, the more cumulative travel time and delays would be imposed on the network.

Table 5: AM Peak Network Travel Time Statistics

	AM	
	AM 2014 Existing Network	AM 2045 Viaducts Replacement Network No Net Traffic Growth
Demand Processed (%)	100%	100%
Total Number of Vehicles Processed	31,761	31,101
Average Network Travel Time Per Vehicle (Minutes)	4.0	5.2
Percent Difference from Base Travel Time	N/A	+31 %

Reviewing the AM peak results, the Viaducts replacement network scenario shows a minor increase in delay per vehicle (approximately one minute) as a result of the blending of Viaducts and surface street traffic as well as new network signals.

Table 6: PM Peak Network Travel Time Statistics

	PM	
	PM 2014 Existing Network	PM 2045 Viaducts Replacement Network No Net Traffic Growth
Demand Processed (%)	100%	100%
Total Number of Vehicles Processed	35,605	35,300
Average Network Travel Time Per Vehicle (Minutes)	4.7	5.6
Percent Difference from Base Travel Time	N/A	+20 %

Reviewing the PM peak results, the Viaducts replacement network scenario shows a minor increase in delay per vehicle (just under a minute) as a result of the blending of Viaducts and surface street traffic as well as new network traffic signals.

4.2.2 POINT TO POINT TRAVEL TIMES

Point to point travel times focus on the journey time between key origins and destinations within the model. Typically, these represent routes between major arterial streets that carry the majority of the traffic volume. The point to point metric allows for closer tracking of the changes in individual routes due to congestion and physical / operational changes as well as differences between dominant AM and PM peak flow patterns. For the full details regarding point-to-point travel times and detailed operational assessments for each intersection, refer to ***Appendix B***.

A summary of point-to-point travel times comparing identical routes from the Phase 2 and Phase 4 reports relative to the existing base is provided in ***Table 7***. The green and red arrows provide an indictor to show whether the Phase 4 (2018) bi-directional Pacific Boulevard network travel time has increased or decreased relative to the Phase 2 (2015) one-way Pacific Boulevard couplet network.

Table 7: Select Point-to-Point Travel Time Comparison Relative to the Existing Base (2045 No Net Traffic Growth)

Period	Route	Origin	Destination	Existing (min)	2045 No Net Traffic Growth		
					Phase 2 *(2015 Network)* (min)	Phase 4 *(2018 Network)* (min)	
AM	Westbound	Main Street / Terminal Avenue	Pacific Boulevard / Cambie Street	5.8	+3.4	+3.1	↓
		Main Street / Terminal Avenue	Dunsmuir Street / Cambie Street	5.9	+3.4	+2.2	↓
		Prior Street / Gore Avenue	Dunsmuir Street / Cambie Street	3.7	+1.2	+2.1	↑
	Northbound	Main Street / Terminal Avenue	Main Street / Union Street	1.7	+0.7	+1.8	↑
PM	Eastbound	Pacific Boulevard / Cambie Street	Main Street / Terminal Avenue	6.2	+1.2	+2.5	↑
		Dunsmuir Street / Cambie Street	Main Street / Terminal Avenue	3.3	+3.4	+4.9	↑
		Dunsmuir Street / Cambie Street	Prior Street / Gore Avenue	2.5	+3.0	+4.8	↑
	Southbound	Main Street / Union Street	Main Street / Terminal Avenue	3.4	+0.4	+0.4	No change

↓ Travel time **reduction** relative to Phase 2 One-Way Pacific Blvd Couplet (2015)

↑ Travel time **increase** relative to Phase 2 One-Way Pacific Blvd Couplet (2015)

In general, based on the selection of key routes in the peak directions, the Phase 4 (2018) two-way Pacific Boulevard network with refined design elements and accommodation of improved pedestrian and cycling connections generally yields increased travel times for the eastbound direction in the PM relative to the Phase 2 (2015) one-way Pacific Boulevard couplet network when using the 2045 No Net Traffic growth scenario.

The reasons for the travel time increases stem from to the addition of several signalized intersections (driven by the need for additional development access points) that were not part of the design during the 2015 Phase 2 report (as previously shown in ***Figure 1***). In addition, formalization of protected only cycling facilities and additional pedestrian connections has led to changes in signal phasing and roadway geometry that can lead to an increase in vehicular delays. It should be noted however that these active transportation connections are an important component in creating a robust and comprehensive walking and cycling network that will help to reduce future automobile mode share.

In the AM westbound direction, travel times were shown to generally improve relative to the Phase 2 (2015) one-way couplet network. This is likely due to the provision of an additional westbound route along Pacific Boulevard (bi-directional) which splits the westbound demand along two parallel roadways (Expo Boulevard and Pacific Boulevard).

For further details regarding intersection operations and anticipated volumes for the 2045 no net traffic growth scenario, refer to ***Appendix B***.

4.3 Scenario B – 2045 Full Traffic Growth

The summary of results and statistics for the 2045 full traffic growth travel demand scenarios are presented below with full details regarding point-to-point travel times and detailed operational assessments for each intersection found ***Appendix C***.

4.3.1 Average Network Travel Time

The results of the average network travel time statistics are shown in ***Tables 8*** and ***9***. Of interest is the change relative to the calibrated model base. For each scenario, the maximum stable processing capacity was used as the reference point, acknowledging that the more vehicles added to the network, the more cumulative travel time and delays would be imposed on the network.

Table 8: AM Peak Network Travel Time Statistics

	AM		
	AM 2014 Existing Network	AM 2045 Existing Network Full Traffic Growth	AM 2045 Viaducts Replacement Network Full Traffic Growth
Demand Processed (%)	100%	85%	90%
Total Number of Vehicles Processed	31,761	33,996	36,000
Average Network Travel Time Per Vehicle (Minutes)	4.0	4.5	5.2
Percent Difference from Base Travel Time	N/A	+14 %	+31 %

Reviewing the AM peak results, the Viaducts replacement network scenario shows a minor increase in delay per vehicle (just over one minute) as a result of the blending of Viaducts and surface street traffic as well as new network signals. Provision of the 2045 existing network reduces average travel time increases; however, this network processes 5% less traffic volume than the Viaducts replacement network due to the limited accessibility and local traffic distribution flexibility.

Table 9: PM Peak Network Travel Time Statistics

	PM		
	PM 2014 Existing Network	PM 2045 Existing Network Full Traffic Growth	PM 2045 Viaducts Replacement Network Full Traffic Growth
Demand Processed (%)	100%	75%	80%
Total Number of Vehicles Processed	35,605	35,425	38,201
Average Network Travel Time Per Vehicle (Minutes)	4.7	4.7	4.9
Percent Difference from Base Travel Time	N/A	0 %	+7 %

Reviewing the PM peak results, the Viaducts replacement network scenario shows a nominal increase in delay per vehicle as a result of the blending of Viaducts and surface street traffic as well as new network signals. Provision for maintaining the Viaducts in the existing full growth forecast scenario avoids average travel time increases; however, results in less traffic volume being processed than the Viaducts replacement network due to the limited accessibility and local traffic distribution flexibility. The maximum traffic volume that can be processed without significant queuing and congestion setting in is approximately equal to the current network volume. The 2045 Full Development with Viaducts replacement network shows a moderate increase in delay per vehicle due to the combination of NEFC and local traffic volume growth; however, this network also has the capacity to process the highest total number of vehicles.

4.3.2 POINT TO POINT TRAVEL TIMES

A summary of point-to-point travel times comparing identical routes from the Phase 2 and Phase 4 reports relative to the existing base is provided below in ***Table 10***. The green and red arrows provide an indictor to show whether the Phase 4 bi-directional Pacific Boulevard travel time has increased or decreased relative to the Phase 2 one-way Pacific Boulevard couplet network.

Table 10: Select Point-to-Point Travel Time Comparison Relative to the Existing Base (2045 Full Traffic Growth)

Period	Route	Origin	Destination	Existing (min)	2045 Full Traffic Growth		
					Phase 2 (2015 Network) (min)	Phase 4 (2018 Network) (min)	
AM	Westbound	Main Street / Terminal Avenue	Pacific Boulevard / Cambie Street	5.8	+3.4	+2.0	↓
		Main Street / Terminal Avenue	Dunsmuir Street / Cambie Street	5.9	+5.4	+1.0	↓
		Prior Street / Gore Avenue	Dunsmuir Street / Cambie Street	3.7	+7.0	+3.4	↓
	Northbound	Main Street / Terminal Avenue	Main Street / Union Street	1.7	+0.6	+1.0	↑
PM	Eastbound	Pacific Boulevard / Cambie Street	Main Street / Terminal Avenue	6.2	+1.6	+2.0	↑
		Dunsmuir Street / Cambie Street	Main Street / Terminal Avenue	3.3	+1.7	+2.0	↑
		Dunsmuir Street / Cambie Street	Prior Street / Gore Avenue	2.5	+2.7	+2.1	↓
	Southbound	Main Street / Union Street	Main Street / Terminal Avenue	3.4	+3.2	+1.0	↓

↓ Travel time **reduction** relative to Phase 2 One-Way Pacific Blvd Couplet (2015)

↑ Travel time **increase** relative to Phase 2 One-Way Pacific Blvd Couplet (2015)

A comparison of the Phase 2 (2015) one-way Pacific Boulevard couplet network and Phase 4 (2018) two-way Pacific Boulevard network with refined design elements and accommodation of improved pedestrian and cycling connections generally yields reductions to most point-to-point travel times despite the additional signalized intersections and protected only cycle tracks when using the 2045 full traffic growth scenario.

The travel time reductions relative to the Phase 2 (2015) network can be attributed to the fact that as development infills to the properties south of Pacific Boulevard, traffic becomes more concentrated along this segment with a significant increase to localized trips within the NEFC. The one-way couplet network functions poorly as drivers must use circuitous routes, particularly circulating around the stadia with overlapping directional flows, to reach their destination. For further details regarding intersection operations and anticipated volumes for the 2045 full growth scenario refer to ***Appendix C***.

4.3.3 OVERALL VEHICLE NETWORK ASSESSMENT

The proposed Viaducts replacement network can accommodate all of the traffic in the system today, and if Transportation 2040 objectives are achieved it can accommodate all of the future traffic as well with minor increases in average network delay. For the conservative case of regional and local development growth leading to an increase in vehicle volumes, the Viaducts replacement network accommodates more new traffic than the existing Viaducts network but reaches the upper limit at approximately 80% of the theoretical future network demand. The 80% threshold reflects the practical upper limit of volume that can be processed given the upstream and downstream network constraints at existing intersections.

Screenline traffic counts for vehicles entering and exiting the downtown core over the past 20 years indicate that despite increased densification, vehicle trips entering the downtown have actually declined by approximately 15%. This can be attributed to the City's goal of reducing vehicular traffic volume while continuing to accommodate population and employment growth as proposed in the Transportation 2040 plan. Based on the wealth of data revealing current trends and considering the City's policy of prioritizing road space to active modes and transit City wide, a no net traffic growth scenario was deemed to be the appropriate scenario for modelling and designing the replacement network.

An important overall observation is that “control” signals along the NEFC periphery are currently capacity constrained and will serve to further limit traffic growth to / through the future NEFC network. These locations include the following:

- Prior Street eastbound and westbound at Gore Avenue;
- Nelson Street southbound at Expo Boulevard;
- Main Street northbound and southbound at Terminal Avenue; and
- Quebec Street northbound and southbound at Terminal Avenue.

As the NEFC develops over many years and improvements to transit, cycling, and pedestrian networks are brought online, vehicle trip generation rates will stabilize and fall toward City targets. Early developments may demonstrate unconstrained vehicle trip rates, but as a compatible mix and density of surrounding land uses fill in and background congestion rises, there may be a long-term convergence towards the constrained rates.

As demonstrated by the comparative micro-simulation analysis scenarios, the benefits of the grade separation for through traffic are marginal when compared with the accessibility and traffic distribution benefits of New Pacific Boulevard and the replacement network.

5.0 CONSTRUCTION PHASING ASSESSMENT RESULTS

Construction phasing plans have been developed as part of the detailed design process which includes nine distinct stages of construction for the removal of the Viaducts and ensuing upgrades to the surrounding network. The work will also include construction of the Georgia Street Ramp, realignment of Pacific Boulevard, and implementing a new westbound route along Pacific Boulevard connecting through to Cambie Street. Significant utilities upgrades will also be undertaken to support growth and development within the Northeast False Creek area.

Based on these plans, it was determined that the most disruptive period for traffic operations occurs when Dunsmuir Viaduct is converted to two-way operations and Georgia Viaduct is simultaneously demolished (Georgia Ramp is not active at this point). Preliminary analysis of this "worst-case" construction phase was undertaken during the first iteration of this report and can be found in ***Appendix D***. A summary of these initial findings is provided below:

- Average network travel time per vehicle increased by 20% (one minute) and the average vehicle speed decreased 10% from 23 to 20 km/h. The analysis found that moderate travel time increases occur (especially in the PM peak) for eastbound traffic via the two-way Dunsmuir Viaduct detour by 207% (over five minutes). Other key routes which are prone to moderate travel time increases include Hastings Street, Pender Street, and the Cambie Bridge as these serve as parallel routes into and out of downtown.
- Moderate increases to vehicular volume were also observed along Cambie Street and Beatty Street as a result of vehicles being forced to turn onto alternative streets due to the Georgia Viaduct closure. It is recommended that protected eastbound left-turn phases be provided for vehicles on Georgia Street to better facilitate these movements.
- Alternate routes into NEFC and downtown were shown to experience increases to vehicular volume of up to 250 vehicles per hour in the peak periods along the Cambie Bridge, Pender Street, and Hastings Street but will stay within their capacity limits.
- Findings suggest that concurrent construction projects in the vicinity should be coordinated to minimize compounding traffic disruption.

As part of the detailed design process, the construction phasing plans were further refined to ensure that the timing of construction activities could accommodate all utilities relocations and associated construction works. As a result, a construction traffic management report was developed to provide specifications for minimum transportation design criteria including identifying the required number of vehicle travel lanes as well as potential detour routes during each stage. In addition, impacts to walking and cycling routes, transit, parking, and event management among others are identified. A summary of the Traffic Management Report findings is provided as follows:

- The transportation network can maintain acceptable traffic operations during all stages of the proposed construction process through the careful implementation of appropriate traffic management plans and travel demand management strategies, well positioned advisory signage, targeted media communications, and continued traffic monitoring to provide feedback on the current conditions.
- The minimum transportation design criteria are provided which forms the baseline to ensure that there is sufficient capacity during each construction stage. This is accomplished by establishing the minimum number of travel lanes, identifying locations for temporary intersections, and proposing adjustments to signal phasing.
- It is important to maintain a direct connection between downtown and the False Creek Flats during all phases of construction. This can be accommodated either through the existing viaducts or through the proposed replacement network via new Pacific Boulevard and Prior Street.
- Two major vehicle detour routes are proposed that will be in place for multiple stages of construction:
  - **Pacific Boulevard Detour** – situated south of the existing Pacific Boulevard alignment between Smithe Street and Quebec Street. Expo Boulevard is closed between Quebec Street and Carrall Street with the Pacific detour providing two-way operations along this segment. Carrall Street is reconfigured to provide a temporarily arterial connection between the Pacific Boulevard detour and Expo Boulevard. The detour will require the temporary installation of up to two new signals with significant modifications to an additional three.
  - **Dunsmuir Viaduct Detour** – maintains a direct eastbound and westbound connection to the False Creek Flats during the Georgia Viaduct removal phase. The Dunsmuir cycling facility will be retained with two-way vehicular operations proposed to span to Homer Street along Dunsmuir Street. Signal modifications will be required at several intersections along Dunsmuir to facilitate two-way flow. This option retains the flexibility to add additional vehicle capacity if needed by reserving the need to relocate the active facility. This may only be warranted based on observations of construction traffic conditions.

- Temporary Dynamic Messaging Signs (DMS) should be placed at strategic points throughout the City to provide awareness of the changing construction conditions and to advise motorists of alternative routes.
- There will be a temporary reduction to local block access; however, there will remain at least one non-impacted access to each major development to ensure that a minimum level of accessibility is maintained.

6.0 STUDY CONCLUSIONS

Since the conclusion of the Phase 2 Multi-Modal Transportation Assessment Report (2015) the design of the viaducts replacement network has undergone significant changes based on previous recommendations as well as from continued engagement with various stakeholders. This document (Phase 4 Operational Assessment) provides an updated operational analysis of the proposed Georgia and Dunsmuir Viaducts replacement network and identifies the progression of the design of the multi-modal network from the previous report. The analysis has been undertaken using a combination of macro and micro-scopic level traffic analysis tools which enables forecasting of development traffic impacts, and multi-modal network geometry and operations. A summary of the findings is provided below:

i. The Viaducts replacement network can accommodate today's traffic volumes with minor increases in travel time of approximately one to five minutes during the peak periods, depending on the route. Minor vehicle volume increases to parallel streets are forecast; however, these diversionary trips are within the capacity of the existing roadways;

ii. Two-way Pacific Boulevard provides improved network and point-to-point travel times, improved block accessibility, reduces unnecessary circulation around the stadia, better traffic distribution between parallel network links, and safer and reduced travel speeds.

iii. Given the City's recent success in reducing vehicular volumes while accommodating increased density and active mode share, a no net traffic growth scenario is deemed appropriate for the modelling and design of the replacement network.

iv. The Viaducts replacement network will enable increased accessibility to new developments due to the reduction in circuitous routing (caused by the existing one-way couplet arrangement) which better distributes local traffic;

v. Significant walking and cycling improvements as part of the Viaducts replacement network will further support the City's initiative of reducing automobile usage and shifting two-thirds of all trips to alternative modes of transportation. These multi-modal network improvements are essential towards meeting the City's Transportation 2040 goals of increased mode split for active transportation and transit and no net increase to current vehicle volumes on City streets;

vi. A number of optimization strategies identified in the previous Phase 2 report have been incorporated. These alterations were further tested to determine their full benefits and if the physical changes required at the street level were feasible. These optimizations include:

a. Management of left-turn movements from New Pacific Boulevard and Georgia Street extension;

b. Additional pedestrian crossing opportunities;

c. Reviewing locations for active facilities including removing of the concept cycle tracks along the Georgia Street extension to better accommodate high pedestrian demands emanating from the stadia.

vii. The City's Transportation 2040 plan has established three future rapid transit corridors of interest to the NEFC study including the Broadway Line, as well as conceptual transit priority enhancements along the Hastings Street corridor and the Main Street / Fraser Street corridor. These improvements could service additional transit trips for the NEFC developments, with a shift toward the eastern study area, bringing the NEFC closer to its Transportation 2040 goals;

viii. Events occurring at the stadia shall continue to be accommodated by providing comparable on-street staging capacity to what is currently available. In addition, improvements to pedestrian permeability in the network from the introduction of the Georgia Ramp connection between Beatty Street and Pacific Boulevard will result in better utilization of stadia accesses. The Viaducts replacement network will also maintain acceptable traffic operations in the local and overall road network through the careful use of appropriate traffic management plans, well positioned advisory signage, targeted media communications, and continued traffic monitoring before, during, and after events. The full event management strategies report is covered in a separate Phase 3 Event Management Strategies report; and

ix. Construction impacts stemming from the Viaducts removal and associated network changes has been assessed in a related detailed design study to determine the minimum transportation design criteria for each construction stage and to identify key impacts to pedestrians / cycling facilities, parking, local block access, and transit among others.

APPENDIX A

Intersection Specific Details

This section presents intersection specific commentary for each of the major intersections within the project study area with an accompanying figure highlighting the proposed layout and signal phasing.

EXPO (WEST) / PACIFIC

The proposed intersection configuration of Expo Boulevard (West) / Pacific Boulevard is shown in ***Figure A.1*** and ***Figure A.2*** presents the proposed signal phasing. The configuration offers dual southbound right turns from Expo Boulevard to westbound Pacific Boulevard as well as a southbound left-turn to eastbound Pacific Boulevard. A single westbound through lane is provided feeding into two receiving lanes downstream. In the eastbound direction, there are two through lanes. Pedestrian crossings are provided on all approaches with cycle tracks on the north and west legs of the intersection.

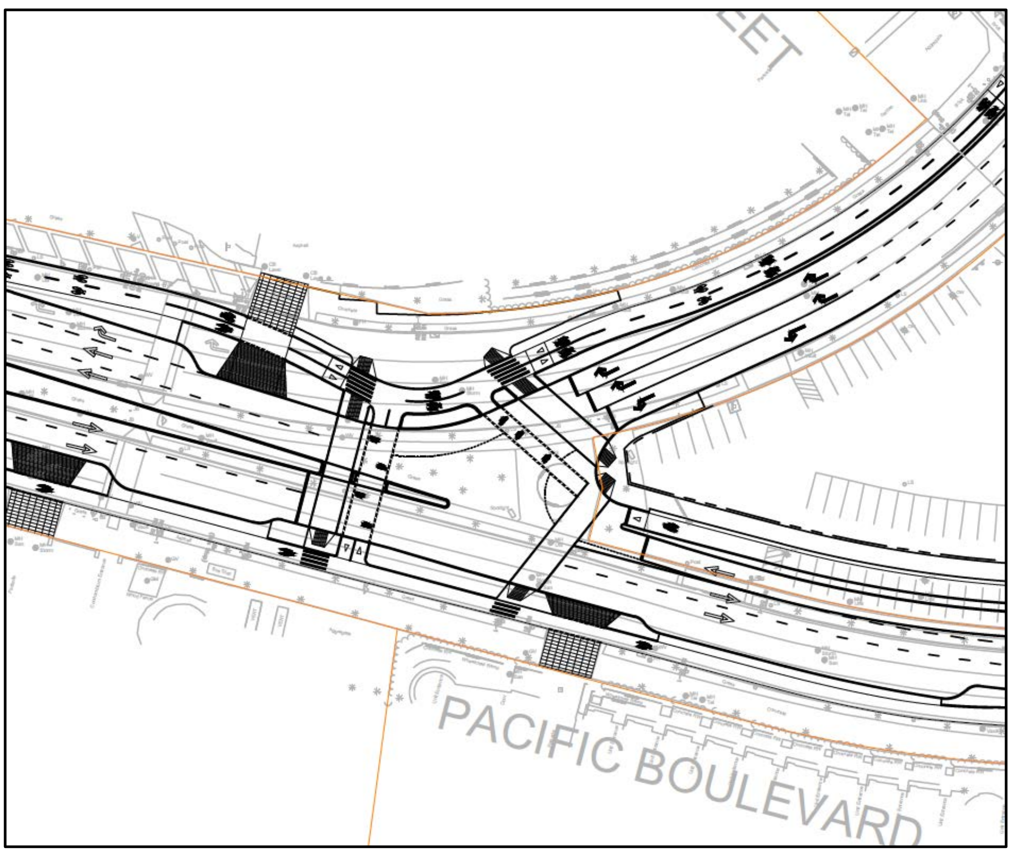


Figure A.1: Expo (West) / Pacific Intersection Configuration

(Source: WSP/MMM Group & Urban Systems Ltd., March 2018)

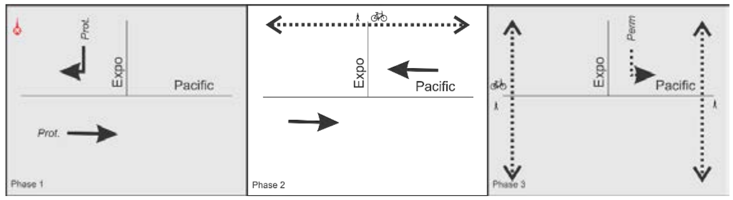


Figure A.2: Proposed Expo (West) / Pacific Intersection Signal Phasing

This intersection will be coordinated with the adjacent signal at Nelson Street / Pacific Boulevard. The single westbound through lane provides an additional routing option for westbound vehicles other than Expo Boulevard. There is expected to be considerable demand for vehicles using the dual southbound right-turn from Expo Boulevard to westbound Pacific Boulevard. The eastbound approach has been designed to accommodate the additional westbound connection afforded by the bi-directional Pacific Boulevard design.

NELSON / PACIFIC

The proposed intersection configuration of Nelson Street / Pacific Boulevard is shown in ***Figure A.3*** and ***Figure A.4*** presents the proposed signal phasing. There are two eastbound through lanes at the west approach with eastbound left-turn and right-turn lanes developing approximately 40 metres and 20 metres from the stop bar, respectively. In the westbound direction, there is a single through lane along Pacific Boulevard with similar left-turn and right-turn facilities provided. On the north approach, there is a dedicated southbound left-turn with an accompanying shared through/right-turn lane. Lastly, on the south approach there is a shared northbound through/left turn with a dedicated right turn. A bi-directional cycling facility is provided on the east leg of the intersection with a uni-directional westbound cycle track on the north approach and similar eastbound facility on the south approach. All approaches to this intersection have pedestrian crossings.

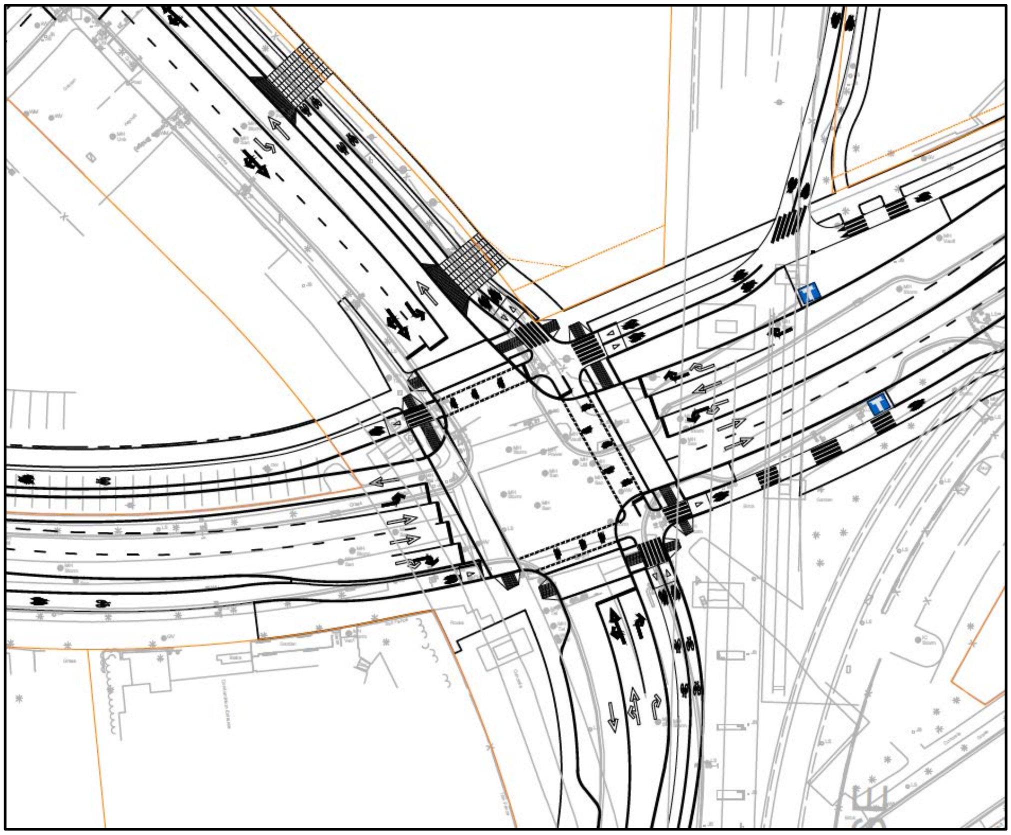


Figure A.3: Nelson / Pacific Intersection Configuration

(Source: WSP/MMM Group & Urban Systems Ltd., March 2018)

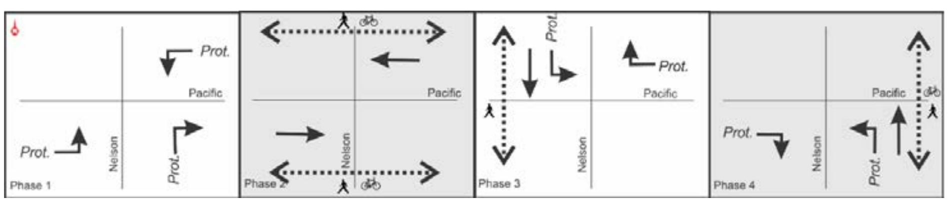


Figure A.4: Proposed Nelson / Pacific Intersection Signal Phasing

This proposed intersection is recommended to operate on a cycle length of 85 seconds coordinated with upstream and downstream intersections along Pacific Boulevard. Due to the heavy forecasted southbound-left turn movements from Nelson Street, a protected southbound left turn phase is proposed. Considerable tour bus traffic emanating and destined for the Vancouver Urban Resort / PARQ to the west will ensure high utilization of the southbound left-turn and westbound right-turn lanes.

SMITHE / PACIFIC

The proposed intersection configuration of Smithe Street / Pacific Boulevard is shown in ***Figure A.5*** and ***Figure A.6*** presents the proposed signal phasing. The configuration provides a single westbound through lane with a protected westbound right-turn. In the eastbound direction, there are two through lanes on Pacific Boulevard with a protected only eastbound left-turn lane developing approximately 40 metres from the stop bar. The Cambie Bridge northbound off-ramp also connects at this location with a concrete median separating the two eastbound streams of traffic. Pedestrian crossings are provided on all approaches with unidirectional cycle tracks on both the north and south sides.

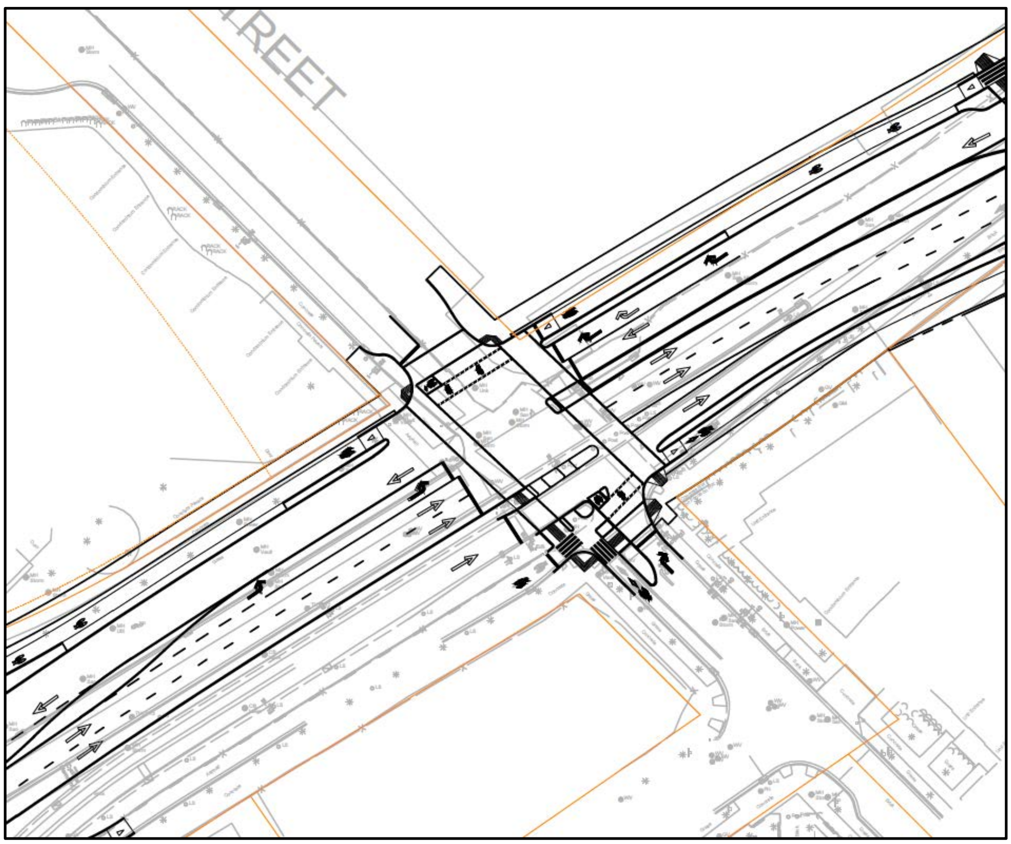


Figure A.5: Smithe / Pacific Intersection Configuration
(Source: WSP/MMM Group & Urban Systems Ltd., March 2018)

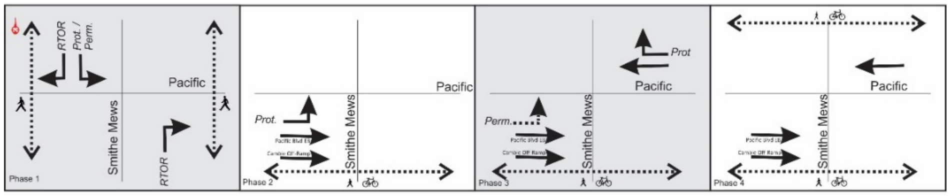


Figure A.6: Proposed Smithe / Pacific Intersection Signal Phasing

This intersection provides access to the Vancouver Urban Resort / PARQ development on the north side of Pacific Boulevard and a right-turn only outlet for developments on the south side. In addition, the northbound off-ramp from Cambie bridge connects to the eastbound link along Pacific Boulevard. The signal will be coordinated with upstream and downstream intersections along Pacific Boulevard.

Initial testing of the downstream access into Site 6B revealed that for vehicles traveling in the eastbound direction along Pacific Boulevard, an abrupt weaving movement would have to be made along a short section of roadway in order to make a right-turn movement into the development. This movement leads to an increased risk of a sideswipe vehicle collision and increases the congestion along Pacific Boulevard. As a result, right-turns into the Site 6B access immediately downstream of Smithe Street were proposed to be banned with eastbound vehicles re-directed a second site access approximately 150 m west. This allows for additional time for drivers to make the appropriate lane changes in a safe manner.

GEORGIA / PACIFIC

The proposed intersection configuration at Georgia Street / Pacific Boulevard is shown in ***Figure A.7*** and ***Figure A.8*** presents the proposed signal phasing. The T-intersection configuration offers dual westbound right-turns and dual southbound left-turns. A single westbound through lane provides a connection to the western portion of Pacific Boulevard and adds another westbound option across Northeast False Creek other than Expo Boulevard. In the eastbound direction, three through lanes feed into three receiving lanes downstream with a single eastbound left-turn lane providing a connection to the Georgia Ramp and Griffiths Way. The north and west approaches to this intersection have pedestrian crossings with a unidirectional westbound cycle track proposed for the north approach. Bus stops are proposed on the west side of the intersection adjacent to development block 10C in either direction.

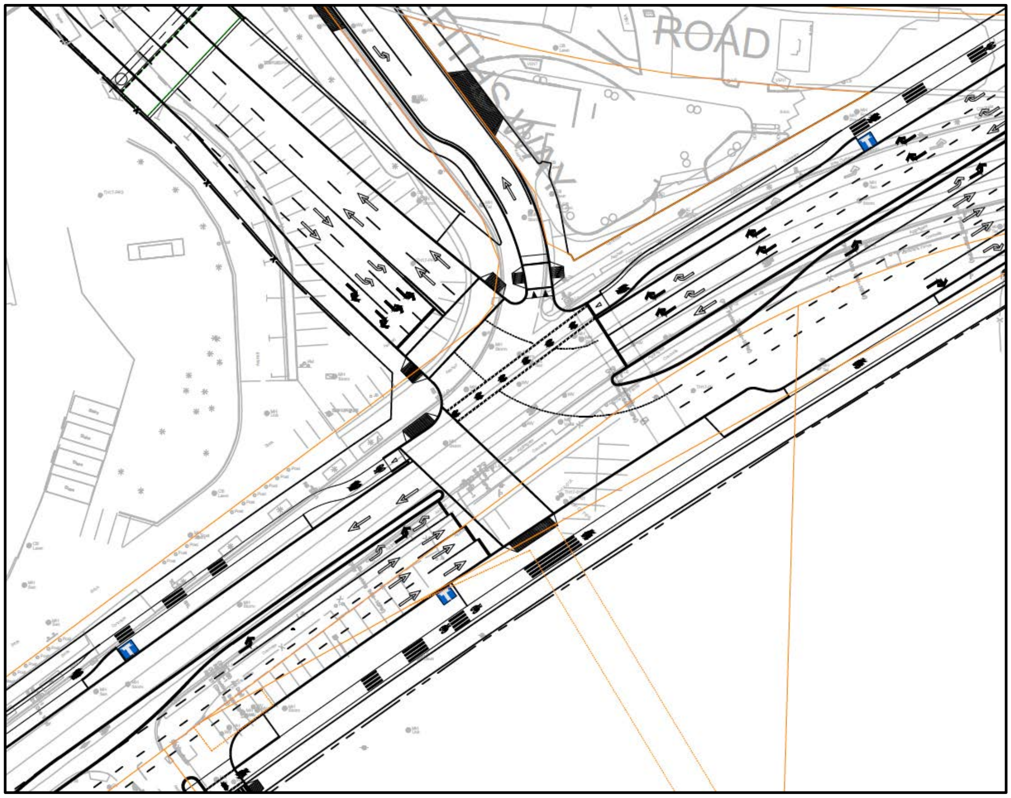


Figure A.7: Georgia / Pacific Intersection Configuration
(Source: WSP/MMM Group & Urban Systems Ltd., March 2018)

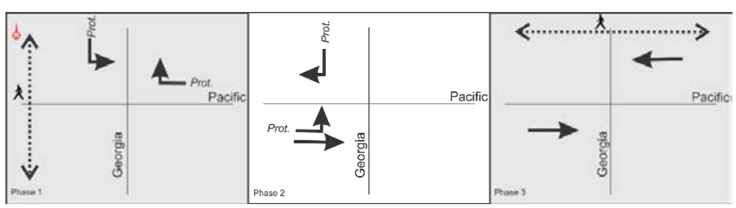


Figure A.8: Proposed Georgia / Pacific Intersection Signal Phasing

This intersection is forecast to be one of the busiest and most congested in the Viaducts replacement network as it will carry the existing traffic demand currently accommodated by both the Georgia and Dunsmuir viaducts. Therefore, this intersection is critically important to traffic operations in the replacement network. As such, the southbound left and westbound-right turns are expected to have significant traffic volume in both the AM and PM peaks.

A full signal cycle length of 120 seconds in the peak is necessary to provide sufficient green-time for each protected vehicle movement while accommodating protected pedestrian and cyclist crossings during peak periods. Coordination with upstream and downstream signals at Pat Quinn Way / Pacific Boulevard and the Georgia ramp mid-block crossing are critical in ensuring that traffic operations do not spillback and block the upstream intersections.

Future consideration may be given to opening the east leg of the intersection to pedestrian traffic. This scenario should be considered after observations and counts have been completed following an appropriate post-construction adjustment period

The potential for a future streetcar route is accommodated at this intersection, with the primary routes along Pacific Boulevard and Quebec Street as shown in ***Figure A.9***. The City of Vancouver is looking to provide flexibility with respect to designing for a potential future streetcar as various alignments have been proposed with the key traffic operations challenge being the need to provide a transit priority phase at selected intersections. At Georgia / Pacific, shifting the westbound streetcar from the curbside lane to the central westbound through-lane would require a weaving movement across the dual westbound right-turn lanes. Conversely, the streetcar may be able to complete a westbound though movement from the right-turn lane if it is given special signal priority; however, due to the forecast congestion at this intersection, there may be considerable traffic operations impacts with adding additional signalized phases.

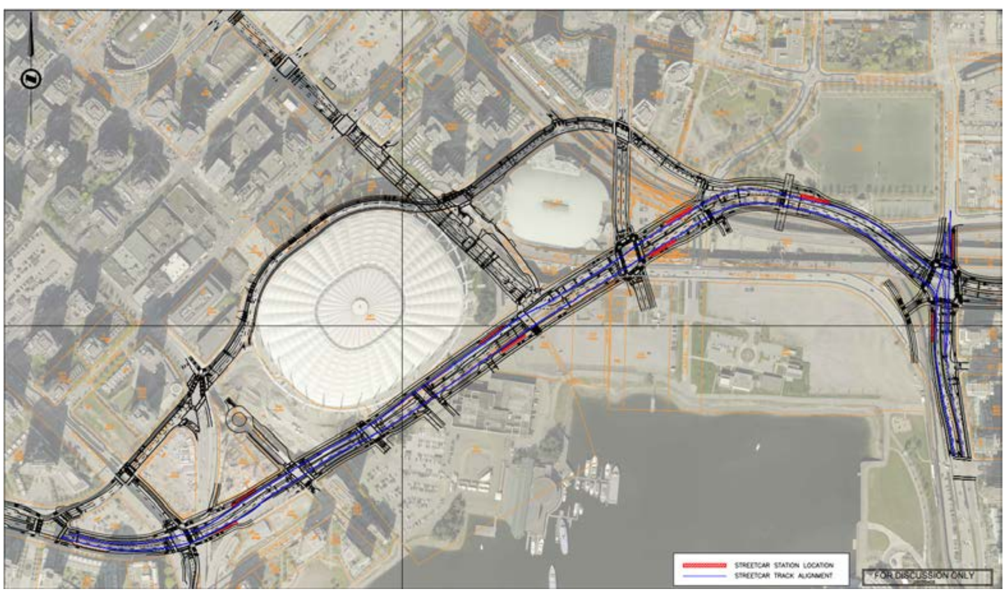


Figure A.9: Potential Future Streetcar Route

(Source: Urban Systems Ltd.)

GEORGIA MID-BLOCK CROSSING

To the northwest of the Georgia Street / Pacific Boulevard intersection, a mid-block pedestrian crossing is proposed on Georgia Street. This crossing will help to facilitate large numbers of pedestrian crossings especially during the ingress and egress periods of events at either stadia. The Georgia ramp mid-block crossing pedestrian phase will be coordinated with the north side pedestrian phase at Georgia / Pacific. During this period, no eastbound left-turn or westbound right-turn movements will be directed up the Georgia Ramp.

SITE 6B / PACIFIC BOULEVARD MID-BLOCK CROSSING

There is also a proposed pedestrian crossing across Pacific Boulevard between Smithe Street and Georgia Street that would provide a connection between the stadia and the proposed Site 6B development south of Pacific. The proposed crossing is coordinated with other accesses planned for the site to ensure adequate traffic progression is maintained due to the tight spacing between intersections.

PAT QUINN WAY / PACIFIC

The proposed intersection configuration at Pat Quinn Way Street / Pacific Boulevard is shown in ***Figure A.10*** and ***Figure A.11*** presents the proposed signal phasing. Two westbound lanes are provided feeding into three receiving lanes downstream. Eastbound traffic is accommodated through three through lanes. Both the east and west approaches have right-turn and left-turn storage bays. In the southbound direction, shared through/left-turn and through/right-turn lanes provide access to Site 6C while in the northbound direction there is a shared through/left turn with accompanying right turn lane. Unidirectional cycling facilities are provided on all approaches in addition to pedestrian crosswalks.

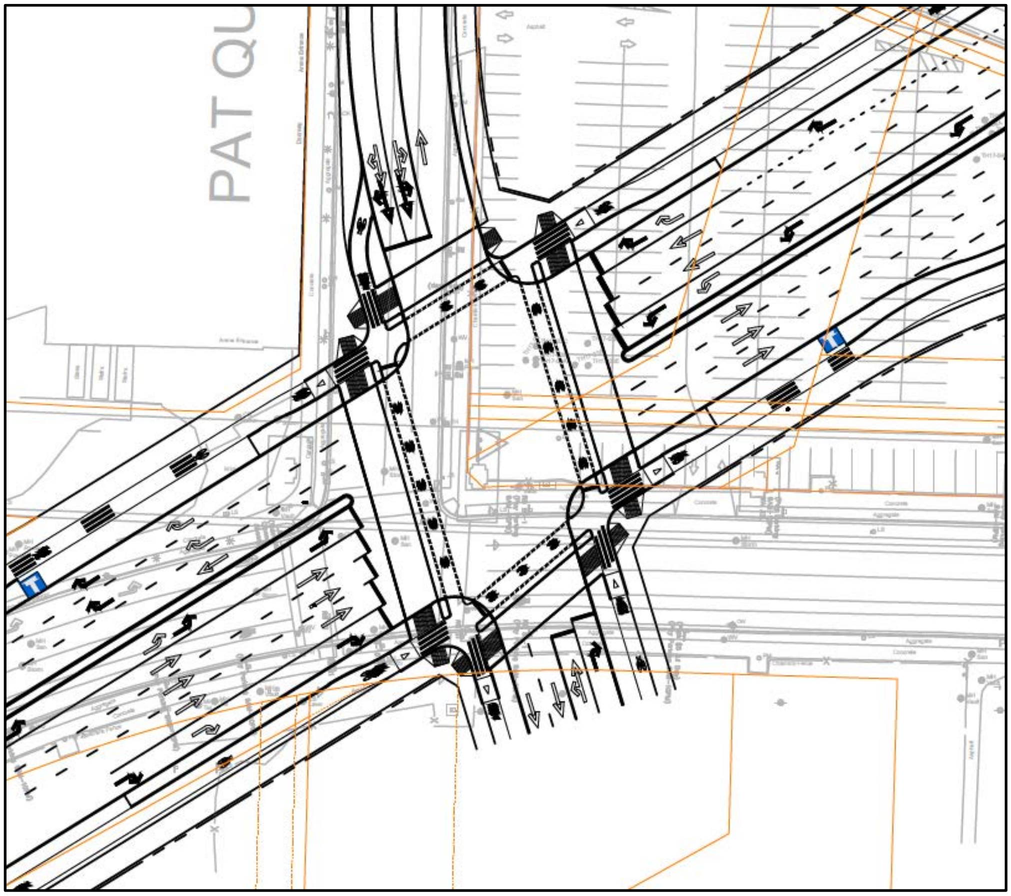


Figure A.10: Pat Quinn Way / Pacific Intersection Configuration

(Source: WSP/MMM Group & Urban Systems Ltd., March 2018)

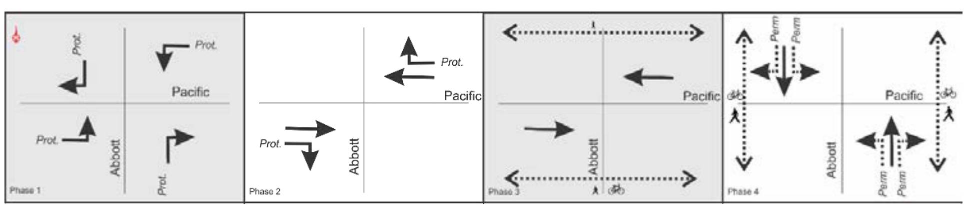


Figure A.11: Proposed Pat Quinn Way / Pacific Intersection Signal Phasing

The key constraint at this intersection stems from the short spacing between Georgia Street / Pacific Boulevard and the Site 6C access / Pacific Boulevard intersections with Pat Quinn Way. Signal coordination is critical in the eastbound and westbound directions as volumes are expected to be significant in the AM and PM peaks.

From the west, the Georgia Street / Pacific Boulevard intersection signal phasing is such that there will always be a vehicle movement that receives a green light to proceed towards Pat Quinn Way. Relatively lengthy north-south crossing distances for pedestrians at Pat

Quinn Way / Pacific Boulevard reduce the amount of green time that may be allocated to the higher volume east-west signal phase. As such, eastbound queues have the potential to propagate towards the Georgia Street / Pacific Boulevard intersection.

Permissive northbound and southbound vehicle turning movements will require vehicles to yield to pedestrians and cyclists on the east and west approach crossings. This signal phasing is partly driven by the need to maximize green time for the higher volume eastbound and westbound through movements and to limit the number of signal phases.

PACIFIC / SITE 6C ACCESS & EXPO (EAST) SLIP-LANE

The proposed intersection configuration of Expo Boulevard (East) & Site 6C Access / Pacific Boulevard is shown in ***Figure A.12*** and ***Figure A.13*** presents the proposed signal phasing. This intersection functions to provide Site 6C with an additional access / egress to Pacific Boulevard. In the westbound direction, there are two through lanes along Pacific Boulevard with an additional curbside lane exiting to Expo Boulevard. A single protected westbound left-turn lane is proposed with a storage length of approximately 30 metres. For eastbound traffic, there are three through lanes with a protected eastbound right-turn only lane. A north-south pedestrian crossing / cycle track is proposed for the west approach to this intersection.

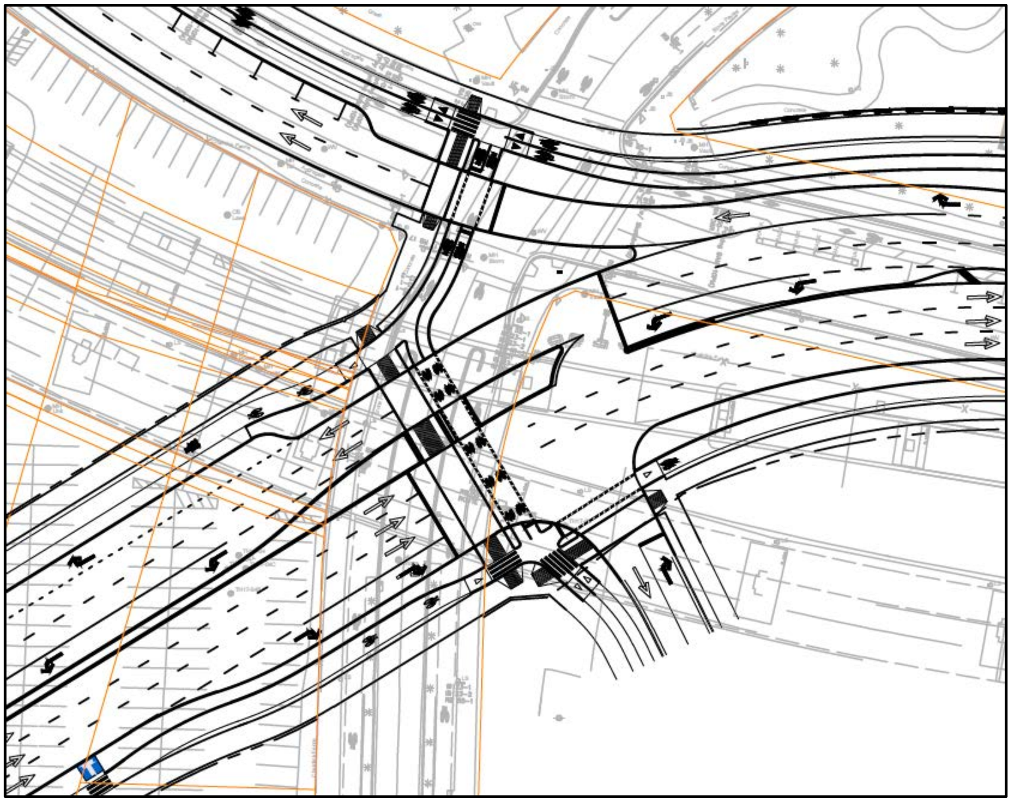


Figure A.12: Pacific / Site 6C access & Expo (East) Slip-lane Intersection
(Source: WSP/MMM Group & Urban Systems Ltd., March 2018)

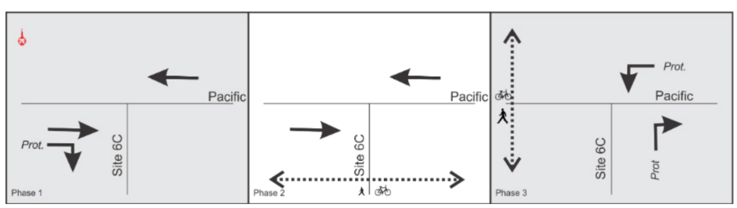


Figure A.13: Proposed Pacific / Site 6C access & Expo (East) Slip-lane Intersection Signal Phasing

Similar to other intersections along Pacific Boulevard, the coordination with upstream and downstream intersections is critical to traffic operations due to the close spacing between signals. Significant proposed development on the north-west side of the Pacific Boulevard / Expo Boulevard intersection necessitates the need for a pedestrian crosswalk connecting Site 6C to the north-west corner. A single stage west approach pedestrian crossing phase is proposed during the northbound right-turn and westbound left-turn signal phases. Analysis shows limited impacts to both local and network wide traffic with a single crosswalk as the westbound and eastbound through movements are still given sufficient green time. It should be noted that this signal phasing is atypical in that it allows for the westbound left-turn to operate in conjunction with the west approach pedestrian and cyclist crossing. Typically, this movement is discouraged as the left-turn vehicles proceed simultaneously with the downstream crosswalk leading to the perception that the initial trajectory of the left-turning vehicles conflicts with the crosswalk. However, at this intersection, left-turning vehicles will be aligned with the SkyTrain column with an additional concrete curb/barrier that will assist in "deflecting" vehicles to the south.

Due to the significant proposed development to Site 6C, the westbound left-turn queue may exceed the limited storage bay length of approximately 30 metres. This non-normalized intersection configuration also does not allow for northbound through egress at this exit from Site 6C which will direct more vehicles to the Abbott Street / Pacific Boulevard exit.

Expo Boulevard is forecast to continue to operate as a reliable and robust east to west connection across Northeast False Creek and therefore adjacent intersections have been designed to allow for a smooth transition. The proposed configuration provides a slip-lane that develops just east of Carrall Promenade. The requirement for a pedestrian crossing at the mid-block of the slip-lane necessitates the need for a separate pedestrian signal. This signal will operate in coordination with Carrall Promenade as it is important that the limited westbound slip-lane storage does not spillback into the westbound through lanes. Analysis shows a half-cycle pedestrian signal operating at 60 seconds is sufficient for this movement to function.

At this location, Pacific Boulevard bends southwest to fit between the existing SkyTrain columns. The relatively low track guideway presents a visual obstruction for drivers and therefore careful consideration has been given to the placement of the signal heads as well as guide signage.

CARRALL / PACIFIC

The proposed intersection configuration of Carrall Promenade / Pacific Boulevard is shown in ***Figure A.14*** and ***Figure A.15*** presents the proposed signal phasing. This configuration provides two through lanes expanding to three lanes with the Expo Boulevard slip lane beginning approximately 50 metres to the east of Carrall Promenade. In the eastbound direction, there are three through lanes. A bus stop is proposed for both sides of Pacific Boulevard, east side of Carrall Promenade. A north-south pedestrian / cyclist connection is proposed connecting Andy Livingstone Park across Pacific Boulevard.

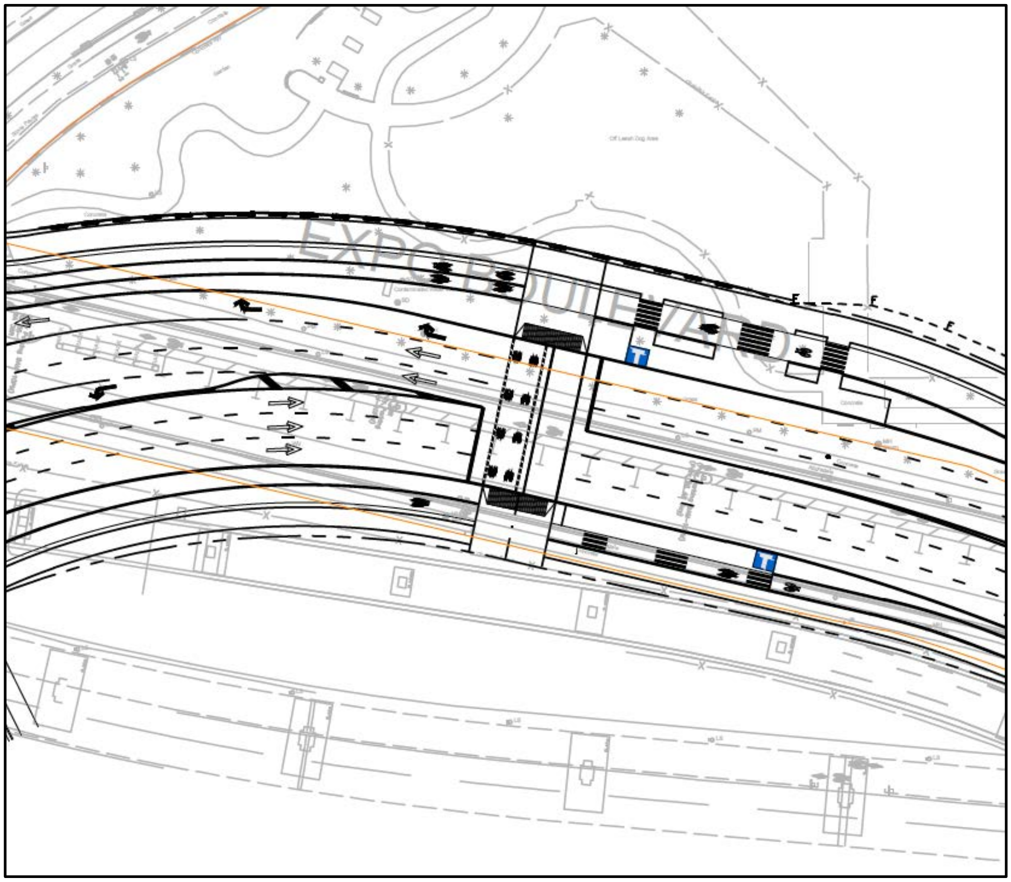


Figure A.14: Carrall / Pacific Intersection Configuration

(Source: WSP/MMM Group & Urban Systems Ltd., March 2018)

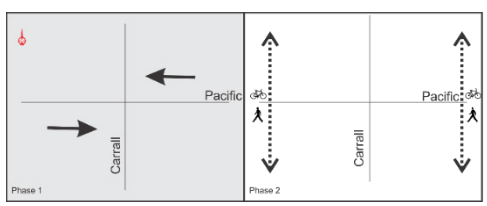


Figure A.15: Proposed Carrall / Pacific Intersection Signal Phasing

The new alignment with Carrall Street closed to vehicular traffic allows Andy Livingstone Park to be better experienced as one large green space, rather than two separate and smaller areas. With the intersection only serving north-south active transportation movements and east-west vehicle through movements, this limits turning conflicts between these modes allowing for a safer connection across Pacific Boulevard. High volumes of both vehicles and active users (pedestrians/ cyclists) are forecasted to navigate through and across this intersection and therefore the safety of road users is a primary concern.

With the proposed slip-lane to Expo Boulevard just downstream, this intersection has been designed to allow for Expo Boulevard to remain a robust and resilient east-west connection through Northeast False Creek. Concepts for keeping the north-south vehicle connection along Carrall Street were shown to require adding extra signalized phases which would increase vehicle delays and potentially extend queues towards upstream intersections. If vehicles were permitted to access Carrall Street from Pacific Boulevard, additional turning bays (both right and left turns) would likely be required as these movements would cross the cycling facility on the north side of Pacific Boulevard. Dedicated turning bays would necessitate taking a larger right-of-way from Andy Livingstone Park and would likely cut into the existing soccer fields resulting in a smaller park area overall.

A review of the existing usage of Carrall Street in the peak hour shows a two-way volume of 300 vehicles. Distributed across Abbott and Quebec for both northbound and southbound movements, this would mean an increase of roughly 85 additional northbound vehicles and 65 additional southbound vehicles along each link (assuming an equal distribution of volumes). This increase in volume is not expected to cause capacity issues based on the proposed signal timing at Quebec / Pacific and Pat Quinn Way / Pacific.

In the eastbound direction, there may be some traffic impacts caused by buses stopping in the curbside lane as demand for the downstream eastbound right turn at Quebec Street is forecast to be significant.

PACIFIC / QUEBEC

The proposed Quebec Street / Pacific Boulevard intersection is shown in ***Figure A.16*** and ***Figure A.17*** presents the proposed signal phasing. This four-leg intersection contains two through lanes in the westbound direction with a single protected westbound right-turn. For eastbound traffic, three lanes on Pacific Boulevard expand to four, containing two through lanes and two right-turn lanes. Northbound vehicles can use the dual left-turn lanes as well as a single through and single right-turn lane. Lastly, in the southbound direction there are separate turn lanes for each movement with the southbound right-turn and left-turn lanes each developing approximately 25 metres from the stop bar. Pedestrian crossings are provided on all approaches along with uni-directional cycle tracks.

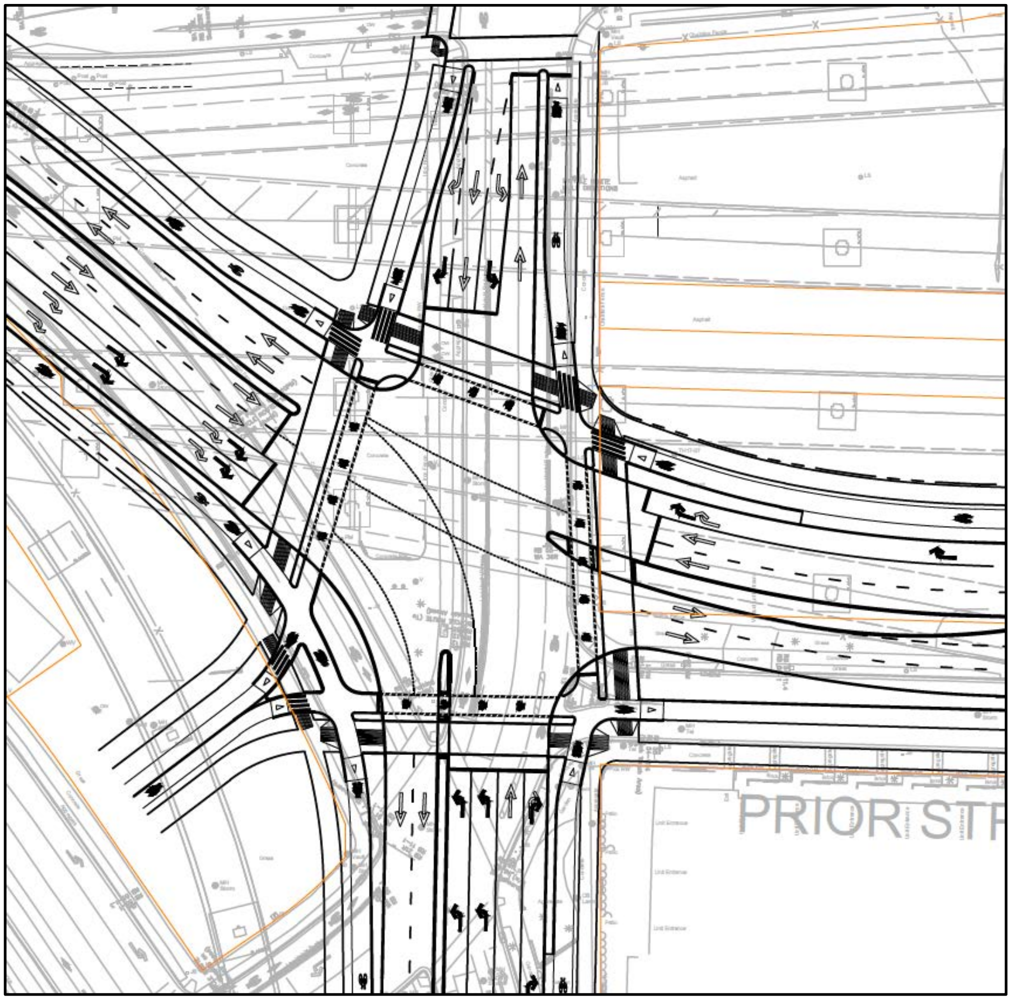


Figure A.16: Quebec / Pacific Intersection Configuration
(Source: WSP/MMM Group & Urban Systems Ltd., March 2018)

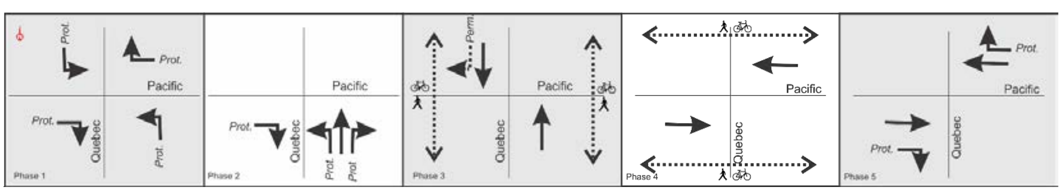


Figure A.17: Proposed Quebec / Pacific Intersection Signal Phasing

The Quebec Street / Pacific Boulevard intersection functions as the interface between the new Pacific Boulevard road network and the existing Prior Street. All existing routes that traversed along Pacific Boulevard, Expo Boulevard, and the Dunsmuir / Georgia Viaducts will be funneled through this intersection. As such, this intersection is critically important to traffic operations in the replacement network. Operating on a proposed 120 second full signalized cycle length during the peak period and coordinated with adjacent signals on

Pacific Boulevard, the dual eastbound right-turns and dual northbound left-turns provide high-capacity movements for both inbound and outbound vehicles to the Northeast False Creek.

Upstream signage for eastbound vehicles will alert drivers that the curbside eastbound travel lane becomes a right-turn lane only. The signage will assist in reducing excessive lane changing maneuvers between Carrall Promenade and Quebec Street as vehicles align themselves into the correct lane.

Eastbound and westbound left-turn movements at this intersection are banned (but allowed at Main Street) in order to allocate more green time for the higher volume inbound and outbound movements along Pacific Boulevard while providing high-quality active transportation connections and crosswalks on all approaches.

Geometric constraints due to Andy Livingstone Park to the north and the SkyTrain guideway to the south limits the number of westbound lanes along Pacific Boulevard. For westbound traffic, the signal phasing is such that the two receiving lanes on the west side of the intersection remain relatively clear as these receiving lanes are expected to experience significant vehicle demand during the peak hours. This is accomplished in part by coordinating all westbound / eastbound movements at adjacent intersections.

The design has taken into account adequate storage for all existing viaducts cyclists as they will be required to pass through this intersection on their route.

MAIN / PRIOR

The proposed Main Street / Prior Street intersection is shown in ***Figure A.18*** and ***Figure A.19*** presents the proposed signal phasing. This intersection provides two westbound and two eastbound through lanes with protected left-turn and right-turn lanes for each direction. Southbound traffic will be accommodated with two dedicated through lanes with an additional shared through/right-turn lane and a protected left-turn lane. In the northbound direction, there are dual left-turns with a single though and shared through/right-turn lane. Pedestrian crossings are provided on all approaches with uni-directional cycle tracks on the north and south sides of the intersection. Bus stops are proposed on the far side of the intersection for westbound and eastbound traffic, respectively.

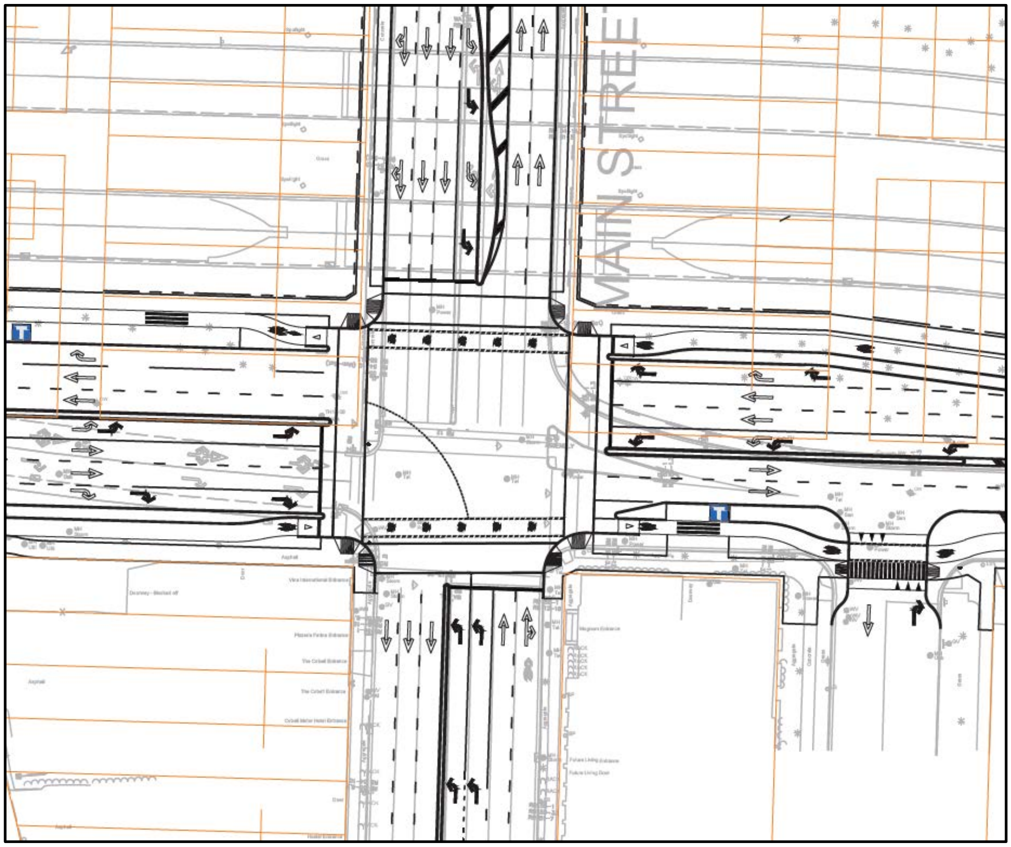


Figure A.18: Main / Prior Intersection Configuration
(Source: WSP/MMM Group & Urban Systems Ltd., March 2018)

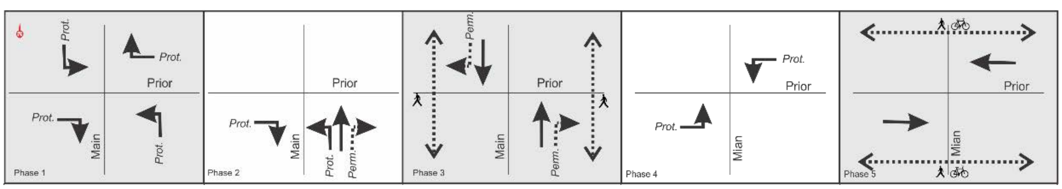


Figure A.19: Proposed Main / Prior Intersection Signal Phasing

Main Street / Prior Street will act as the connection point between Northeast False Creek and the future False Creek Flats arterial road. From a traffic operations standpoint, the proposed layout requires a relatively long north-south pedestrian crossing phase due to physical constraints that limit the pedestrians waiting areas. As such these are located further apart and result in longer crossing times.

The eastbound right turn bay provides a protected movement from Prior Street to southbound Main Street; however, due to site constraints, the storage length is limited to the mid-block alley way west of the intersection.

Based on traffic operations analysis, the northbound left-turn movement operates close to its maximum capacity in the peak hours. Congestion at this intersection can be mitigated by ensuring a balance between the northbound left-turn throughput at both Quebec Street and Main Street.

ABBOTT / EXPO

The proposed intersection configuration of Abbott Street / Expo Boulevard is shown in ***Figure A.20***. There are two westbound through lanes (with the southmost through lane allowing for left-turns) at the east approach of Abbott Street with a westbound right-turn lane developing approximately 30 metres from the stop line. A bi-directional cycle track runs along the north approach with two receiving lanes for both northbound and southbound traffic. To the west, Expo Boulevard continues with two westbound through-lanes and a right-turn lane directly downstream for vehicles wanting to access the Costco Tire Centre. ***Figure A.20*** shows the proposed intersection layout and ***Figure A.21*** presents the proposed signal phasing.

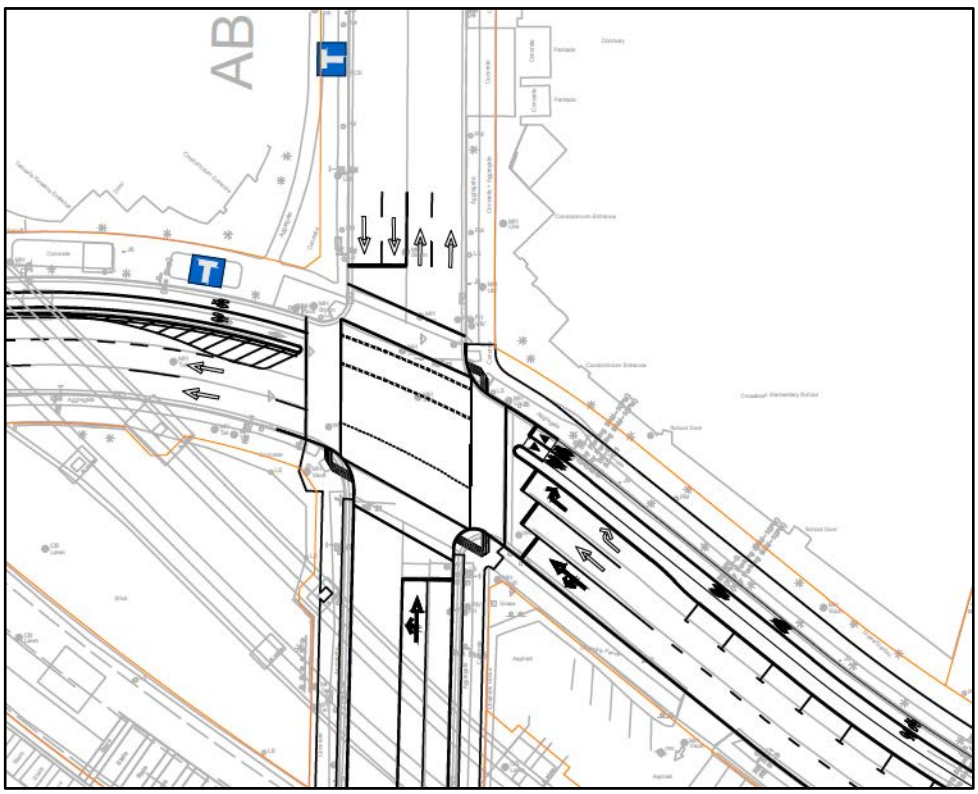


Figure A.20: Abbott / Expo Intersection Configuration (Source: WSP|MMM)
(Source: WSP/MMM Group & Urban Systems Ltd., January 2018)

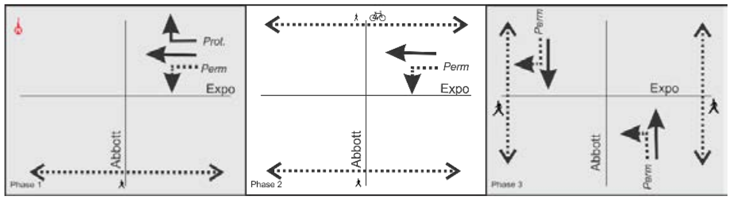


Figure A.21: Proposed Abbott / Expo Intersection Signal Phasing

Due to the location of the proposed bi-directional cycle track on the north approach as well as the considerable demand for westbound right-turning vehicles, it is necessary to provide a protected signal phase (right-on-red banned) for this movement to reduce the potential for a vehicle-cyclist and vehicle-pedestrian conflict. The relatively short pedestrian crossing distances on all approaches allows for the cycle length to be kept at a nominal 65 seconds. A westbound right-turn storage bay length of approximately 30 metres is expected to be able to accommodate the 95th percentile queue.

The westbound right turn to the Costco Tire Centre (downstream of Abbott Street along Expo Boulevard) presents a potential safety conflict with un-signalized right-turninrg traffic turning against a bi-directional cycle track. While turning movement volumes here are expected to remain relatively low (peak of <50 veh/hr), there is still a concern that drivers may be unaware of cyclists approaching from both directions. Additional paint marking and/or signage will be used to warn drivers and oncoming cyclist traffic. An example of such signage can be found below in ***Figure A.22***.

Figure A.22: Sample Right-Turn Yield to Cyclists Signage

Staging of event trucks along the southmost lane on Expo Boulevard, west of Abbott Street may constrain the capacity of westbound vehicles along Expo Boulevard leading to increased delays and longer queues. As a result, Temporary Variable Message (VM) signs will be placed upstream of the intersection of Abbott Street / Expo Boulevard to provide advance notice of congestion and lane closures. This strategy will reduce the likelihood that queues will spill back and affect adjacent intersections during stadia events. A detailed assessment of variable message signs can be found in the Phase 3 - Event Management Strategies report.

GRIFFITHS / EXPO

The proposed intersection configuration of Griffiths Way / Expo Boulevard is shown in ***Figure A.23*** and ***Figure A.24*** presents the proposed signal phasing. There are two westbound through lanes at the east approach with two receiving lanes downstream. Alignment of these lanes must accommodate a skew as the southmost lane west of Griffiths Way is proposed to be converted to a truck staging only lane. The bi-directional cycle track runs along the north approach crossing the Costco Parking entranceway. Griffiths Way feeds into the intersection from the south with a single shared through/left turn lane. Pedestrian crossings are proposed on all approaches at this intersection.

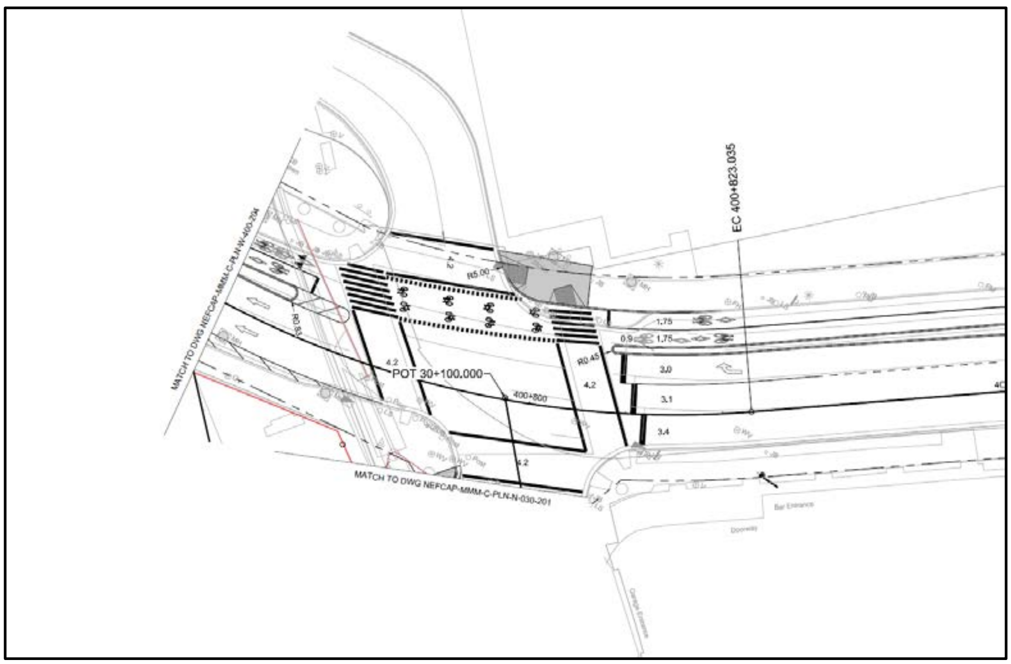


Figure A.23: Griffiths / Expo Intersection Configuration

(Source: WSP/MMM Group & Urban Systems Ltd., March 2018)

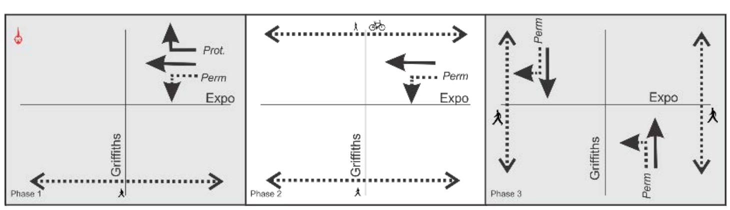


Figure A.24: Proposed Griffiths / Expo Intersection Signal Phasing

It is necessary to provide a protected only phase for the westbound right-turn to reduce the potential for a vehicle-cyclist and vehicle-pedestrian conflict. Appropriate lane markings will assist drivers traversing through the intersection to skew their path as the southernmost lane is converted to a truck staging lane west of Griffiths Way.

The relatively short pedestrian crossing distances on all approaches allows for the cycle length to be kept at a nominal 65 seconds. A westbound right-turn storage bay length of approximately 30 metres will accommodate the 95th percentile queue.

SMITHE / EXPO

The proposed intersection configuration of Smithe Street / Expo Boulevard is shown in ***Figure A.25*** and ***Figure A.26*** presents the proposed signal phasing. The configuration offers dual westbound right-turn lanes from Expo Boulevard to Smithe Street. In addition, two westbound through lanes are provided with three receiving lanes downstream. Along Smithe Street, there is a single northbound left-turn lane to Expo Boulevard while three northbound through lanes feed into four lanes downstream lanes. Bidirectional cycling facilities are provided on the north, south, and east approaches to the intersection. Pedestrian crossings are provided on all four approaches.

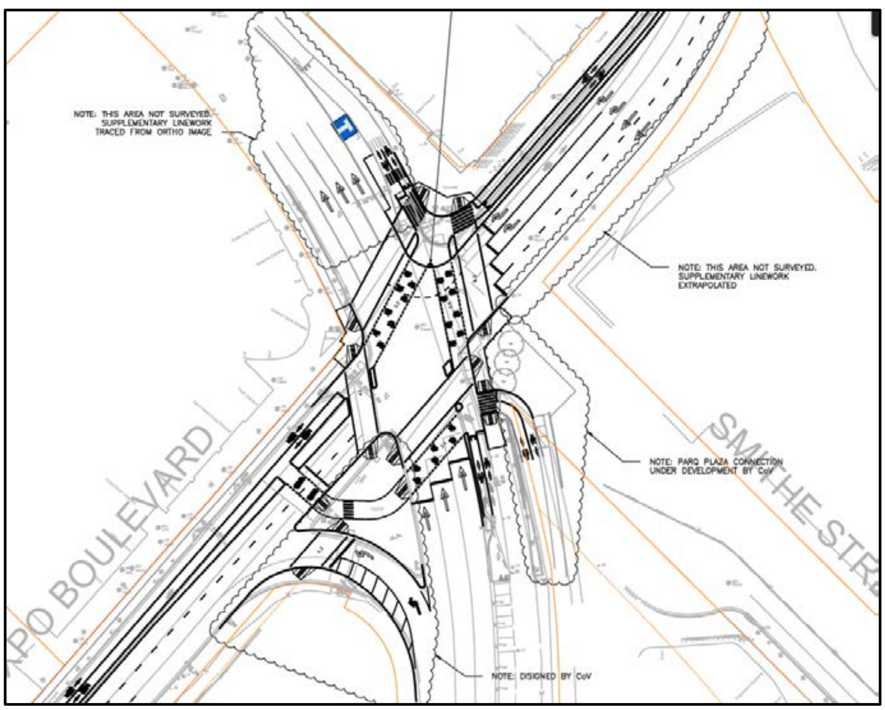


Figure A.25: Smithe / Expo Intersection Configuration
(Source: WSP/MMM Group & Urban Systems Ltd., March 2018)

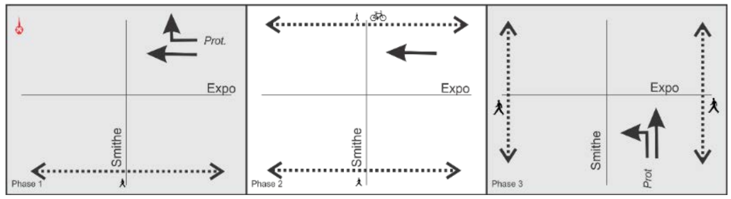


Figure A.26: Proposed Smithe / Expo Intersection Signal Phasing

This intersection is proposed to function on a 65 second cycle length coordinated with the downstream intersections on Smithe Street. The proposed bidirectional cycle tracks warrant the need to provide fully protected signal phasing for right-turning traffic from Expo Boulevard to Smithe Street. As such, traffic analysis has shown the need for a minimum of two through lanes along Expo Boulevard in addition to dual right-turn lanes. Due to the additional protected signal phases and high traffic demands, the pedestrian walk speed will be increased to 1.1 m/s for the north and south approach crosswalks (across Smithe Street) in order to allocate additional green time to the heavier volume Cambie Bridge to Smithe Street movement.

This intersection operates with two signal controller units, consistent with the current setup, in order to provide a lag phase for the second set of traffic signals downstream on Expo Boulevard. This lag phase will terminate the through phase for Expo Boulevard traffic prior to the downstream signal terminating therefore allowing for vehicles to clear the full length of Expo Boulevard without becoming trapped mid-way through the intersection.

The northbound left-turn turn from Smithe Street to westbound Expo Boulevard is proposed to have a single storage lane. This represents a reduction from the current two-lane configuration. There may be instances where the left-turn queue extends back into western most northbound through lane due to the short storage bay length (approximately 30 m). This impacted northbound through lane may therefore act as a defacto NBL lane during peak periods.

EXPO / NELSON

The proposed intersection configuration of Nelson Street / Expo Boulevard is shown in ***Figure A.27*** and ***Figure A.28*** presents the proposed signal phasing. There are three westbound through lanes feeding into three downstream receiving lanes that are continuous with the dual right-turns and single left-turn downstream at Pacific Boulevard. At the north and south approaches along Nelson Street, shared northbound through / left turn and southbound through / right turn movements are provided. Bidirectional cycle tracks are proposed for the north and eastern approaches with pedestrian crossings on all sides.

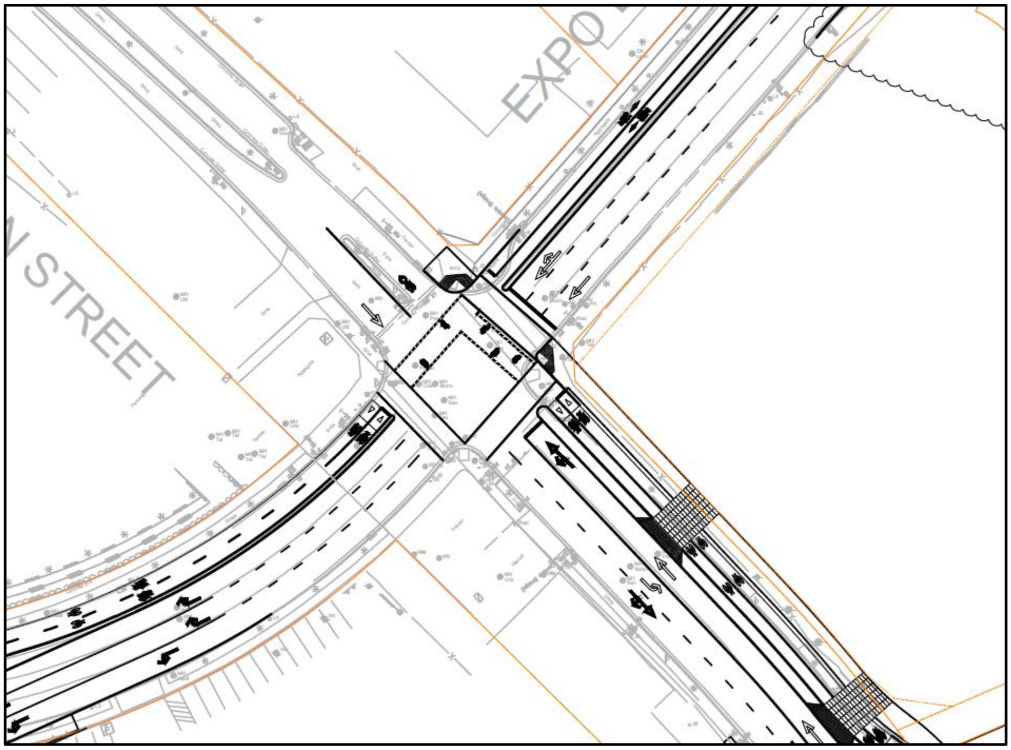


Figure A.27: Expo / Nelson Intersection Configuration
(Source: WSP/MMM Group & Urban Systems Ltd., March 2018)

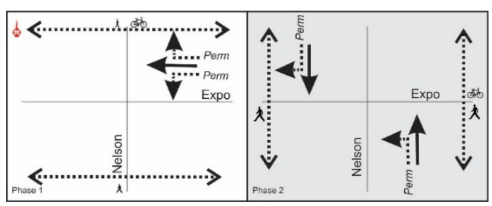


Figure A.28: Proposed Nelson /Expo Intersection Signal Phasing

Right turns on red are banned when crossing a perpendicular bi-directional cycle track as it presents a challenge to drivers who may be unaware of cyclists approaching from both sides. Appropriate lane markings will assist drivers traversing through the intersection to provide positive guidance as the westbound fast lane leads to a downstream left turn only lane. The relatively short pedestrian crossing distances on all approaches allows for the cycle length to be kept at 65 seconds.

GEORGIA / BEATTY

The proposed Beatty Street / Georgia Street intersection is shown in ***Figure A.29*** below. The configuration provides two through lanes along Georgia Street in both directions with separate right turn-lanes. For traffic along Beatty Street, there is a single through lane with a right-turn facility for eastbound traffic. All approaches have pedestrian crossings with Beatty Street also allowing for uni-directional cycle tracks on the curb side. The existing Citadel Parade access will be restricted to a stop-controlled right-turn outbound movement only. The wide downstream eastbound link on Georgia Street is proposed to accommodate a bus stop. ***Figure A.29*** shows the proposed intersection layout and ***Figure A.30*** presents the proposed signal phasing.

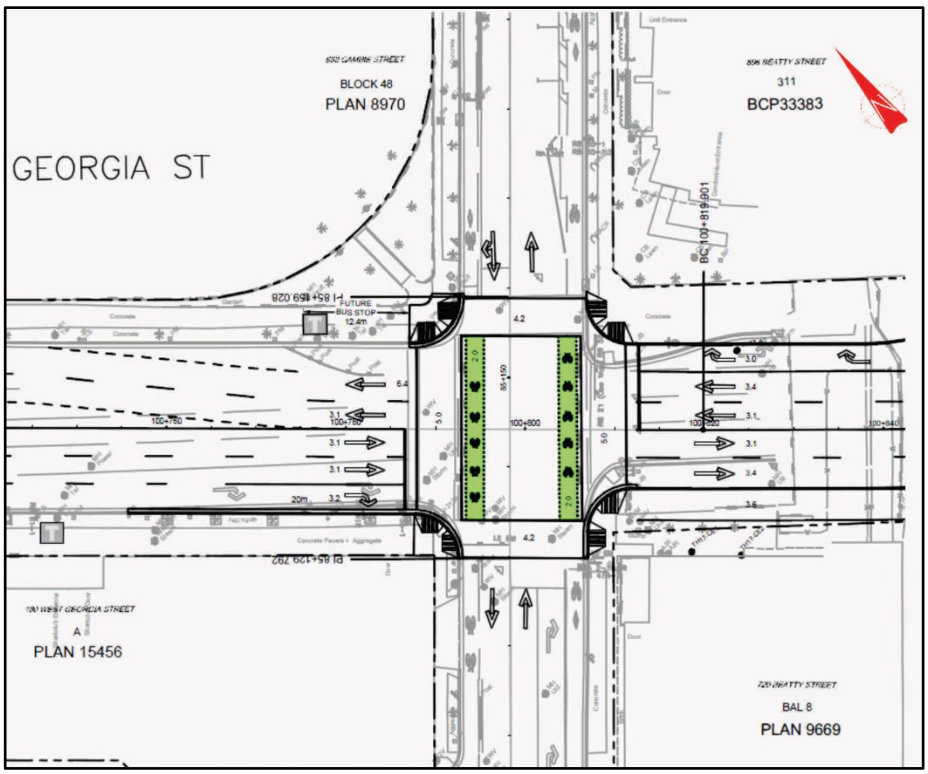


Figure A.29: Beatty / Georgia Intersection Configuration

(Source: WSP/MMM Group & Urban Systems Ltd., March 2018)

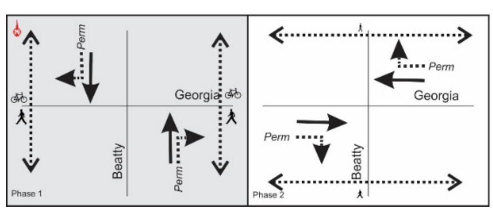


Figure A.30: Proposed Beatty / Georgia Intersection Signal Phasing

This intersection connects the proposed Georgia Ramp with the existing downtown street network. It is recommended that all left-turn movements be banned to provide additional green time to the heavier volume through movements. This will ensure this signal does not act to meter traffic and to potentially accommodate protected turning movements for the northbound and southbound right-turns that conflict with the uni-directional cycle tracks.

The signal at this location is proposed to operate on an 85 second cycle length that is coordinated with the signal at Cambie Street / Georgia Street. Bus stops along Georgia Street have also been placed to avoid blocking the through lanes where applicable, as significant traffic volumes are forecast to travel along the eastbound and westbound directions.

GEORGIA / CAMBIE

The proposed Cambie Street / Georgia Street intersection is shown in ***Figure A.31***. This configuration offers two through lanes along Georgia Street with the westbound movement sharing a right-turn lane. Left-turns are permitted with associated turning bays developing from the mid-block. Along Cambie Street, a single through lane is provided with shared right-turn and left-turns as well as curbside parking. ***Figure A.31*** shows the proposed intersection layout and ***Figure A.32*** presents the proposed signal phasing.

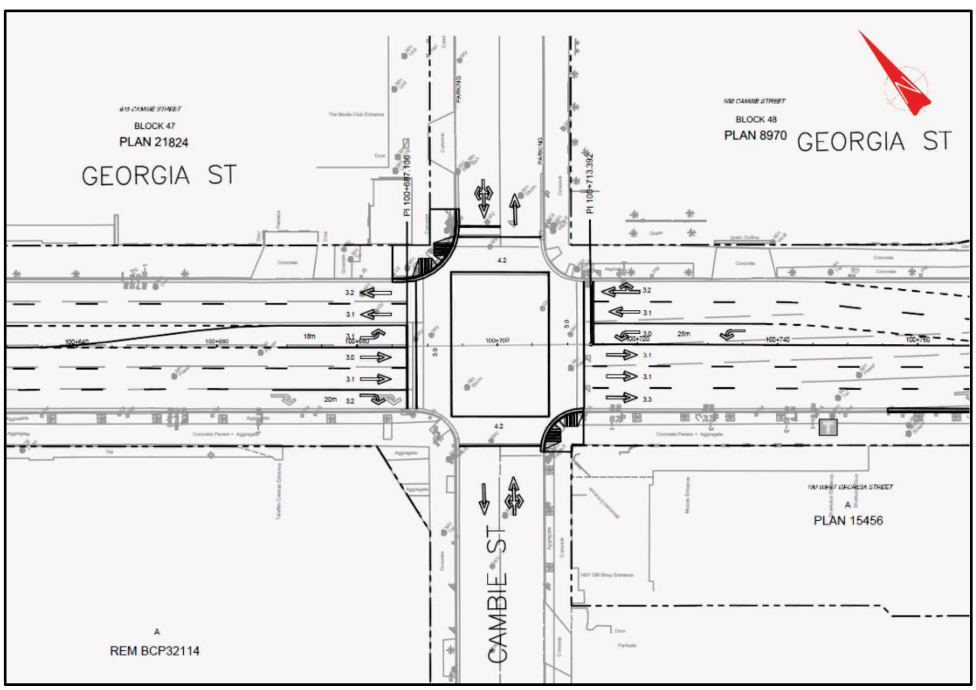


Figure A.31: Cambie / Georgia Intersection Configuration
(Source: WSP/MMM Group & Urban Systems Ltd., March 2018)

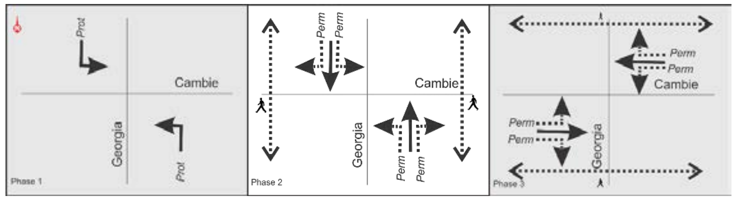


Figure A.32: Proposed Cambie / Georgia Intersection Signal Phasing

This intersection is proposed to operate on a signal cycle length of 85 seconds coordinated with both upstream and downstream signals along Georgia Street at Beatty Street and Hamilton Street. The left turns along Georgia Street each have dedicated turn bays as well as protected / permissive phasing to ensure adequate left-turning capacity.

The westbound through movement shares the curbside lane with right-turns. Depending on the level of pedestrian traffic crossing the north approach, this may limit the capacity of the through movement as a queue may develop behind right-turning vehicles. With high traffic volumes forecast along Georgia Street, consideration may be given to providing a protected right-turn phase to "flush" the right-turn movement from blocking upstream traffic if future observations of traffic operations warrant it.

The constrained five lane cross-section and forecast high traffic volumes along Georgia Street offers considerable challenges in the placement of bus stops. Where available, the bus stops will be placed to avoid blockage of the main through lanes by positioning them within a right-turn bay.

CAMBIE / PACIFIC

This intersection is not anticipated to undergo major geometric changes, although a bi-directional cycle track is proposed for the north approach. Based on discussion with City staff, this intersection will utilize the existing signal timing and phasing plans.

DUNSMUIR / BEATTY

At Dunsmuir Street westbound, there will be a significant reduction in overall traffic volume due to the removal of the inbound Dunsmuir Viaduct and shift to Georgia Street. However, Dunsmuir Street will be converted to accommodate two-way vehicle traffic which poses additional safety concerns particularly with turning vehicles conflicting with the cycle track. As such, signal phasing will be adjusted to fully protect turning vehicles from the bi-directional cycle track by introducing protected signal phasing.

In general, the overall reduction in vehicular traffic will improve the safety and comfort for the adjacent Dunsmuir Street cycle track as turning conflicts will be significantly reduced. There will, however, be an increase in northbound left-turns from Beatty Street for diverted vehicles wishing to access Dunsmuir Street from the new Georgia Ramp.

DUNSMUIR / CAMBIE

As with the Dunsmuir / Beatty intersection, there will be a significant reduction in westbound traffic volume due removal of the Dunsmuir Viaduct. Similar to the Dunsmuir / Beatty intersection discussed in the previous section, the conversion to two-way vehicle traffic will require additional protection for cyclists either through protected signal phases or banning of certain movements. In general, the reduction in overall vehicle traffic will improve safety and comfort for the adjacent Dunsmuir Street cycle track as right-turn conflicts will be significantly reduced. There will, however, be an increase in northbound left-turns from Cambie Street for diverted vehicles wishing to access Dunsmuir Street from the new Georgia Ramp.

PRIOR / GORE

The Prior Street signalized intersection at Gore Avenue will provide access into development block 6D and the Strathcona neighbourhood. To improve safety and reduce delays to left-turning traffic, the eastbound left-turn will be banned during peak periods.

GEORGIA STREET (BETWEEN HOWE STREET AND BEATTY STREET)

Intersections along Georgia Street within the downtown street network will be reconfigured to accommodate westbound flow from the Georgia Ramp. As a result of supplemental traffic analysis along this corridor as summarized in ***Appendix E***, several left-turn bays will be implemented along Georgia Street where appropriate. The conversion of the centre lane into opposing left-turns allows for the remaining lanes to retain a consistent alignment such that drivers travelling straight through do not have to make any lane changing maneuvers. This leads to better utilization of the roadway and increases the safety due to a reduction in potential weaving conflicts.

DUNSMUIR STREET (BETWEEN HOMER STREET AND CITADEL PARADE)

Intersections along Dunsmuir Street within the downtown network will be reconfigured to a single lane in each direction to accommodate two-way vehicle flow between Homer Street and Citadel Parade. A new westbound only truck route is proposed to operate along Dunsmuir Street with access from Homer Street (connecting between Georgia Street and

Dunsmuir Street). The truck route provides an additional link for westbound trucks between Homer Street and Burrard Street, thereby reducing circuitousness for local access and increasing overall goods movement resiliency. Dunsmuir Street will continue to provide high quality active transportation facilities with protected and separated cycle tracks and ample sidewalk space. At the eastern extent, Dunsmuir Street is proposed to connect to the active bridge that will provide a direct pedestrian / cyclist only connection to Creekside Park and Andy Livingstone Park.

APPENDIX B

No Net Traffic Growth Scenario

Detailed Results

APPENDIX B: NO NET TRAFFIC GROWTH SCENARIO DETAILED RESULTS

This appendix presents detailed findings for the No Net Traffic Growth scenario including point-to-points travel times and forecast intersection operations.

Point-to-Point Travel Times

Figures B1 through ***B4*** shows the comparative point to point travel times between the western and eastern extents of the NEFC network. ***Figure B1*** shows the comparative westbound AM peak travel times by scenario for trips along the Expo Boulevard surface street network. ***Figure B2*** shows the comparative westbound AM peak travel time by scenario for trips along the Dunsmuir Viaduct network, as well as northbound travel times along Main Street. ***Figure B3*** shows the comparative eastbound PM peak travel time by scenario for trips along the Pacific Boulevard surface street network. ***Figure B4*** shows the comparative eastbound PM peak travel time by scenario along the Georgia Viaduct street network, as well as the southbound travel times along Main Street.

Figure B1: AM Peak Westbound – Expo Boulevard with Viaducts Replacement

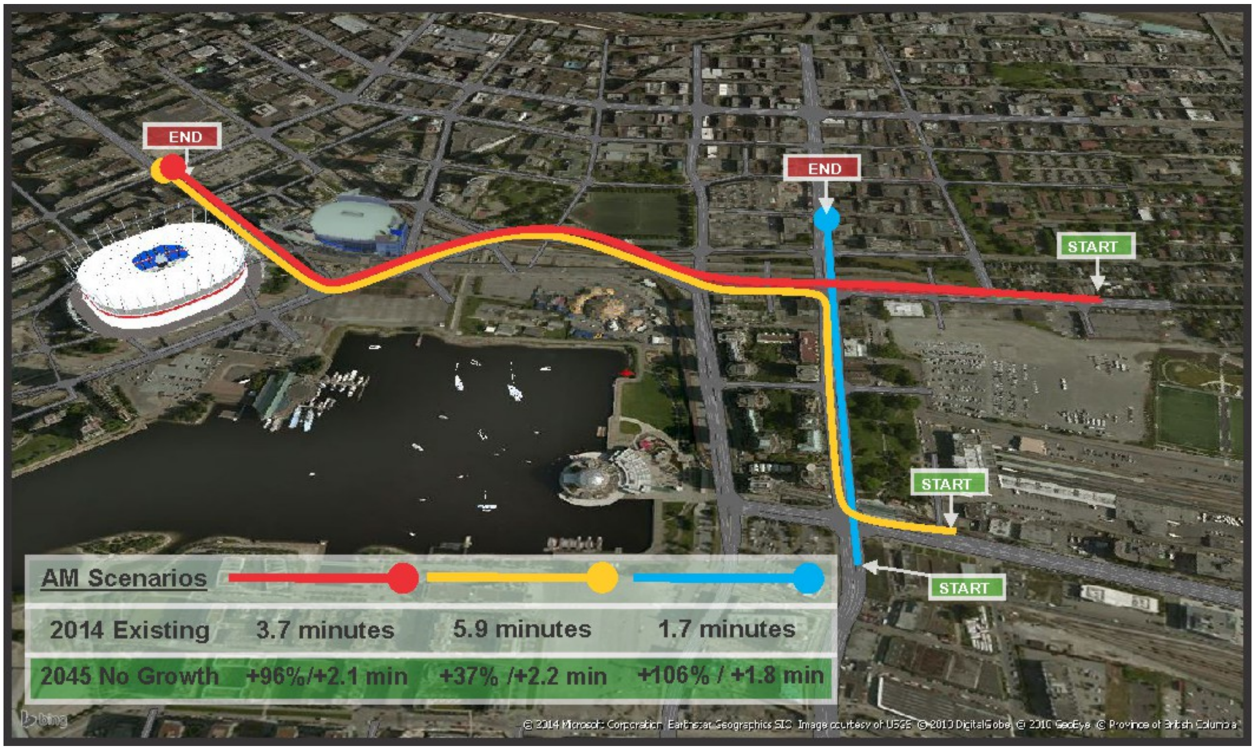


Figure B2: AM Peak Westbound – Dunsmuir Street with Viaducts Replacement

Figure B3: PM Peak Eastbound – Pacific Boulevard with Viaducts Replacement

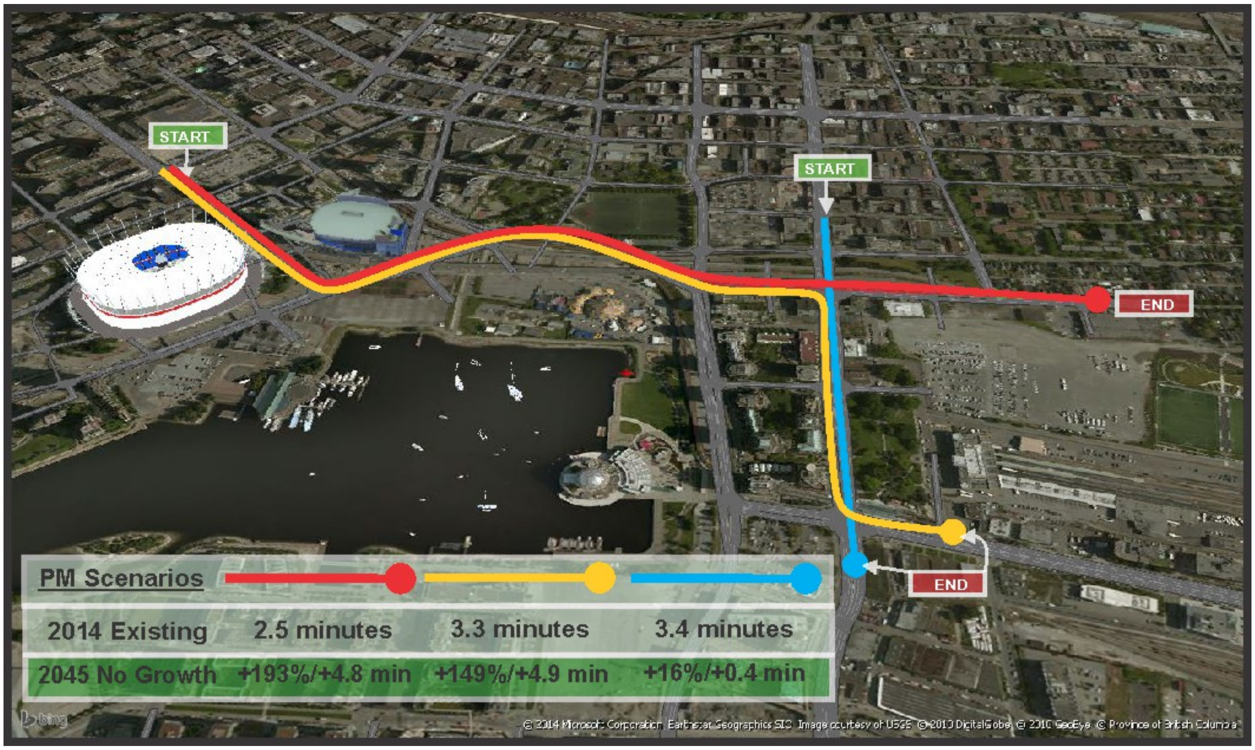


Figure B4: PM Peak Eastbound – Georgia Street with Viaducts Replacement

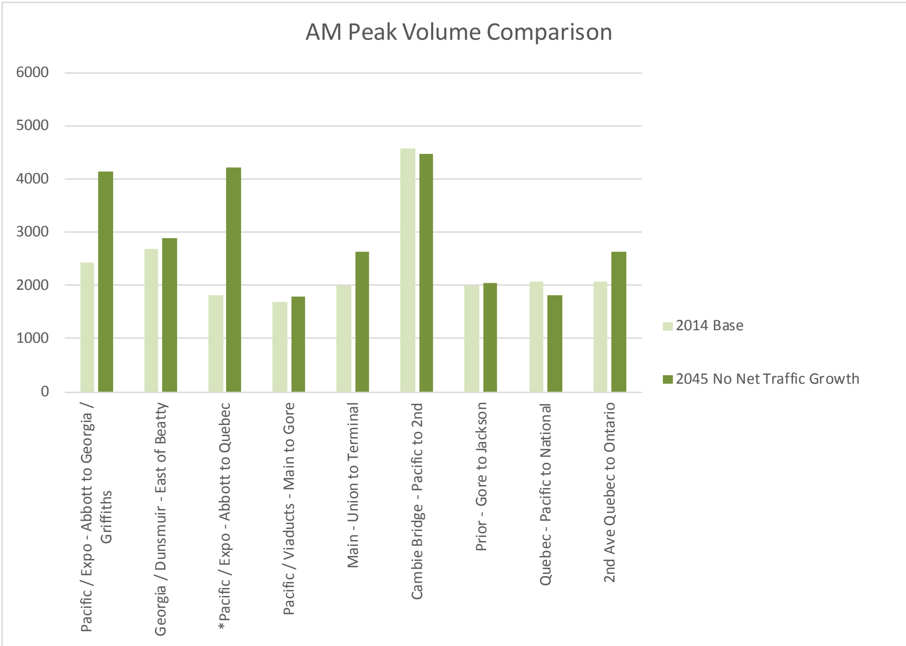
Generally speaking, travel times increase by one to five minutes depending on the route. The largest travel time increases are noted for users of the current Viaducts due to the introduction of new traffic signals along the travel route.

A travel time increase of one to five minutes is unlikely to cause longer distance trips (e.g., from the Northeast sector of the region) to seek an alternate route due to the proportionally small increase to their base travel times. However, local Vancouver-based users could find these modest travel time increases significant relative to their shorter base travel times, and could potentially change their choice of mode, time of day travel, or route.

Volume Comparisons

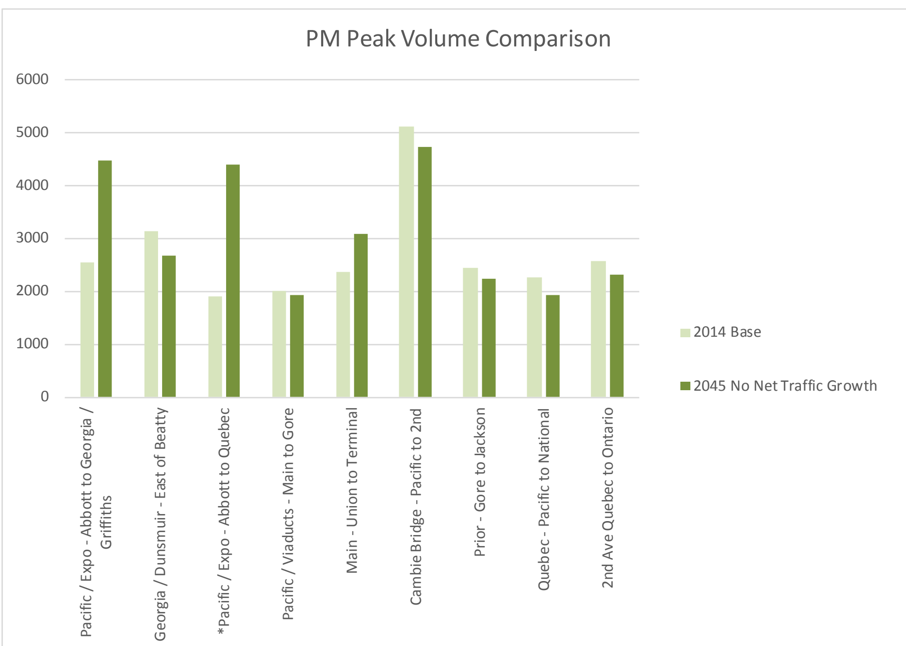
Volume outputs for selected road links can be summarized to indicate the expected net changes due to development and road network modifications. Peak hour volumes can then be factored up to daily traffic volumes to be used as input to future road classification, noise and environmental impact considerations.

Figure B5 and ***Figure B6*** show the comparative link flows for the no net vehicle growth compared with observed existing conditions. These flows are bundled as two-way totals.



***Volume extracted west of Carrall Street (includes Expo slip-lane volume)*

Figure B5: AM Peak Hour Volume Comparison



***Volume extracted west of Carrall Street (includes Expo slip-lane volume)*

Figure B6: PM Peak Hour Volume Comparison

The most significant increases are expected for the Pacific / Expo couplet due to the blending of Georgia and Dunsmuir Viaduct traffic with Pacific and Expo Boulevard traffic between Griffiths Way and Quebec Street. Volume increases are much less pronounced along external network connections such as Main Street and the Cambie Bridge.

There is no expected change to the volume or distribution of traffic on the network. This was achieved by design iterations in development of the conceptual designs for the replacement network.

Table B1 summarizes the resultant daily traffic volumes. Daily traffic volumes were calculated from peak hour volumes by comparing differences to the regional EMME model for each individual link and factoring each proportionally. Light and heavy truck proportions are also shown, which have been estimated using sample classification counts at key intersections.

Table B1: Daily Volume Comparison

Street	Representative Block	Current Volumes					Projected Volumes – 2045 No Net Traffic Growth and Viaducts Replacement				
		All Vehicles - 24 Hr (2-way Volume)	AM Peak (Volume)	PM Peak (Volume)	Light Trucks %	Heavy Trucks %	All Vehicles - 24 Hr (2-way Volume)	AM Peak (Volume)	PM Peak (Volume)	Light Trucks %	Heavy Trucks %
Abbott	Pacific to Expo	3876	158	323	2	2	3300	112	216	2	2
Expo	Abbott to Georgia / Griffiths	12864	1038	1072	1.2	1.2	8500	540	910	1.2	1.2
New Pacific	Abbott to Georgia / Griffiths	n/a	n/a	n/a	n/a	n/a	42800	3601	3569	2	2
Pacific (Current)	Abbott to Georgia / Griffiths	17544	1400	1462	2	2	n/a	0	0	n/a	n/a
Georgia	East of Beatty	23160	1252	1930	2.2	2.2	30000	2776	2516	2.2	2.2
Dunsmuir	East of Beatty	14568	1446	1214	2.2	2.2	1900	105	154	2.2	2.2
Quebec	Pacific to National	27204	2070	2267	2	2	25400	1809	1931	2	2
Pacific	Abbott to Quebec	13344	841	1112	2	2	43600	3577	3647	2	2
Expo	Abbott to Quebec*	9480	989	790	1.2	1.2	9200	640	770	1.2	1.2
New Pacific	Quebec to Main	n/a	n/a	n/a	n/a	n/a	31600	2479	2630	2	2
New Pacific / Prior	Main to Gore	2375	130	198	3	3	23200	1795	1934	2	2
Viaducts	Main to Gore	21792	1571	1816	2	2	n/a	0	0	n/a	n/a
Main	Union to Terminal	28500	2002	2375	2	2	16000	2647	3073	2	2
Main	Union to Pender	13284	949	1107	2	2	14300	1514	1940	2	2
Pacific	Cambie to Nelson	17988	1350	1499	2	2	20800	1329	1734	2	2
Cambie Bridge	Pacific to 2nd	61548	4575	5129	2	2	70000	4479	4740	2	2
Terminal	Main to Station	29556	2503	2463	2	2	31000	2145	2289	2	2
Prior	Gore to Jackson	29196	1985	2433	2	2	30600	2038	2227	2	2
2nd Ave	Quebec to Ontario	30960	2061	2580	2	2	31000	2627	2322	2	2

**Projected 2045 volumes between Carrall and Abbott*

Intersection Performance

The performance of individual intersections can be investigated in further detail using the Synchro capacity analysis program. Conventional intersection performance statistics such as Level of Service rating (from A to F), average vehicle delay, and movement volume to capacity ratios can be reported. The Synchro model's simplicity allows for rapid testing of alternative configurations to reduce delays or increase throughput before re-inserting into the PARAMICS model for testing. The signal timings take into accounts the numerous pedestrian and cycling crossings as well as coordination between adjacent intersections. A cycle length of 120 seconds was used along Pacific Boulevard from Georgia Street to Main Street.

It should be noted that the operational performance garnered from Synchro can sometimes underreport movements with exceedingly high delays and poor levels of service. In addition, volumes imported from PARAMICS to Synchro represent the total supply of vehicles and any unserved demand at the intersection that is not processed will not be realized in the Synchro results. To ensure the validity of the Synchro results, testing was conducted in parallel in a microsimulation environment to determine the soundness of the proposed designs.

Intersection capacity analysis results presented in ***Table B2*** were developed by using forecast vehicle volumes extracted from the microsimulation traffic model and imported to Synchro. Intersections with critical movement volume to capacity ratios greater than 0.90 or a Level of Service rating lower than D (representing an average 55 seconds of delay per vehicle) are highlighted in red as these exceed typical performance standards.

The intersection performance statistics are summarized in ***Table B2***, with a comparison of the existing conditions and the forecast No Net Traffic Growth Viaducts replacement scenarios. The Georgia / Pacific intersection will remain most congested in the network due to its multiple conflicting vehicle and pedestrian phases as well as high background and local development traffic volumes.

APPENDIX B: NO NET TRAFFIC GROWTH SCENARIO DETAILED RESULTS

Table B2: Intersection Performance Statistics

Intersection	2014 Existing Baseline								2045 No Net Traffic Growth Viaducts Replacement					
	AM Peak Hour				PM Peak Hour				AM Peak Hour			PM Peak Hour		
	Avg. Delay (sec / veh)	LoS	v/c Ratio	95th Percentile Queue Length (m)	Avg. Delay (sec / veh)	LoS	v/c Ratio	95th Percentile Queue Length (m)	Avg. Delay (sec / veh)	LoS	v/c Ratio	Avg. Delay (sec / veh)	LoS	v/c Ratio
Main / Terminal	96.2	F	1.44	310.5 NB	103.2	F	1.33	330.4 SB	93.5	F	1.33	101.2	F	1.36
Quebec / Expo / Pacific	14.0	B	0.52	64.3 WB	57.5	E	0.49	62.8 WB	n/a	n/a	n/a	n/a	n/a	n/a
New Pacific / Quebec	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	63.8	E	0.98	59.1	E	1.01
Gore / Prior	72.5	E	1.16	153.2 WB	40.0	D	1.02	146.2 EB	17.1	B	0.82	37	D	0.94
Georgia Viaduct EB Off-Ramp / Main	6.5	A	0.59	21.1 NB	29.8	C	1.04	140.2 EB	n/a	n/a	n/a	n/a	n/a	n/a
Prior / Main	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	58.3	E	0.94	69.7	E	1.17
Main / Union	18.9	B	0.65	41.7 WB	20.0	C	0.69	45.1 WB	12.3	B	0.49	15	B	0.38
Pacific / Carrall	2.6	A	0.24	22.0 EB	3.2	A	0.33	15.0 SB	8.5	A	0.63	12	B	0.69
Expo / Carrall	15.2	B	0.67	70.7 SB	14.7	B	0.59	64.5 SB	n/a	n/a	n/a	n/a	n/a	n/a
Pacific / Abbott	12.0	B	0.45	34.6 EB	5.2	A	0.59	32.0 SB	9.2	A	0.64	15.8	B	0.7
Expo / Abbott	7.0	A	0.42	13.9 NB	9.6	A	0.34	31.2 NB	10.1	B	0.34	12	B	0.43
Pacific / Nelson	14.6	B	0.70	64.3 SB	53.1	D	1.16	125.1 SB	29.6	C	0.67	36.8	D	0.95
Pacific / Smithe Mews	15.5	B	0.57	67.4 EB	21.0	C	0.78	62.6 EB	24.2	C	0.72	20.8	C	0.57
Expo / Griffiths	5.1	A	0.42	12.7 WBT	9.6	A	0.53	19.8 WB	5.7	A	0.36	7.8	A	0.45
Expo / Smithe	22.5	C	0.63	62.8 WBR	17.1	B	0.85	98.1 WBR	43.7	D	1.04	37.1	D	0.98
Expo / Nelson	24.2	C	0.77	62.0 WBT	45.5	D	1.05	101.9 WBT	14.6	B	0.44	18.2	B	0.62
Beatty / Georgia	6.1	A	0.51	27.8 WB	14.0	B	0.85	47.7 NBR	10.9	B	0.64	11.9	B	0.78
Georgia / Cambie	12.0	B	0.50	43.1 EB	14.2	B	0.59	53.5 EB	35	D	0.98	26.5	C	0.89
Georgia / Citadel Parade	0.8	A	0.28	6.5 WB	0.7	A	0.43	2.5 SB	n/a	n/a	n/a	n/a	n/a	n/a
New Pacific / Georgia	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	74.9	E	1.24	64.9	E	0.99

APPENDIX C

Full Traffic Growth Scenario

Detailed Results

This appendix presents detailed findings for the Full Traffic Growth scenario including point-to-points travel times and forecast intersection operations.

Point-to-Point Travel Times

Figures C1 through ***C8*** shows the comparative point to point travel times between the western and eastern extents of the NEFC network. ***Figures C1*** and ***C2*** shows the comparative westbound AM peak travel times by scenario for trips along the Expo Boulevard surface street network. ***Figures C3*** and ***C4*** show the comparative westbound AM peak travel time by scenario for trips along the Dunsmuir Viaduct network, as well as northbound travel times along Main Street. ***Figures C5*** and ***C6*** show the comparative eastbound PM peak travel time by scenario for trips along the Pacific Boulevard surface street network. ***Figures C7*** and ***C8*** show the comparative eastbound PM peak travel time by scenario along the Georgia Viaduct street network, as well as the southbound travel times along Main Street.

Figure C1: AM Peak Westbound – Expo Boulevard with Viaducts

APPENDIX C: FULL TRAFFIC GROWTH SCENARIO DETAILED RESULTS

Figure C2: AM Peak Westbound – Expo Boulevard with Viaducts Replacement

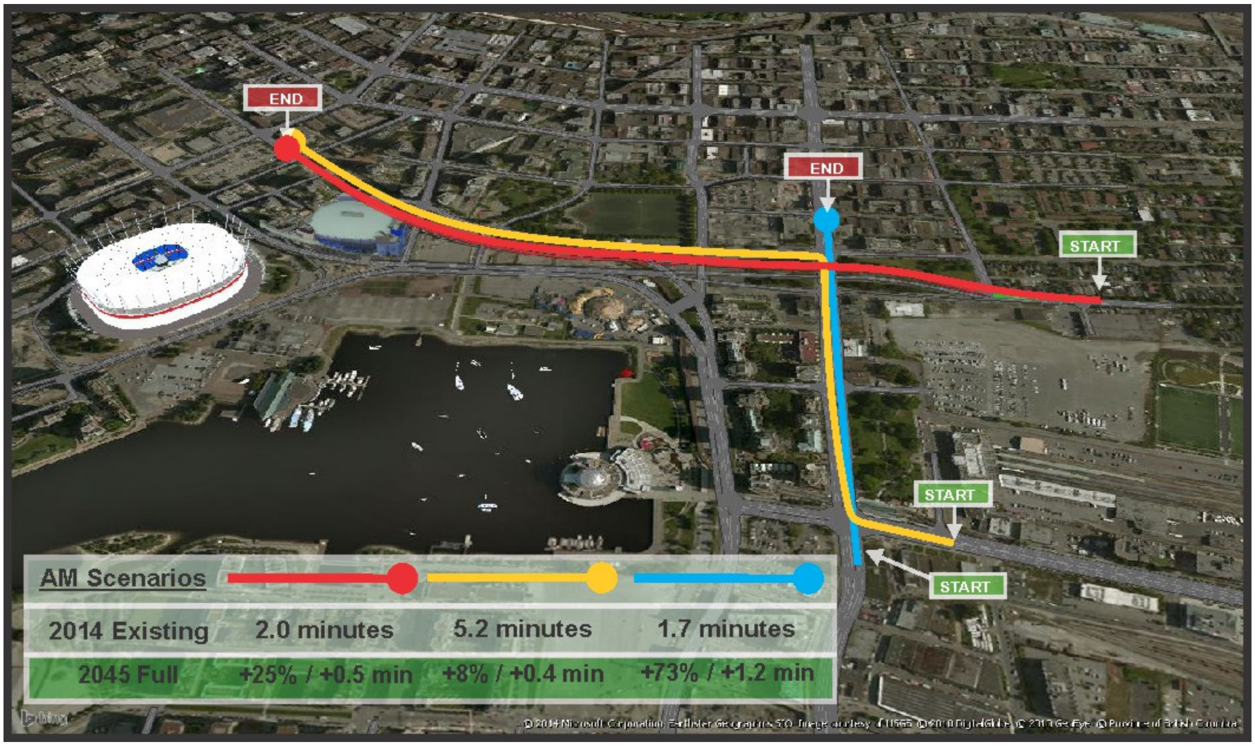


Figure C3: AM Peak Westbound – Dunsmuir Street with Viaducts

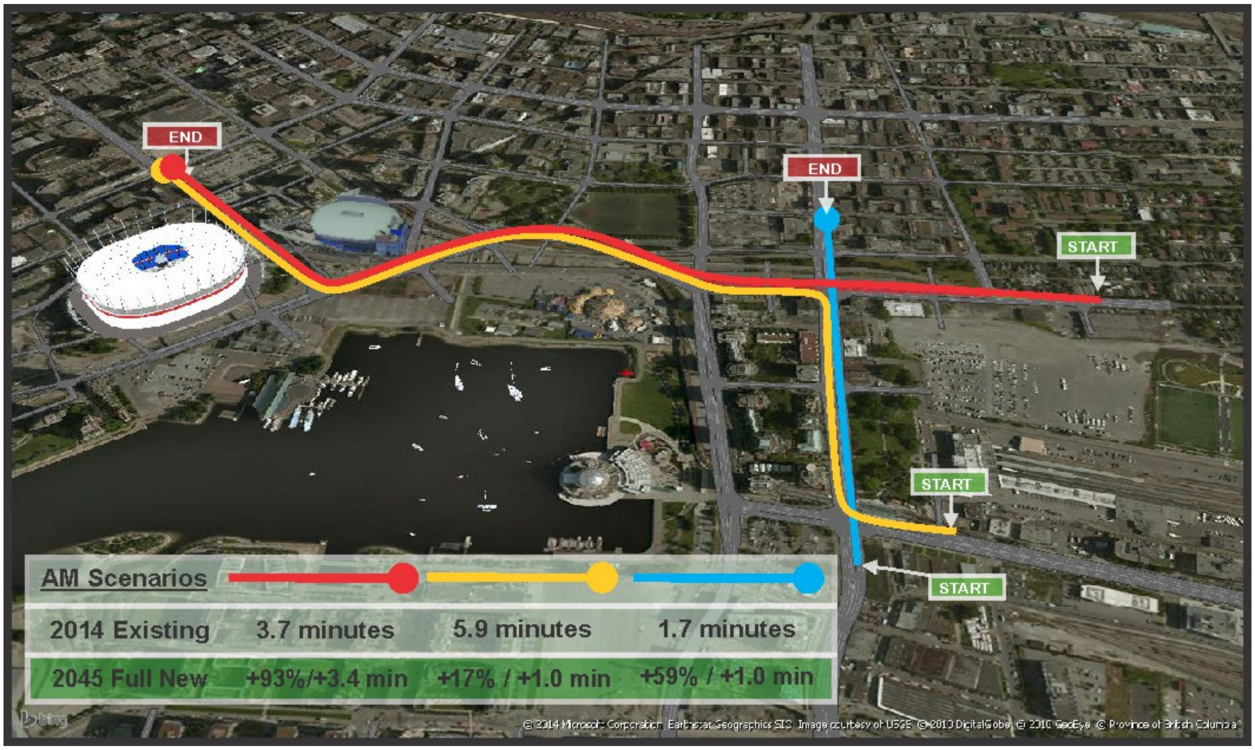


Figure C4: AM Peak Westbound – Dunsmuir Street with Viaducts Replacement

Figure C5: PM Peak Eastbound – Pacific Boulevard with Viaducts

APPENDIX C: FULL TRAFFIC GROWTH SCENARIO DETAILED RESULTS

Figure C6: PM Peak Eastbound – Pacific Boulevard with Viaducts Replacement

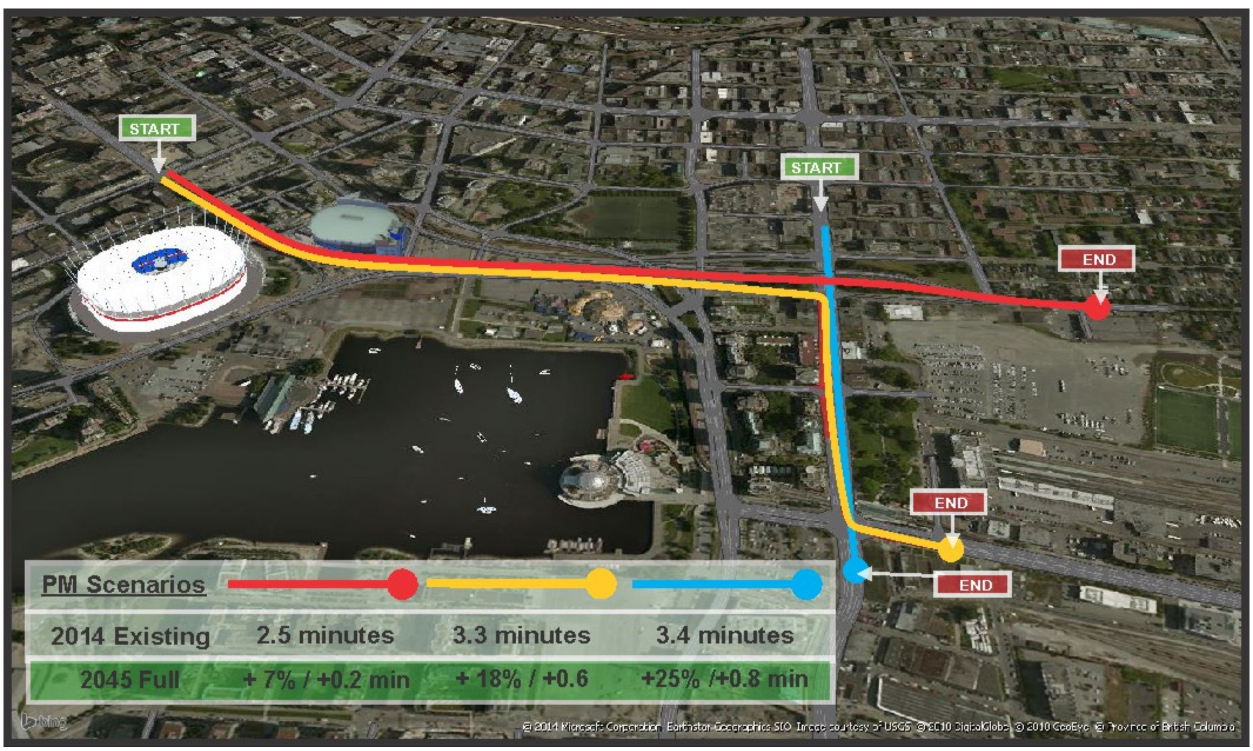


Figure C7: PM Peak Eastbound – Georgia Street with Viaducts

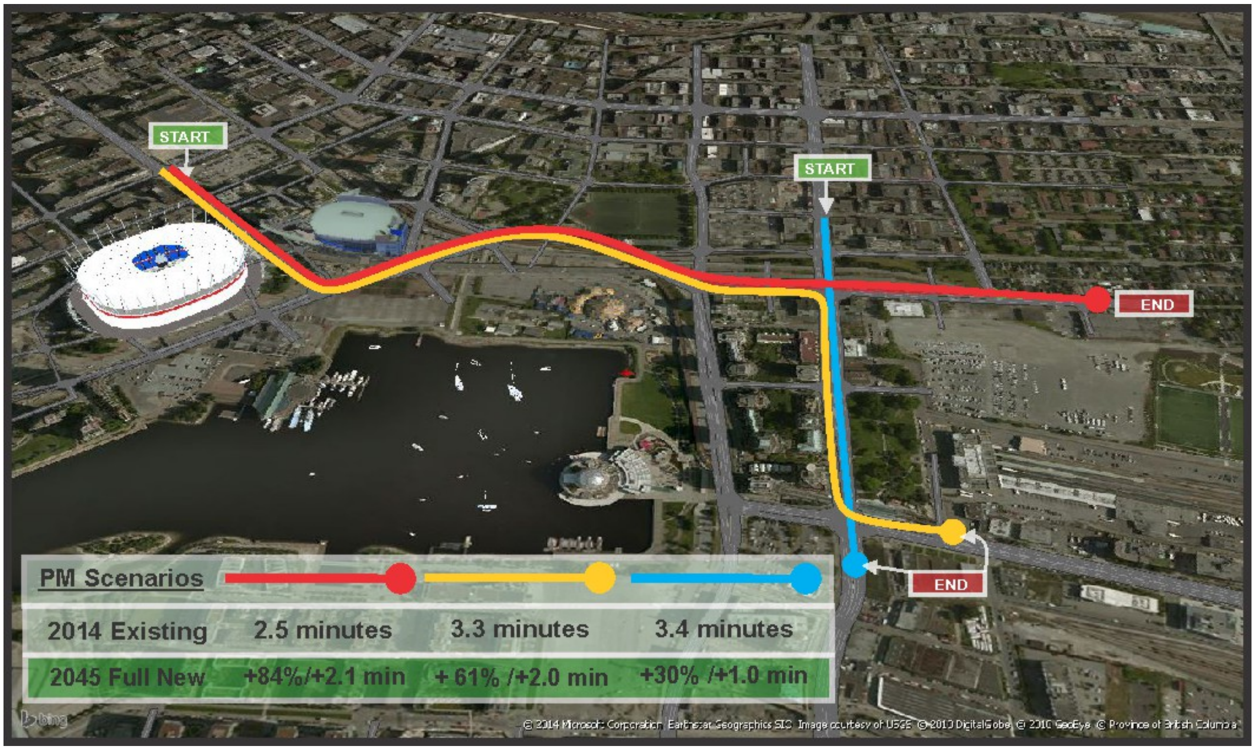


Figure C8: PM Peak Eastbound – Georgia Street with Viaducts Replacement

On the whole, travel times increase by one to nearly four minutes depending on the route. The largest travel time increases are noted for AM westbound users of the current Viaducts.

The estimated travel time increases to motorists in both travel demand scenarios are not expected to translate to travel time increases to Emergency Service Providers. During emergencies, priority is given to these vehicles by general purpose traffic. Furthermore, the emergency vehicles have the ability to cross the directional dividing line and onto lanes of oncoming traffic to bypass areas of congestion.

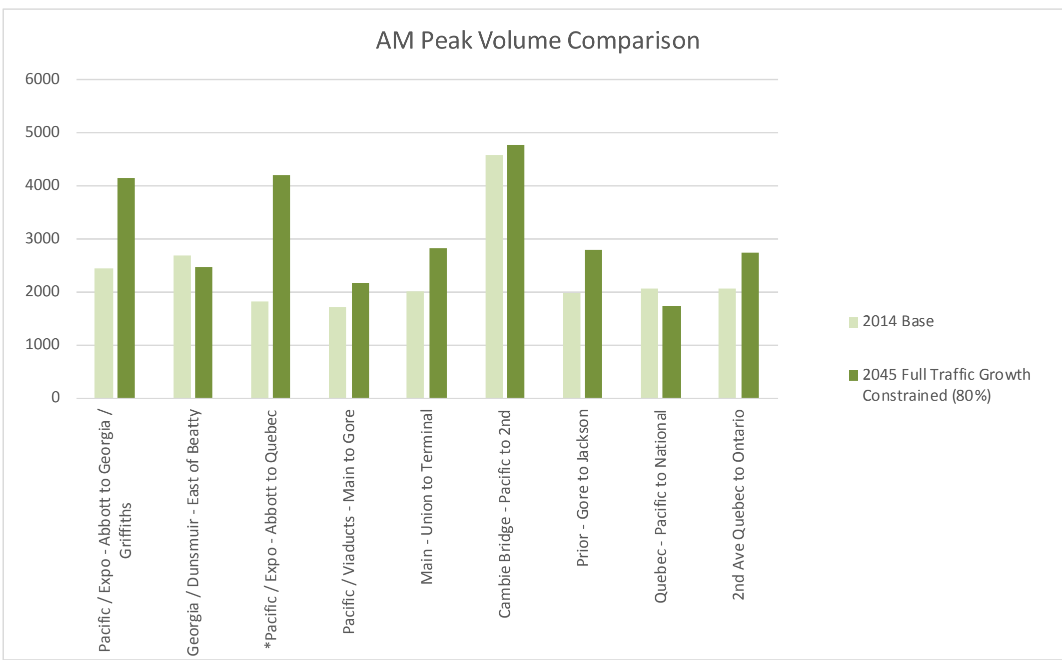
Examining the effects with the Viaducts removed, Georgia Ramps connection to Pacific Boulevard, and at-grade Pacific Boulevard connection to Quebec Street provides improved access for emergency vehicles. The proposed at-grade Pacific Boulevard alignment would allow better direct access from the existing Fire Hall on Heatley Avenue to the two stadia, which would also hold true for the proposed Hospital in the False Creek Flats. An at-grade Pacific Boulevard would provide emergency vehicles improved access to the Chinatown and Downtown East Side and to downtown via Georgia Ramps as they would no longer be constrained by the lack of exit points from the Viaducts.

Volume Comparisons

Volume outputs for selected road links can be summarized to indicate the expected net changes due to development and road network modifications. Peak hour volumes can then be factored up to daily traffic volumes to be used as input to future road classification, noise and environmental impact considerations.

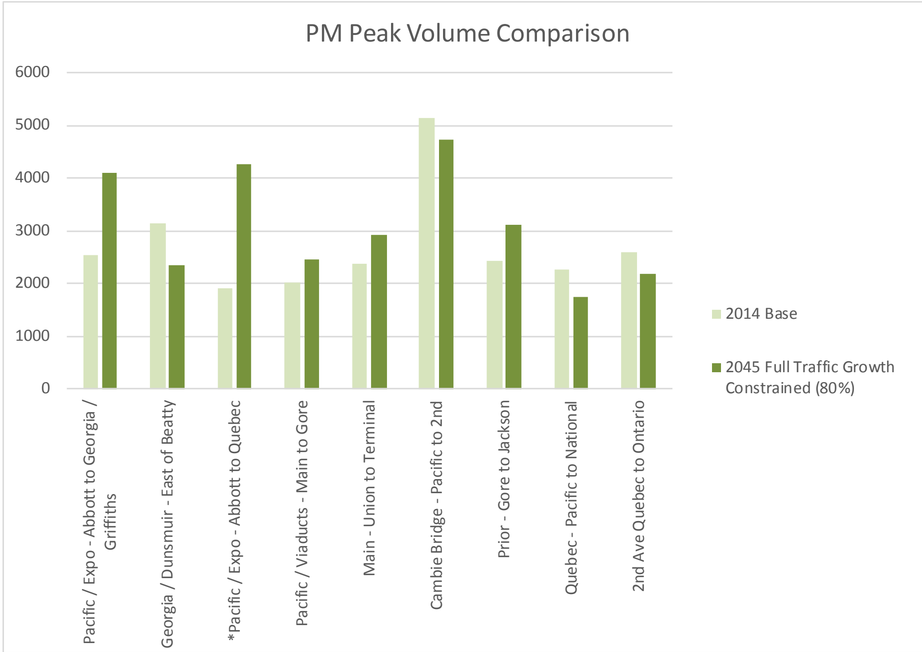
Given the constraints encountered in processing the full development scenario traffic, a volume comparison scenario has been illustrated assuming a "constrained" forecast that reflects the upstream and downstream constraints on traffic growth as observed in the PARAMICS micro-simulation model. The constrained forecast represents 80% of combined background and NEFC traffic demand during the peak hours.

Figures C9 and ***C10*** show the comparative link flows for each of the scenarios as compared with observed existing conditions. These flows are bundled as two-way totals.



***Volume extracted west of Carrall Street (includes Expo slip-lane volume)*

Figure C9: AM Peak Hour Volume Comparison



***Volume extracted west of Carrall Street (includes Expo slip-lane volume)*

Figure C10: PM Peak Hour Volume Comparison

The most significant increases are expected for the Pacific / Expo couplet due to the blending of Georgia and Dunsmuir Viaduct traffic with Pacific and Expo Boulevard traffic between Griffiths Way and Quebec Street. Volume increases are much less pronounced along external network connections such as Main Street and the Cambie Bridge.

Table C1 summarizes the resultant daily traffic volumes for the major analysis scenarios. Daily traffic volumes were calculated from peak hour volumes by comparing differences to the regional EMME model for each individual link and factoring each proportionally. Light and heavy truck proportions are also shown, which have been estimated using sample classification counts at key intersections.

APPENDIX C: FULL TRAFFIC GROWTH SCENARIO DETAILED RESULTS

Table C1: Daily Volume Comparison

Street	Representative Block	Current Volumes					Projected Volumes – 2045 Full New Constrained (80%)				
		All Vehicles - 24 Hr (2-way Volume)	AM Peak (Volume)	PM Peak (Volume)	Light Trucks %	Heavy Trucks %	All Vehicles - 24 Hr (2-way Volume)	AM Peak (Volume)	PM Peak (Volume)	Light Trucks %	Heavy Trucks %
Abbott	Pacific to Expo	3876	158	323	2	2	2800	126	236	2	2
Expo	Abbott to Georgia / Griffiths	12864	1038	1072	1.2	1.2	10000	846	796	1.2	1.2
New Pacific	Abbott to Georgia / Griffiths	n/a	n/a	n/a	n/a	n/a	42000	3307	3305	2	2
Pacific (Current)	Abbott to Georgia / Griffiths	17544	1400	1462	2	2	0	0	0	n/a	n/a
Georgia	East of Beatty	23160	1252	1930	2.2	2.2	26600	2351	2187	2.2	2.2
Dunsmuir	East of Beatty	14568	1446	1214	2.2	2.2	1800	130	159	2.2	2.2
Quebec	Pacific to National	27204	2070	2267	2	2	21600	1735	1758	2	2
Pacific	Abbott to Quebec	13344	841	1112	2	2	42000	3497	3511	2	2
Expo	Abbott to Quebec*	9480	989	790	1.2	1.2	9000	700	750	1.2	1.2
New Pacific	Quebec to Main	n/a	n/a	n/a	n/a	n/a	31000	2503	2643	2	2
New Pacific / Prior	Main to Gore	2375	130	198	3	3	25000	2180	2446	2	2
Viaducts	Main to Gore	21792	1571	1816	2	2	0	0	0	n/a	n/a
Main	Union to Terminal	28500	2002	2375	2	2	31000	2824	2908	2	2
Main	Union to Pender	13284	949	1107	2	2	22600	1638	1802	2	2
Pacific	Cambie to Nelson	17988	1350	1499	2	2	19900	1732	1852	2	2
Cambie Bridge	Pacific to 2nd	61548	4575	5129	2	2	70500	4768	4740	2	2
Terminal	Main to Station	29556	2503	2463	2	2	31900	1852	2002	2	2
Prior	Gore to Jackson	29196	1985	2433	2	2	33000	2786	3125	2	2
2nd Ave	Quebec to Ontario	30960	2061	2580	2	2	34000	2748	2174	2	2

**Projected 2045 volumes between Carrall and Abbott*

Intersection Performance

The performance of individual intersections can be investigated in further detail using the Synchro capacity analysis program. Conventional intersection performance statistics such as Level of Service rating (from A to F), average vehicle delay, and movement volume to capacity ratios can be reported. The Synchro model's simplicity allows for rapid testing of alternative configurations to reduce delays or increase throughput before re-inserting into the PARAMICS model for testing.

It should be noted that the operational performance garnered from Synchro can sometimes underreport movements with exceedingly high delays and poor levels of service. In addition, volumes imported from PARAMICS to Synchro represent the total supply of vehicles and any unserved demand at the intersection that is not processed will not be realized in the Synchro results. To ensure the validity of the Synchro results, testing was always compared with the PARAMICS microsimulation environment to corroborate any Synchro output.

Intersection capacity analysis results presented in ***Table C2*** were developed by using forecast vehicle volumes from the microsimulation traffic model. Intersections with critical movement volume to capacity ratios greater than 0.90 or a Level of Service rating lower than D (representing an average of 55 seconds of delay per vehicle) are highlighted in red as these exceed typical performance standards.

It was observed that considerable congestion may occur at the major intersections based on forecast traffic volumes. Several intersections may experience high average delays and may have at least one movement with a volume to capacity ratio greater than 1.00. It should be noted that these delays are not unique to the Viaducts replacement network within the Northeast False Creek, as sample intersections in the vicinity also operate at congested levels during peak hours. Peripheral intersections will also continue to affect traffic flows into and out of the NEFC area will continue to serve as volume controls. The following mitigation options were explored as part of the Synchro analysis:

- Prohibition of eastbound and westbound left-turns at the Georgia / Beatty intersection and provision of protected eastbound and westbound left-turns at the Georgia / Cambie signalized intersection – left-turns from the new two-way section of Georgia Street were observed to create significant delays in the shared through / left-turn configuration and the provision of a separate bay at Cambie Street will avoid impacts to through traffic.
- Conversion of the Georgia / Citadel Parade intersection to right-in / right-out only (removal of existing signal).

- Provision of an eastbound left-turn bay at the Prior / Gore signalized intersection. This would facilitate access to the eastern half of the 6D development block as well as the Strathcona neighbourhood while avoiding impacts to eastbound through traffic.
- Optimizing signal timing and phasing along the Viaducts replacement network.

All mitigation options were carried forward with the exception of the eastbound left-turn at Prior / Gore due to potential reconfiguration of the future False Creek Flats arterial. In the interim, this turning movement is proposed to be restricted during peak hours to facilitate increased through capacity. Other mitigation measures were explored such as split signal phases and dual left-turn movements for the Smithe Mews and Griffiths Way intersections with Pacific / Expo. These were deemed to be impractical due to the need to service pedestrian crossing phases on both legs of the intersection which would result in significantly increased cycle lengths and delays for all modes throughout the day. The intersection performance statistics are summarized in ***Table C2***. The Georgia / Pacific intersection will remain the most congested in the network, due to its multiple conflicting vehicle and pedestrian phases as well as high background and local development traffic volumes.

APPENDIX C: FULL TRAFFIC GROWTH SCENARIO DETAILED RESULTS

Table C2: Intersection Performance Statistics

Intersection	2014 Existing Baseline								2045 Full New Constrained With Mitigation (85%)					
	AM Peak Hour				PM Peak Hour				AM Peak Hour			PM Peak Hour		
	Avg. Delay (sec / veh)	LoS	v/c Ratio	95th Percentile Queue Length (m)	Avg. Delay (sec / veh)	LoS	v/c Ratio	95th Percentile Queue Length (m)	Avg. Delay (sec / veh)	LoS	v/c Ratio	Avg. Delay (sec / veh)	LoS	v/c Ratio
Main / Terminal	96.2	F	1.44	310.5 NB	103.2	F	1.33	330.4 SB	102.3	F	1.55	98.6	F	1.41
Quebec / Expo / Pacific	14.0	B	0.52	64.3 WB	57.5	E	0.49	62.8 WB	n/a	n/a	n/a	n/a	n/a	n/a
New Pacific / Quebec	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	56.4	E	1.01	47	D	0.99
Gore / Prior	72.5	E	1.16	153.2 WB	40.0	D	1.02	146.2 EB	24.1	C	0.88	31.2	C	0.85
Georgia Viaduct EB Off-Ramp / Main	6.5	A	0.59	21.1 NB	29.8	C	1.04	140.2 EB	n/a	n/a	n/a	n/a	n/a	n/a
Prior / Main	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	54.8	D	0.92	65.4	E	1.03
Main / Union	18.9	B	0.65	41.7 WB	20.0	C	0.69	45.1 WB	5.8	A	0.35	11.2	B	0.41
Pacific / Carrall	2.6	A	0.24	22.0 EB	3.2	A	0.33	15.0 SB	21.2	C	0.8	14.1	B	0.75
Expo / Carrall	15.2	B	0.67	70.7 SB	14.7	B	0.59	64.5 SB	n/a	n/a	n/a	n/a	n/a	n/a
Pacific / Abbott	12.0	B	0.45	34.6 EB	5.2	A	0.59	32.0 SB	12.6	B	0.57	11.8	B	0.66
Expo / Abbott	7.0	A	0.42	13.9 NB	9.6	A	0.34	31.2 NB	11.7	B	0.51	11.5	B	0.41
Pacific / Nelson	14.6	B	0.70	64.3 SB	53.1	D	1.16	125.1 SB	31.1	C	0.82	39.1	D	0.91
Pacific / Smithe Mews	15.5	B	0.57	67.4 EB	21.0	C	0.78	62.6 EB	30.5	C	0.95	51.1	D	1.31
Expo / Griffiths	5.1	A	0.42	12.7 WBT	9.6	A	0.53	19.8 WB	12	B	0.52	10.7	B	0.63
Expo / Smithe	22.5	C	0.63	62.8 WBR	17.1	B	0.85	98.1 WBR	31.7	C	0.97	30.1	C	0.97
Expo / Nelson	24.2	C	0.77	62.0 WBT	45.5	D	1.05	101.9 WBT	21	C	0.83	31.6	C	1.04
Beatty / Georgia	6.1	A	0.51	27.8 WB	14.0	B	0.85	47.7 NBR	11.6	B	0.59	11.8	B	0.49
Georgia / Cambie	12.0	B	0.50	43.1 EB	14.2	B	0.59	53.5 EB	27.6	C	0.83	29.9	C	0.83
Georgia / Citadel Parade	0.8	A	0.28	6.5 WB	0.7	A	0.43	2.5 SB	n/a	n/a	n/a	n/a	n/a	n/a
New Pacific / Georgia	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	66.7	E	1.21	73.2	E	1.05

APPENDIX D

Preliminary Construction Analysis

The preliminary construction phasing developed proposes nine stages of construction for the removal of the Viaducts. The stages were reviewed at a high level for their overall impact to traffic and the Stage shown in ***Figure D.1*** below was deemed to have the greatest overall impact to traffic. As shown, this stage involves the demolition of the existing Georgia Street Viaducts from Beatty Street to its connection to the east at Main Street while accommodating eastbound traffic by providing a two-way route via the existing one-way Dunsmuir Viaduct. The duration of construction for this stage is anticipated to take between six to ten months to complete. This section provides a high-level overview and analysis of the potential impacts to the immediate surrounding area during this proposed second stage of construction. A full assessment of construction impacts was conducted in a separate detailed design process which identified key impacts to pedestrians / cycling facilities, parking, local block access, transit among others. The detailed traffic management report specifies minimum transportation design criteria which ensures that the network is functional during the construction process.

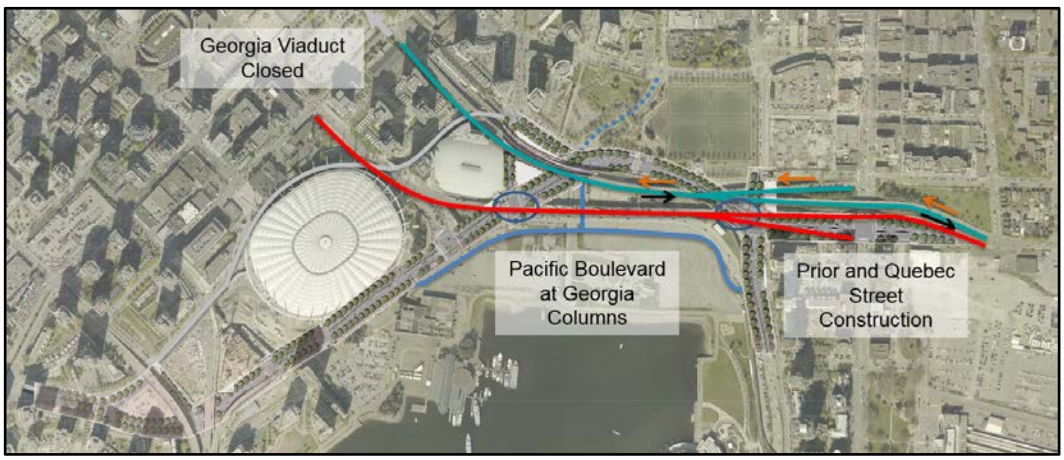


Figure D.1: Construction Phasing Stage of Proposed Plan (MMM|WSP, 2017)

The removal of the Georgia Viaduct during stage two would necessitate approximately 1,900 vehicles, which previously used the Georgia Viaduct during the PM peak hour, to reroute through the network and use alternative streets. In addition, the conversion of one-way Dunsmuir to a two-way single lane road in stage one would constrain existing trips into and out of downtown. It is expected that over time, later construction stages would allow drivers to adapt to the temporary construction network and re-route to routes that provide more efficient travel times. This stage imposes the first significant physical and operational changes that would require drivers to use alternate routes. These changes, which include closures and detours, are implemented on a relatively short time scale and therefore would not allow drivers to make appropriate adjustments to their trip initially.

D.1 Methodology and Assumptions

The PARAMICS model used for the 2014 existing network analysis was adapted to investigate construction impacts. Analysis was focused on the PM peak commuter hours with a simulation period ranging from 3:30 to 5:30 PM. The PM peak represents the worst-case scenario as these hours exhibit the highest volumes throughout the day. The PARAMICS model was calibrated to ensure it was capable of reasonably replicating baseline traffic volumes, travel times and queuing behaviour. Travel demands were obtained from an origin-destination traversal matrix cut from the 2011 RTM. It should be noted that by constraining the construction scenario demands to the microscopic model extents, some long range diversionary trips would not be captured in the model. However, by using existing demands, the model is more reflective of an opening day scenario where drivers have not transitioned to changing their travel behaviour and provides a conservative estimate of resulting traffic impacts. For the construction modelling analysis, a manual reassignment of trips from Georgia Street to Dunsmuir Street was conducted to reflect the removal of Georgia Viaduct. It is expected that some drivers would reroute to Dunsmuir Street at the intersection with Homer Street and Hamilton Street before entering the model. The model extents are highlighted in green in ***Figure D.2***.

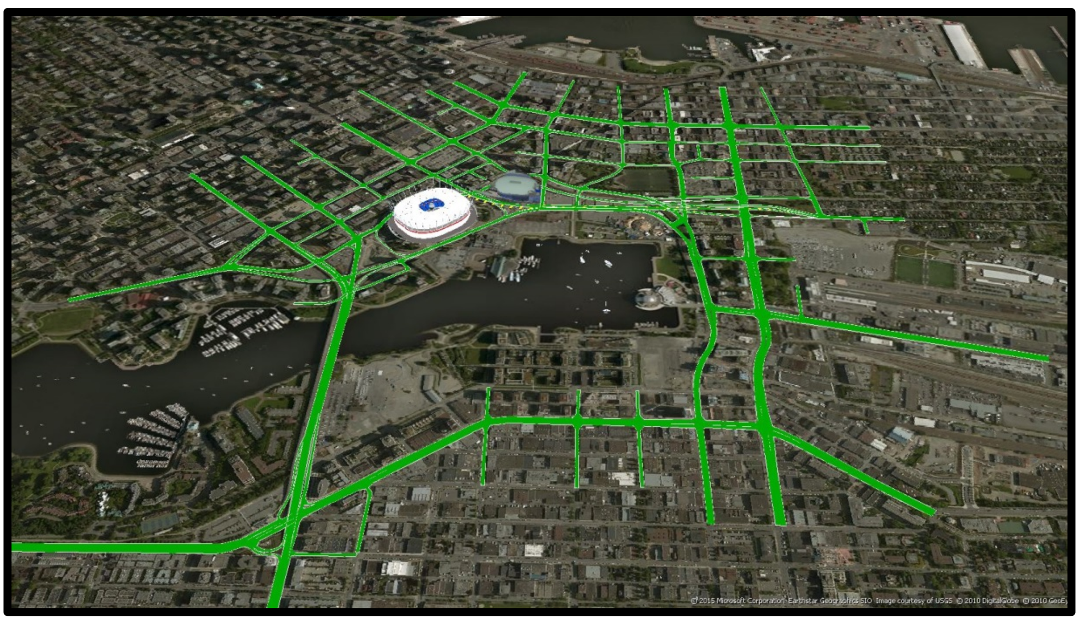


Figure D.2: PARAMICS Model Extents

Modelling the stage two construction scenario involved removal of the Georgia Viaduct, east of Beatty Street including the Main Street and Prior Street off-ramps to the east. The Dunsmuir Viaduct is converted to a two-way road with a three-lane vehicle cross-section (two-westbound and one eastbound). West of Beatty Street, the single lane configuration widens to two lanes for westbound traffic. The single lane configuration is maintained for eastbound vehicles on Dunsmuir from the model extents at Cambie Street all the way to Prior Street with the exception of the intersection at Beatty Street where a second lane is available to accommodate left turn movements. It should be noted that the two-way lane geometry on Dunsmuir potentially could extend up to Homer Street, which is outside the extents of the PARAMICS model.

Minor signal timing adjustments were also made to reflect the changes in road geometry and traffic patterns. The following contains a list of changes were made:

- Removal of the eastbound fixed signal phase at the intersection of Main Street and Georgia Viaduct off-ramp;
- Rebalancing the green splits at Prior Street and Gore Avenue to provide additional east-west green time for vehicles on the Dunsmuir Viaduct; and
- Rebalancing the green splits along Dunsmuir Street at Citadel Parade, Beatty Street, and Cambie Street to accommodate the additional eastbound traffic.

D.2 Modelling Results

The PARAMICS model was run to generate a variety of descriptive traffic performance statistics. Of particular interest were the following metrics:

Total Vehicles Processed

The total vehicles processed metric is used to confirm that the full travel demand is capable of being accommodated by the transportation network as coded within the model. If congestion results in blockage to intersections or traffic loading zones, the processed model volume will fall below the total applied demand. Models with blocking issues can result in unreliable comparative metrics due to excessive delay imposed on selected vehicles and exaggerated route diversion effects. The metric is also useful for gauging the total level of traffic activity in each scenario

Average Network Travel Time

Average network travel time represents the aggregate time that all vehicles spend within the model network between their origin and destination. This global statistic is divided by the total number of vehicles processed to create a measure of average travel time per vehicle. It is a single network-wide statistic and allows for easy comparison across scenarios by capturing all possible trip types, origins and destinations. The results of the average network travel time statistics are shown in ***Table D.1***. Of interest is the change relative to the calibrated model base.

VEHICLE KILOMETRES TRAVELLED

Vehicle kilometres travelled provides an aggregate of the total distance that all vehicles have traversed throughout the simulation. This global statistic is one of the performance indicators that is widely used as a common measure of roadway use. It is used in estimating congestion and can provide a general measure of the rerouting behaviour. In addition, this indicator is used for transportation greenhouse gas (GHG) emissions and air quality calculations.

AVERAGE VEHICLE SPEED

Average vehicle speed represents the relationship between vehicle distance travelled and vehicle travel time. This metric provides an easy comparison between scenarios to highlight how well vehicles can move through the network. In general, a lower vehicle speed represents increased congestion.

Table D.1 provides network statistics related to the proposed construction phase stage two plan compared to the existing base.

Table D.1: Network Statistics

	PM	
	PM 2014 Existing With Viaducts	PM 2014 Construction Phase Stage 2
Demand Processed (%)	100%	100%
Total Number of Vehicles Processed	35,605	35,484
Average Network Travel Time Per Vehicle (Minutes)	4.7	5.6
Percent Difference from Base	N/A	+20 %
Vehicle Kilometres Travelled (km)	65,310	65,202
Average Vehicle Speed (km/h)	23.2	19.6

Reviewing the PM peak construction phase stage two statistics, the network is capable of processing approximately the same demand as the PM base case. Additionally, vehicle kilometres travelled did not change significantly. This implies that congestion does not result in significant blockage to intersections or traffic loading zones. As stated previously, manual reassignment of traffic from Georgia Street to Dunsmuir Street was made to reflect trips which would reroute outside of the model extents.

A moderate increase in average network travel time of approximately one minute per vehicle was observed. This increase is likely due rerouting behaviour exhibited by vehicles making eastbound and westbound trips across Dunsmuir Viaduct. Congestion along Dunsmuir also increases the trip time and would potentially make other routes in to and out of downtown more viable from a value of time perspective.

Overall network travel speed decreased by approximately 10% from 23 to 20 km/hr. Similar to network travel time, this statistic shows that there is more congestion in the network.

TRAVEL TIMES

Point to point travel times focus on the journey time between key origins and destinations within the model. Typically, these represent routes between major arterial streets that carry the majority of the traffic volume. The point to point metric allows for closer tracking of the changes in individual routes due to congestion and physical / operational changes as well as differences between dominant peak flow patterns. The travel times presented in the following section should be considered to be conservative as construction related changes to the road network will likely cause changes to travel behavior including shifting trips away from automobile usage to active modes, altering the time of day that trips are made, or rerouting trips outside of the immediate NEFC area.

Figure D.3 shows the comparative eastbound PM peak travel time by scenario for trips along the Pacific Boulevard surface street network. ***Figure D.4*** shows the comparative eastbound and westbound PM peak travel time by scenario along the modified Dunsmuir Viaduct street network, as well as the southbound travel times along Main Street. The dashed lines indicate potential Stage Two construction detour routes for vehicles typically traveling eastbound from Georgia Street. For example, vehicles that originate from Georgia Street that are destined for Terminal Avenue can potentially use the dashed yellow route during the construction period, whereby they travel to Pender Street, turn south onto Abbott Street and eventually connect with Pacific Boulevard to reach Terminal Avenue. It should be noted that these routes represent only one of several potential routes that drivers may use to reach their destination.

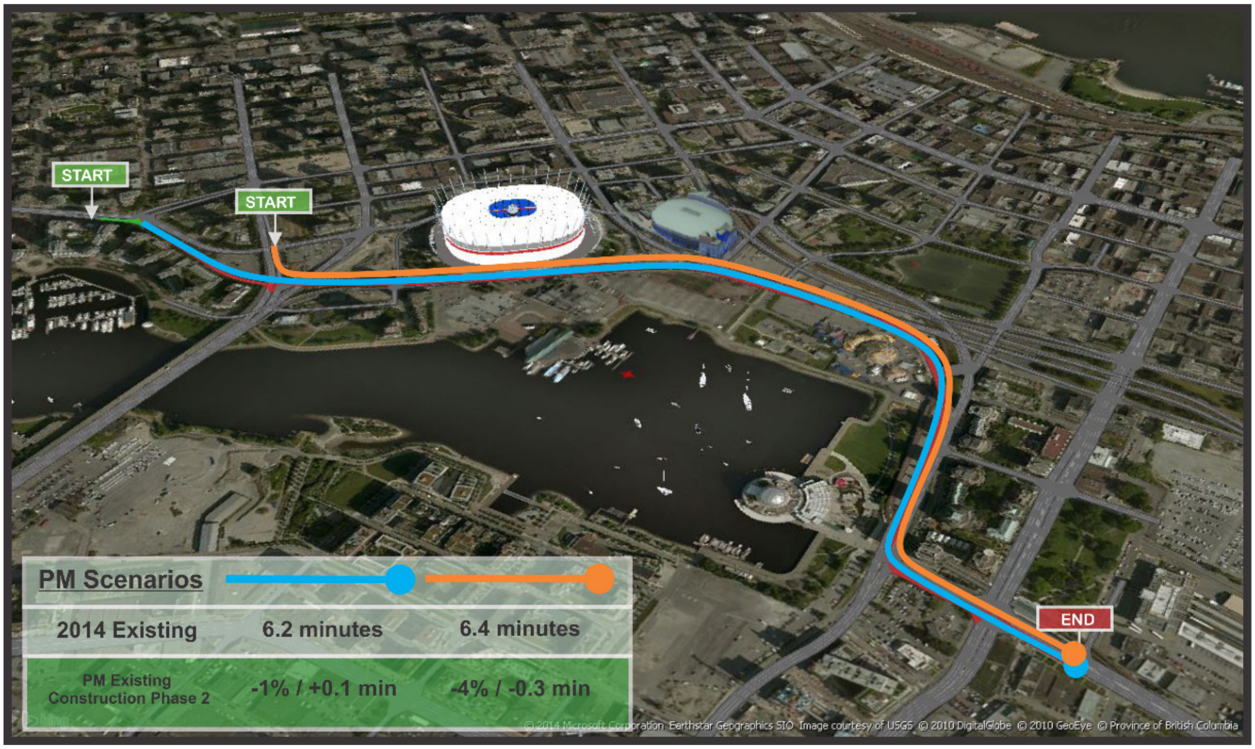


Figure D.3: PM Peak Eastbound – Pacific Boulevard

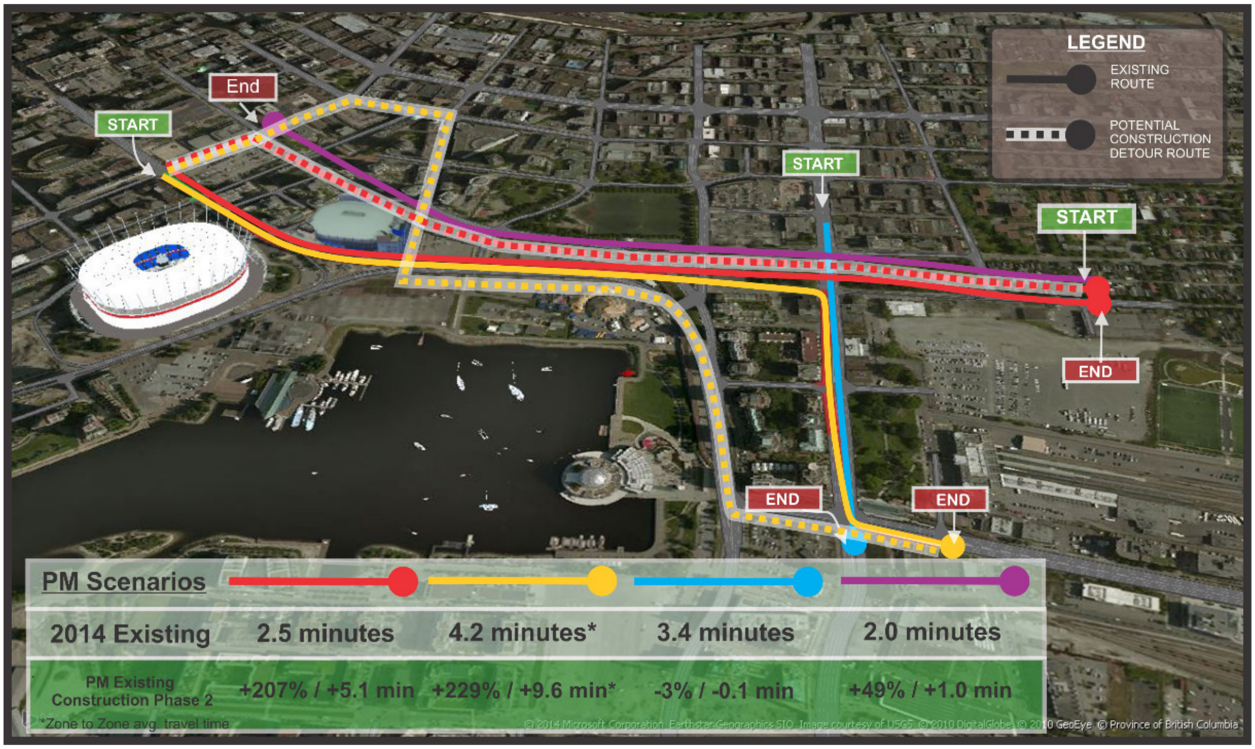


Figure D.4: PM Peak Eastbound – Dunsmuir and Georgia Viaducts

No significant travel time increases were observed for eastbound routes along Pacific Boulevard to Terminal Avenue. Travel times for eastbound trips which utilized the Georgia Viaduct connector to Terminal Avenue in the base case increased significantly by nearly ten minutes in the construction scenario. Westbound travel times along the Dunsmuir Viaduct increased by approximately 49%, likely caused by the reduction from two lanes to one lane. New eastbound travel times along the Dunsmuir Viaduct increased by 207% (over five minutes) due to re-routing onto Dunsmuir from Georgia Street and the reduction from two lanes to one lane. No significant travel time differences were observed for southbound traffic on Main Street.

VOLUME COMPARISONS

Volume outputs for the entire network were exported for the base case and for the stage two construction scenario to provide an indication of how traffic volume patterns have changed due to the physical and operational modifications. ***Figure D.5*** shows the model extents volume differences between the existing base case and the stage two construction scenario for 4:30 to 5:30 PM. Green links indicate a reduction in volume compared to the base case, whereas red links indicate an increase in link volumes. ***Table D.2*** shows the volume differences and percent change for key links within the study area.

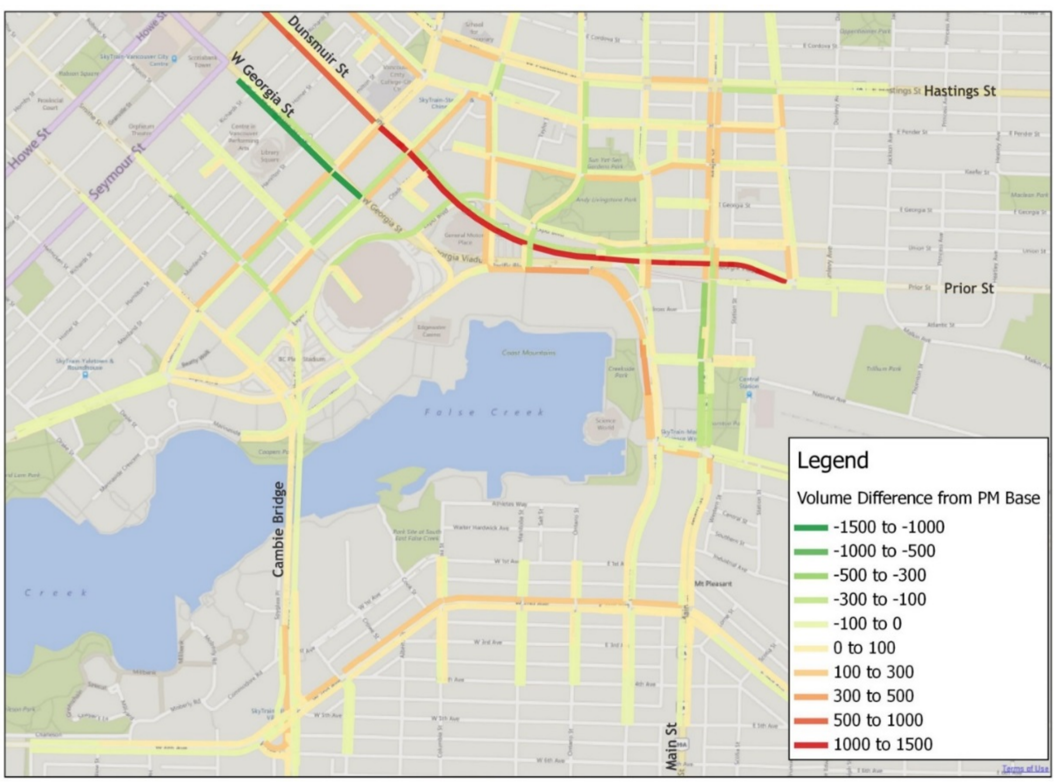


Figure D.5: Link Volume Differences (PM Base versus Construction Phase Stage 2)

Table D.2: Link Volume and Percentage Difference

Link	PM Base Model Volume	PM Construction Phase Stage 2 Model Volume	Volume Difference from Base	Percent Difference from Base
Georgia East of Cambie - EB	1,600	560	-1,040	-65%
Georgia East of Cambie - WB	270	120	-150	-55%
Dunsmuir East of Beatty - EB	N/A	1,160	+1,160	N/A
Dunsmuir East of Beatty - WB	1,370	1,150	-220	-16%
Pender East of Beatty - EB	690	890	+200	29%
Pender East of Beatty - WB	660	600	-60	-9%
Cambie South of Dunsmuir - NB	80	250	+170	229%
Cambie South of Dunsmuir - SB	440	460	+30	6%
Beatty South of Dunsmuir - NB	80	350	+270	361%
Beatty South of Dunsmuir - SB	320	70	-250	-77%
Abbott South of Pender - NB	260	160	-100	-37%
Abbott South of Pender - SB	280	490	+220	78%
Main North of Union - NB	580	660	+80	14%
Main North of Union - SB	1,120	1,360	+240	21%
Main North of Terminal - NB	1,790	1,670	-120	-7%
Main North of Terminal - SB	1,690	1,310	-380	-23%
Quebec North of Terminal - NB	940	980	+40	4%
Quebec North of Terminal - SB	1,130	1,470	+340	30%
Cambie Bridge Mid-Span - NB	2,160	2,120	-40	-2%
Cambie Bridge Mid-Span - SB	2,010	2,080	+70	4%
Cambie Bridge Off-Ramp to 2nd/6th Ave - EB	70	180	+110	161%
Expo East of Smithe - WB	980	900	-80	-8%
Pacific East of Carrall - EB	880	1,270	+380	43%

The impact of detouring traffic caused by the stage two construction scenario can be quantified by examining the volume link plot and corresponding table shown above. The largest increase in volumes due to detours is along the newly modified eastbound lane on Dunsmuir Street. The volumes on Prior Street east of Gore Avenue remain the same due to the fixed outbound demand assumed in the model. It is expected that a portion of eastbound trips on Georgia Street would detour to Dunsmuir Street outside of the model extents. Moderate volume increases were also observed along Cambie Street and Beatty Street. Eastbound vehicles on Georgia are forced to turn onto alternative streets as a result of the Georgia Viaduct closure.

Trips destined for south eastern destinations originating from Georgia Street reroute to northbound or southbound Cambie Street and Beatty Street. Higher volumes were observed along southbound Abbott Street as well as eastbound on Pacific Boulevard, east of Abbott Street. There were nominal changes to northbound volumes on Cambie Bridge. Southbound bridge volumes increased marginally with the largest change occurring at the Cambie bridge off-ramp to eastbound 2nd/6th Avenue where approximately 110 more vehicles were processed. North of Union Street, there was a noticeable increase in the utilization of Main Street. This is likely the result of increased congestion on the single lane Dunsmuir Viaduct causing routes along Pender Street and Hastings Street to be more attractive for trips destined downtown.

Due to the numerous simultaneous construction events in the City of Vancouver, it is recommended that the construction phasing be coordinated such that concurrent projects minimize delay, particularly in the NEFC area.