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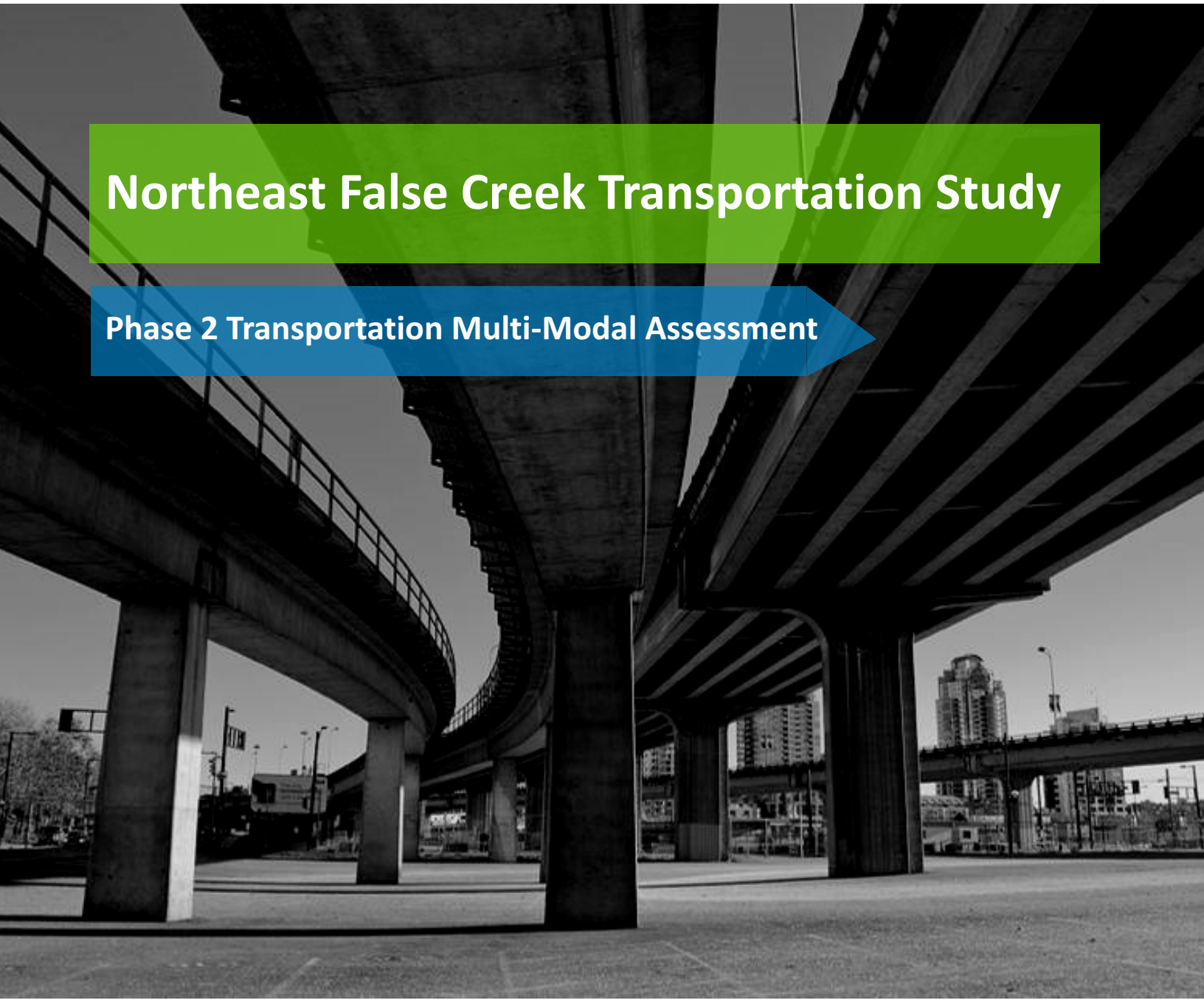

Northeast False Creek Transportation Study

Phase 2 Transportation Multi-Modal Assessment

SEPTEMBER 2015
SW1227

Submitted By:

PARSONS

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EXECUTIVE SUMMARY

As part of a detailed operational review of the proposed Georgia and Dunsmuir Viaducts replacement network, a number of opportunities and constraints have emerged. These changes have been evaluated using a combination of forecast development traffic impacts, conceptual multi-modal network geometry and operations, and a variety of macro and micro-scopic level traffic analysis tools.

The reference point for the comparative analysis was identified as the 2014 AM and PM peak hour base network with the Viaducts in place. Alternative traffic volume and network scenarios are described as follows:

- Viaducts replacement network with no net traffic growth. This would represent a long term horizon where the City's Transportation 2040 goals of no net traffic increases on the City road network have been met, despite planned residential / employment growth and development. These goals are supported by the observed historical trends in the City over the last 15 to 20 years which has seen significant growth in employment, residents, and total transportation trips, but a net reduction in vehicle trips by approximately 15%.
- Existing Viaducts network with full build out traffic from the NEFC development blocks at current traffic generation rates.
- Viaducts replacement network with full build out traffic from the NEFC development blocks at current traffic generation rates.

NEFC development blocks consisted 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. These numbers are speculative and for transportation analysis only. They do not necessarily reflect council approved densities or densities that would be supported by the City of Vancouver Planning Department.

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

1. The Viaducts replacement network can accommodate today's traffic volumes with minor increases in travel time of approximately one to three minutes during the peak periods, depending on the route. As a result, impacts to parallel adjacent streets in surrounding communities are also expected to be minor as the minor travel time increase is expected to lead to a similarly minor potential diversion of traffic to other routes. However, this increase in travel time would not extend to Emergency Service Providers given the priority given to these vehicles by general purpose traffic and the ability to cross the directional dividing line to avoid congestion. Adjacent parallel streets such as Cordova Street, Powell Street

and Hastings Street have some reserve capacity combined to accommodate the low volume shift anticipated of approximately 500 vehicles.

2. The Viaducts replacement network is better suited to accommodating the total future traffic demand as a result of the new developments in the area and any regional growth. This is due to the additional accessibility of the network, which reduces circuitous routing and better distributes local traffic to the broader regional transportation system. As such, the Viaducts replacement network will help protect adjacent communities from the potential impacts of displaced through traffic as NEFC developments are built and potentially add more local traffic to the network.

3. The Viaducts replacement network has significantly improved walking and cycling infrastructure and opportunities for transit which will contribute to lower vehicle traffic generation rates as NEFC developments are built when compared to the existing network. 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.

4. A number of optimization strategies have been identified which could provide further network benefits under the Viaducts replacement scenarios. These include the management of left-turn movements from New Pacific Boulevard and Georgia Street extension, local block-to-block connecting links, additional pedestrian crossing opportunities, and most importantly the opportunity to convert Expo and Pacific Boulevards to two-way operation between Nelson Street and Abbott Street. These proposals were further tested to determine their full benefits and if the physical changes required at the street level are feasible. Additional analysis and commentary is provided in Appendix A.

5. A high level review for the worst-case construction phasing stage two found that the network was capable of processing the full existing demands, and from a network perspective, the 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 also found moderate travel time increases in the PM peak for eastbound traffic via the two-way Dunsmuir Viaduct by 207% (over five minutes) and modest travel time increases were observed for other notable routes.

6. Event management strategies for the stadia events have been considered and are covered in a separate Phase 3 Event Management Strategies memo.

1.0 BACKGROUND & STUDY CONTEXT

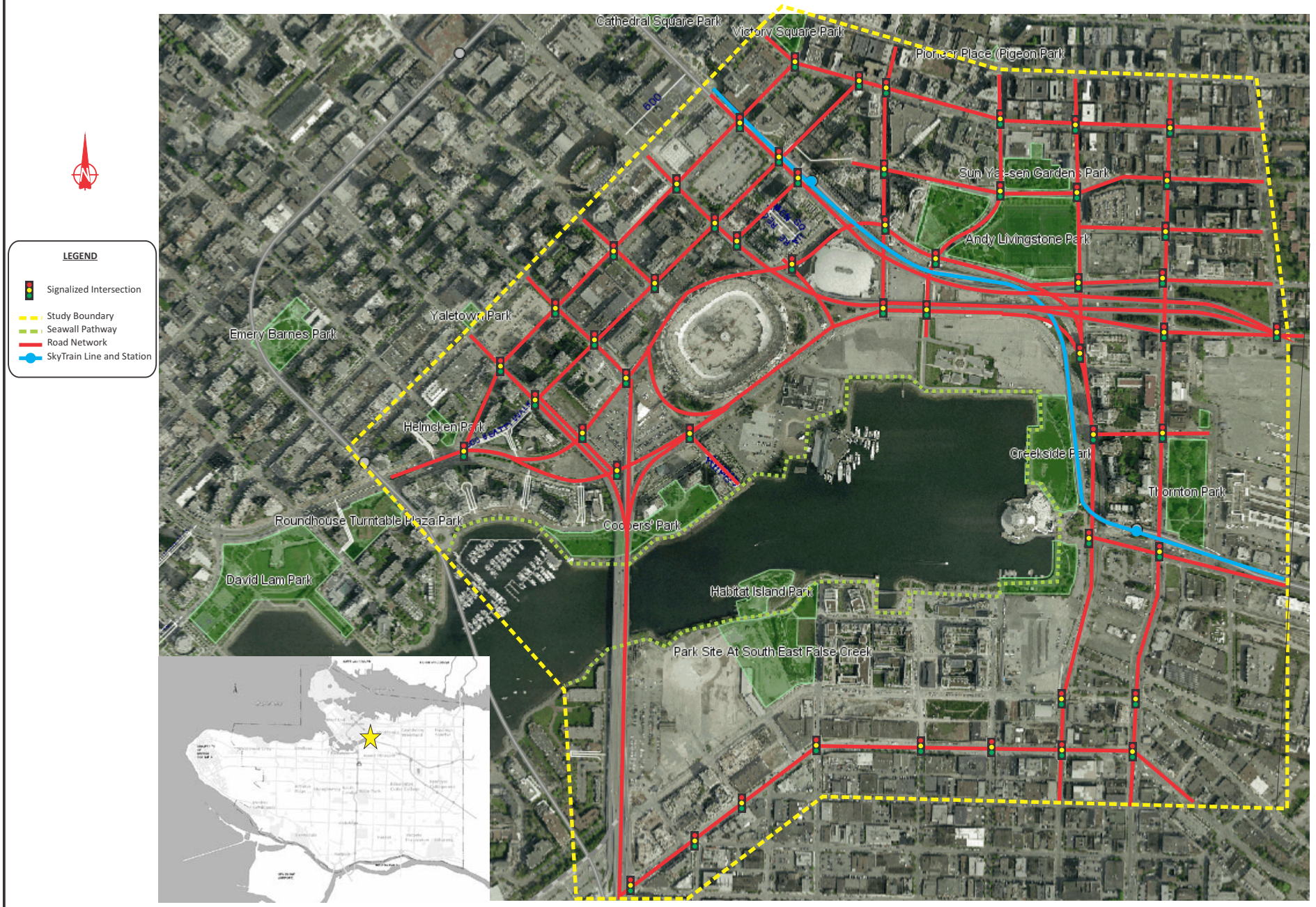
The City of Vancouver is continuing to advance plans for the Northeast False Creek (NEFC) area. A number of previous studies have been completed in and around the area and have contemplated significant changes to land use as well as transportation network modifications. In order to provide technical support to the NEFC planning process, and address questions raised to date by stakeholders, a comprehensive transportation study has been undertaken by Parsons in association with Alta Planning + Design. The transportation study was divided into three phases. The first phase focused on establishing baseline conditions on the study area transportation network. The second phase, which is the subject of the current technical memo, assesses the forecast impacts of alternative growth and transportation network modification scenarios. The third phase provides an assessment of anticipated traffic and event management impacts for major special events in the area and develops a strategy to address the recurrent events.

1.1 Study Area

The NEFC Transportation Study boundaries are shown in ***Figure 1.1***, with an inset showing the study area in the context of the overall City of Vancouver.

The area transportation network is multi-modal and complex, including the False Creek Seawall recreational pathway, protected and painted on-street bikeways, small passenger ferries, a SkyTrain station and guideway, local transit stops, numerous service accesses, a pair of elevated one-way viaducts, and a high capacity one-way arterial couplet. The surrounding land use varies from commercial retail, to high density residential, to sports and entertainment facilities including two stadia and a casino complex. Numerous surface parking lots serve the traffic generated by events in this area.

The focus of the transportation study is on the multi-modal transportation network between Cambie Street and Gore Avenue from west to east, and between Hastings Street and Terminal Avenue from north to south. However, the study area is much larger than the core focus area shown, as the entire street network has been captured in the macro-scopic analysis. As such, impacts on transportation facilities and communities outside of the core focus area, such as along 2nd Avenue on the south side of False Creek have also been quantified as appropriate in this study.



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Study Area Transportation Network

Figure 1.1

1.2 Proposed Road Network and Development Impacts

On the transportation network side, the existing Georgia and Dunsmuir elevated Viaducts and their ramp connections are proposed to be replaced with a new predominantly at-grade arterial street network. Details of this replacement network continue to evolve, but the core components of the plan include the following:

- Removal of the Georgia Viaduct between Citadel Parade and Gore Avenue including the off-ramp to Main Street;
- Removal of the Dunsmuir Viaduct and its protected two-way cycle track between Gore Avenue and the Rogers Arena north plaza including the on-ramp from Main Street;
- Provision of a new two-way, four lane ramp connection between Citadel Parade and Pacific Boulevard (Georgia Street extension) with a new signalized "T" intersection combining Pacific Boulevard, Georgia Street and Griffiths Way;
- Removal of existing Pacific Boulevard between Abbott Street and Quebec Street;
- Realignment and reconfiguration of Expo Boulevard between Abbott Street and Quebec Street to provide a new two-way six lane arterial roadway (New Pacific Boulevard) with signalized intersections at Abbott Street and Carrall Street;
- Provision of a new four to six lane arterial roadway along the New Pacific Boulevard / Prior Street alignment with signalized intersections at Quebec Street, Main Street and Gore Avenue. Six lanes will be provided west of Main Street and four lanes will be provided east of Main Street;
- Closure of Carrall Street between Keefer Place and the Seawall to motorized traffic; and
- Provision of a new pedestrian and cycling connection between the Union Street bikeway and the Dunsmuir cycle track.

The replacement road network supports a number of strategic City objectives including Transportation 2040, which is the foundational plan for accommodating future travel growth through transit, walking and cycling; as well as the Greenest City Action Plan targeting a reduction in greenhouse gas emissions by reducing average distance driven per resident. A number of supporting studies are also underway including the design of the Georgia Ramp structure between Beatty Street and New Pacific, environmental reviews of soils surrounding the Viaducts, a road safety assessment of Prior Street east of Main Street, and urban planning strategies for the False Creek Flats area to the east of NEFC.

On the land use side, the type and intensity of land uses will change significantly with a mix of residential, office, commercial and recreational amenities being developed within and around the parcels freed up by the Viaduct footprint removal.

Table 1.1 summarizes the potential mix and intensity of land uses being considered based on discussions with the City's planning department and directions emerging from NEFC planning studies.

Providence Health Care is also planning a new hospital on the currently vacant site east of Station Street directly north of the Pacific Central railway train station in the False Creek Flats area, adjacent to the study area. This new hospital is expected to replace St. Paul's Hospital in downtown Vancouver and is anticipated to open in 2022. Its expected land use is also provided in the table below following the NEFC developments.

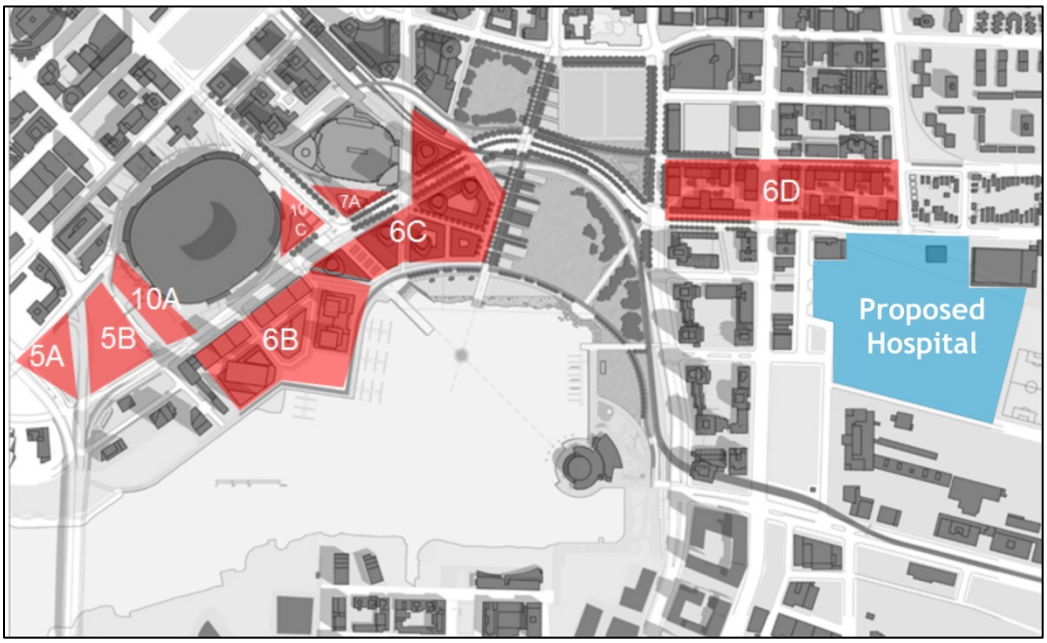
Table 1.1: Potential NEFC Development Totals (approximate ft^2)

Block	Address	Residential	Non-Residential
5B West	998 Expo Boulevard	397,435	20,968
5B East	68 Smithe Street	303,209	44,993
6B	750 Pacific Boulevard (Plaza of Nations)	1,505,510	438,154
6C	n/a (Concord Pacific)	1,444,000	220,000
6D	Quebec – Gore Block	800,000	0
7A	800 Griffiths Way	401,698	215,278
9	n/a (Waterfront Park)	0	0
10A	39 Smithe Street	0	753,420
10C	n/a (BC Place)	310,000	85,000
11	701 Expo Boulevard	0	22,131
DD-CD1	720 Beatty (Central Heat Plant)	217,680	459,546
Totals		5,379,532	2,259,490
Proposed Hospital	Station Street and National Avenue	-	929,887

*note: these population and employment numbers are speculative and for transportation analyses only. They do not necessarily reflect council approved densities or densities that would be supported by the City of Vancouver Planning Department.

Figure 1.2 shows the development blocks superimposed on the conceptual Viaducts replacement transportation network.

Figure 1.2: Viaducts Replacement Concept and NEFC Development Blocks



1.3 Guiding Principles and Study Objectives

In discussions with staff and area stakeholders, a number of guiding principles have emerged to direct the development of the NEFC area. These principles are listed as follows in no particular order:

- Reconnect the Historic Communities (Gastown, Chinatown, Downtown East Side) with the False Creek waterfront;
- Expand parks and open spaces;
- Repair the urban fabric;
- Explore housing development and place-making opportunities on the City blocks;
- Create a vibrant waterfront district;
- Increase efficiency of the street network;
- Improve connectivity between Downtown, NEFC, and the waterfront;
- Enhance pedestrian and cyclist movement;
- Develop a fiscally responsible approach; and
- Engage residents and stakeholders in a meaningful way.

With these guiding principles in mind and with consideration for outstanding questions to be resolved, the following transportation study objectives have been prepared:

1. Confirm the Viaduct replacement street network has sufficient capacity to accommodate forecast commuter vehicles and goods movement. The study should determine how existing neighbouring communities will be affected and how planned NEFC developments will impact the street network;
2. Identify ways that multiple events can be more effectively managed;
3. Identify where event support and delivery vehicles will be staged before, during and after events;
4. Determine effects on area parking supply and demand;
5. Assess the benefits / disbenefits of a new Stadium-Chinatown SkyTrain Station access to the southern side of Expo Boulevard;
6. Assess the interaction of pedestrian / cyclist movements at New Pacific Boulevard;
7. Determine if there are viable alternatives to the realignment and use of Carrall Street;
8. Determine if there are viable alternatives to a dedicated pedestrian and cycling bridge connecting Dunsmuir Street directly to the Union / Carrall bikeways;
9. Determine a preferred configuration for dedicated transit lanes along New Pacific Boulevard;
10. Determine if there is an impact to pedestrian safety or capacity where dual turn lanes are provided; and
11. Confirm the number of lanes required for vehicle traffic on proposed NEFC streets.

Objectives 1 and 6 through 11 are the focus of the subject memo, with reference to Objectives 4 and 5. Objectives 2 and 3 are addressed in the separate Phase 3 Event Management Strategy report.

2.0 TRAFFIC MODEL OVERVIEW

Given the complexity and geographic influence of the existing transportation network, and the range of forecast impacts to be addressed, two primary transportation models have been utilized in this study: a travel demand model and an operational micro-simulation model. These models allow for analysis of both the high level travel demand impacts and the detailed operational impacts of the proposed transportation network and land use changes.

2.1 Travel Demand Model

TransLink has developed the Regional Transportation Model (RTM) on the Emme travel demand model software platform. This model is used for a variety of strategic planning purposes and is intended to assess the macro-level impacts of major transportation and land use changes. Model inputs include population and employment totals for Metro Vancouver and its component municipalities, road and transit network details such as number of lanes, capacity, length and connectivity, as well as other special features such as traffic generation zones for trucking activity centres. By definition, the model has a relatively coarse zone structure which is reflective of major development blocks of homogenous land uses and specific physical or jurisdictional boundaries.

The RTM Phase 2 was used to generate background traffic on the NEFC network for the baseline and forecast model analysis scenarios. The RTM Phase 2 represents two region-wide reference horizons. The baseline RTM has been calibrated against year 2011 conditions and represents the most recent calibrated regional model at the time of the study. The baseline model assumes a 2.68 M regional population (including the Fraser Valley Regional District) and the transportation network in place at the time. As of 2014, BC Stats estimates the combined population to be approximately 2.76 M. The future model represents the year 2045 which assumes a 4.01 M regional population with distributions consistent with area Official Community Plans. These reference years were selected by TransLink based on their long range planning horizons. The TransLink horizon years have been carried forward for the subject study in order to provide consistency with other regional planning initiatives.

The RTM consists of over 682 Traffic Analysis Zones or TAZ. These zones represent discrete geographical areas defined by similar land uses or specific zoning / geographic features and are used to generate trips to the network based on the expected level of activity. Within the NEFC, ***Table 2.1*** summarizes the TAZ as originally represented within the model and the forecast population and employment statistics:

Table 2.1: TransLink RTM Original Assumptions for NEFC

Traffic Analysis Zone	ID	Population		Employment	
		2011	2045	2011	2045
BC Place / Concord / Casino Zone	1	2,277	2,688	2,486	8,976
Rogers Arena Zone (between Viaducts)	2	1,508	2,093	911	1,697
NEFC Zone (bounded by Keefer / Main)	3	2,022	9,292	594	687
Totals		5,807	14,073	3,991	11,360
Growth			+8,266		+7,369

Figures 2.1 and ***2.2*** show a model screenshot from the RTM, illustrating both the zone boundaries and the relative population (blue bar) and employment (green bar) totals. Thick red lines represent zone boundaries while thin grey lines represent the modeled road network. Although it is generally desirable to use major road network components as boundaries, often adjacent homogenous land uses dictate that the zone be expanded to incorporate multiple blocks.

Figure 2.1: RTM Zone Structure and Population / Employment Assumptions for NEFC 2011

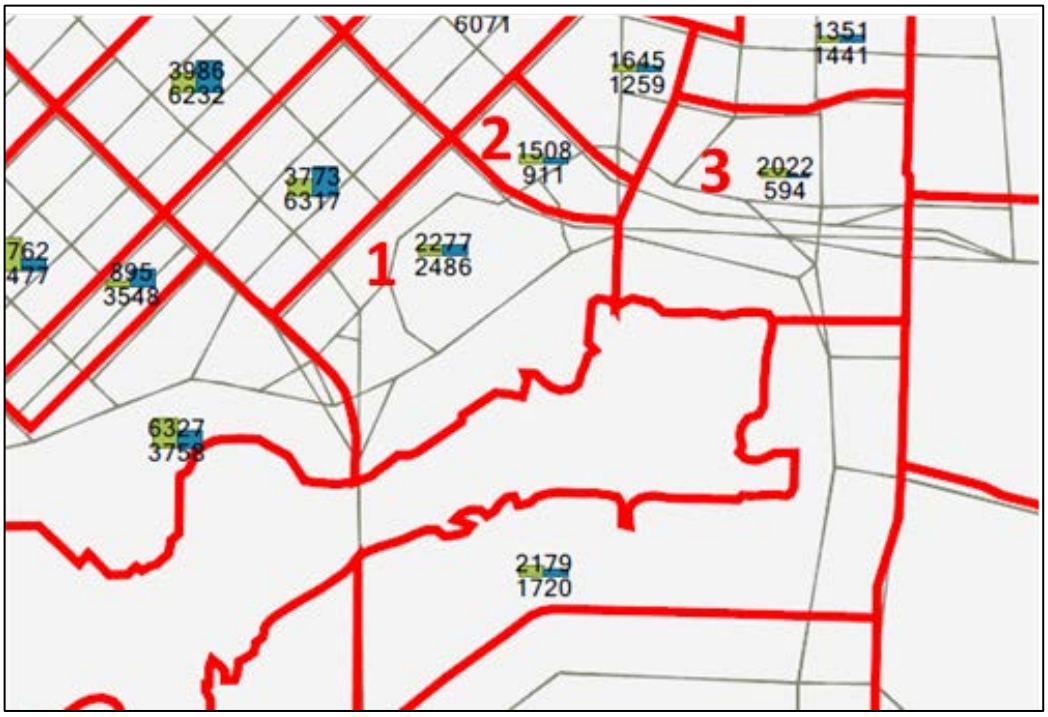
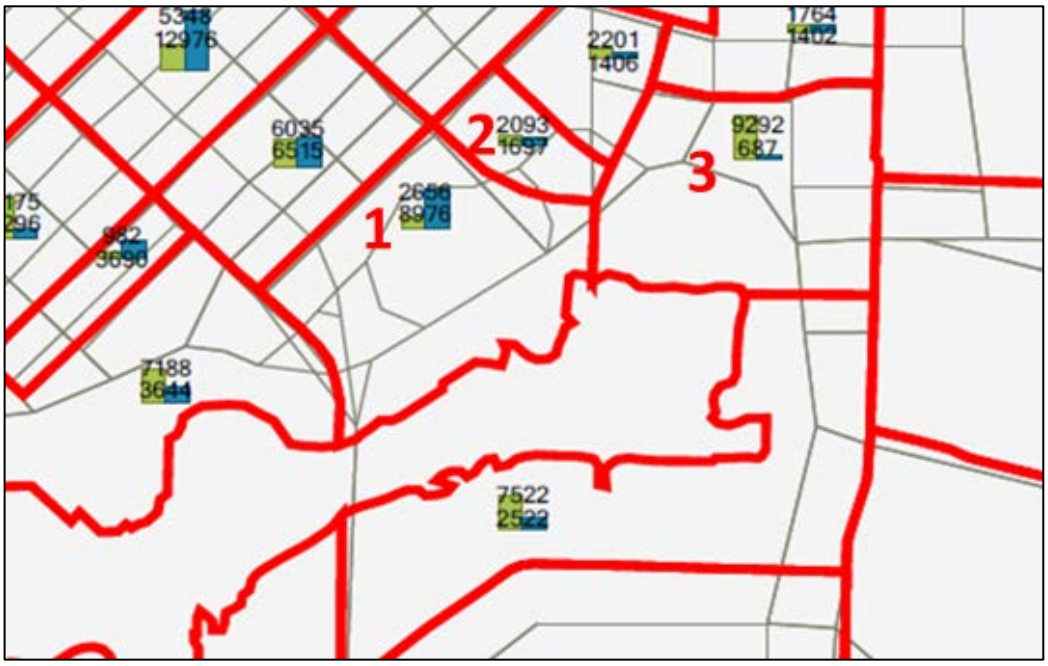


Figure 2.2: RTM Zone Structure and Population / Employment Assumptions for NEFC 2045



The assumptions above were reviewed with the City planning department and updated to reflect current direction. ***Table 2.2*** shows the updated assumptions and resulting growth.

Table 2.2: City of Vancouver Updated Population and Employment Assumptions for NEFC*

Traffic Analysis Zone	ID	Population		Employment	
		2011	2045	2011	2045
BC Place / Concord / Casino Zone	1	1,800	10,267	2,100	9,699
Rogers Arena Zone (between Viaducts)	2	1,520	2,200	900	1,700
NEFC Zone (bounded by Keefer / Main)	3	1,300	4,300	500	1,040
Totals		4,620	16,767	3,500	12,439
Growth			+12,147		+8,939

*note: these population and employment numbers are speculative and for transportation analyses only. They do not necessarily reflect council approved densities or densities that would be supported by the City of Vancouver Planning Department.

As shown, the City of Vancouver population and employment growth assumptions for NEFC have increased relative to the original RTM assumptions. These changes have been captured in the NEFC site-specific trip generation review documented in Section 4.0.

The 2045 RTM also takes into consideration transportation network changes that are either committed or have a high likelihood of being implemented over the forecast period. Of specific interest to the City of Vancouver in general and the NEFC in particular are the following RTM assumed network improvements:

- The Viaducts replacement network including removal of the Georgia and Dunsmuir Viaducts and construction of a new at-grade Pacific Boulevard and Georgia Ramp connection (Viaducts replacement);
- The Malkin Connector providing a new road link between Clark Drive and Prior Street east of Gore Avenue;
- The Evergreen Line rapid transit system providing service to adjacent suburban municipalities (Burnaby, Coquitlam, Port Moody); and
- The Broadway Rapid Transit line extension from VCC-Clark station to the UBC Campus.

The above development and transportation network assumptions influence the forecast background traffic conditions and traffic distribution patterns in the NEFC and regional network. To demonstrate the high-level impacts of these combined changes, the RTM was run to produce a difference plot showing the change in traffic volumes between the 2011 Baseline and 2045 Future networks. The difference plot highlights increased traffic volume link flows in red and decreases in green. Of particular interest is the cumulative total of vehicle trips crossing the east-west and north-south screenlines bounding the NEFC. ***Figures 2.3*** and ***2.4*** show the differences for the AM peak and PM peak hours, respectively.

Figure 2.3: TransLink RTM Difference Plot AM Peak 2011 versus AM Peak 2045

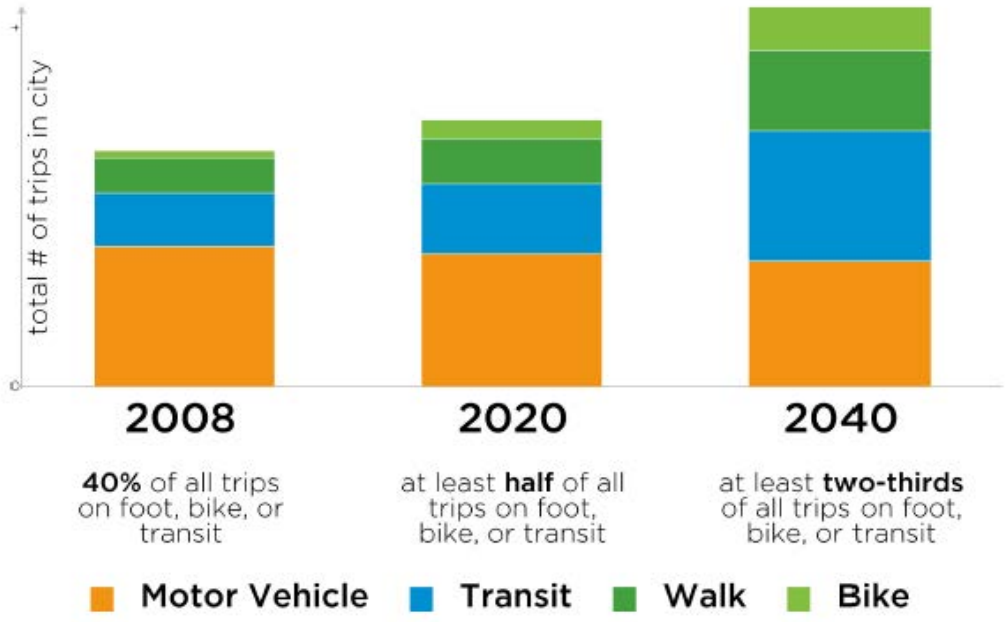
Figure 2.4: TransLink RTM Difference Plot PM Peak 2011 versus PM Peak 2045

A number of macro-level observations can be drawn from the plots above. The first is that despite significant population and employment increases and the replacement of the Viaducts network, most link volumes on the roads leading to/from the NEFC are not substantially affected. Although net increases are observed on Malkin Street, Cambie Bridge, Hastings Street, and the Powell / Cordova one-way pair, these individual link changes average less than several vehicles per minute which can typically be accommodated without significant impact. Analysis of forecast link volume to capacity ratios for the ***Figure 2.3*** and ***Figure 2.4*** screenlines indicates residual capacity is available in the aggregate and that only one link would exceed capacity (Hastings Street westbound during the AM peak hour).

A second observation is that in order to meet the City's Transportation 2040 goals of no net increase in vehicular traffic on City streets, the net increases highlighted in the RTM plots will need to be addressed through increases in transit ridership, walking and cycling, and/or deferral of peak hour travel. In recent years, success has been demonstrated in this regard, with traffic volumes entering the downtown core declining year on year

despite significant residential and employment growth. As illustrated conceptually in ***Figure 2.5***, the implications of no net growth in vehicular travel imply that transit, walk and bike trips must account for any increase in future trips on the network.

Figure 2.5: City Modal Share Targets (Transportation 2040)



For compatibility with the City's Transportation 2040 goals, the forecast NEFC vehicular traffic volumes documented in the subsequent analysis represent trips that must either displace an equivalent amount of existing trips through the NEFC network or be converted to transit, walk or bike trips.

As the RTM 2045 outputs show a net growth in vehicle volumes on the City road network which is inconsistent with the Transportation 2040 objectives of accommodating all trip growth by active modes and transit (as has been achieved over the last 15 years of available traffic count data), two separate forecast growth scenarios have been utilized moving forward. The first scenario is based on an assumption of zero net growth vehicle traffic volumes (referred to as the 2045 No Vehicle Growth scenario) and a second, more conservative analysis reflects potential background and local development vehicle traffic impacts (referred to as the 2045 Full Vehicle Growth scenario).

2.2 Operational Micro-Simulation Model

To provide a much more detailed operational assessment of forecast network conditions, a micro-simulation model was developed on the PARAMICS platform. The PARAMICS model built for the NEFC includes the following characteristics:

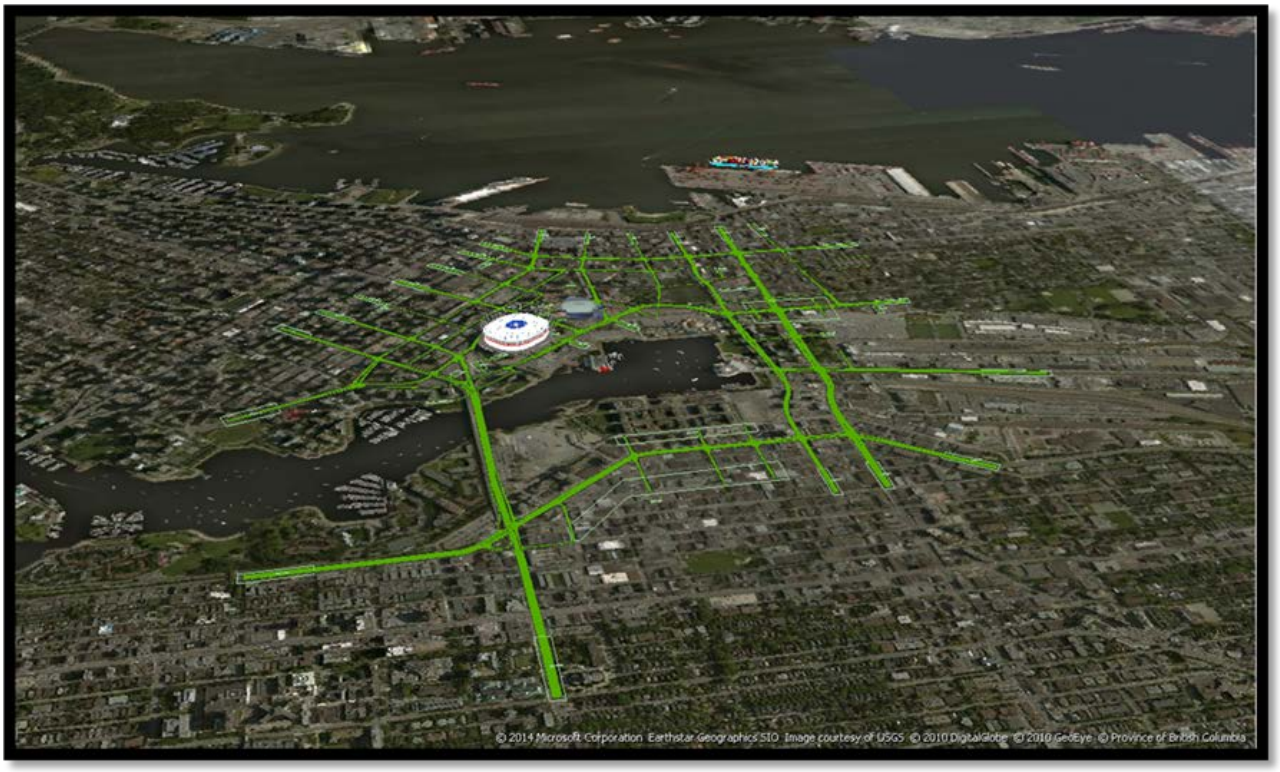
- Multiple vehicle types with representative braking and acceleration characteristics (passenger cars, light trucks, heavy trucks, buses);
- Separate origin and destination travel demand matrices extracted from the higher level RTM for single occupant and high occupant (2+) passenger vehicles, light trucks, and heavy trucks;
- Pedestrian crossing volumes based on observed conditions;
- Transit vehicle routing and stop locations;
- Traffic generation zone structure compatible with the RTM zone structure;
- Road network coded by posted speed, number of lanes, classification (major / minor street), on street parking, bus routes and stop locations;
- Intersections coded by number and type of turning lanes, signal timing, signal phasing, vehicle detection and signal actuation, other regulatory restrictions (stop, yield, no right-turn on red); and
- Time profiles to represent seeding and dissipation of peak hour traffic volumes.

Another important aspect to PARAMICS is its ability to model vehicle-vehicle and pedestrian-vehicle interactions within the traffic stream. As each vehicle or pedestrian has an assigned origin and destination zone, this create realistic weaving, lane utilization, and queuing behaviour that is not seen in basic capacity analysis programs or the macro-level RTM platform. The model continually calculates the most optimal routing for vehicles as they are added to the road network, allowing for dynamic route shifting in response to congestion or blockage.

Prior to any alternative scenario analysis, 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. Following inclusion of roadway geometrics and traffic operational characteristics, the model was iteratively run and refined for the AM and PM peak hours in order to compare simulated and observed traffic volumes. Adjustments were made to the raw RTM traversal matrix in order to correct for the coarseness of macro model zones and to capture localized traffic movements.

As noted, the PARAMICS model focuses on the AM and PM peak commuter hours with simulation periods ranging from 6:30 to 8:30 AM and 3:30 to 5:30 PM. The two hour peak period simulation includes a "shoulder" hour adjacent to the peak hour of interest. The model extents are shown highlighted in green in ***Figure 2.6*** below.

Figure 2.6: PARAMICS Micro-simulation Model Extents



3.0 ANALYSIS SCENARIOS

Using the PARAMICS micro-simulation model, four distinct 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 3.1***.

- 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 amount of existing trips on the network or be converted to transit, walk or bike trips as per Transportation 2040 objectives.
- 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 of 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 3.1: 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	✓	×

As a starting point for assessing the Viaducts replacement network scenario, the conceptual geometrics for the road network as of approximately September 2014 were coded into the PARAMICS model environment. Snapshots of the assumed geometrics are shown in ***Figure 3.1***.

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Viaducts Replacement Network Conceptual Plan

Figure 3.1

4.0 DEVELOPMENT TRIP GENERATION ASSUMPTIONS

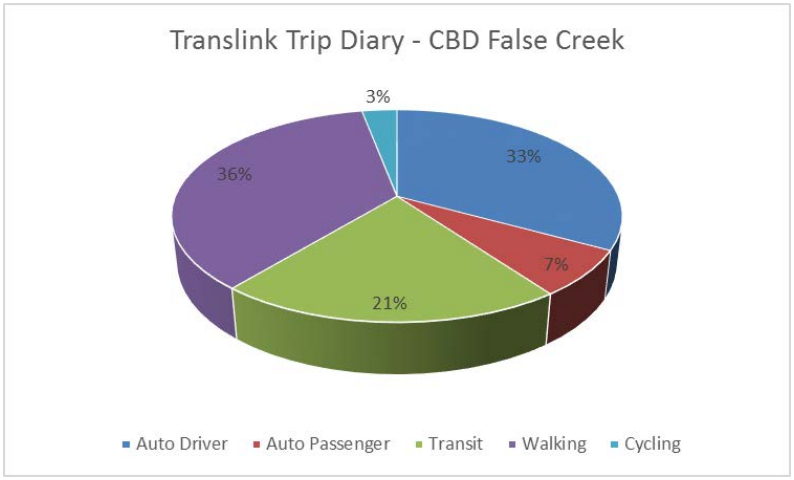
To generate the forecast trips for the NEFC development scenarios, a number of assumptions were reviewed pertaining to typical trip rates per unit of development, as well as the proportion of trips by mode for analogous City neighbourhoods.

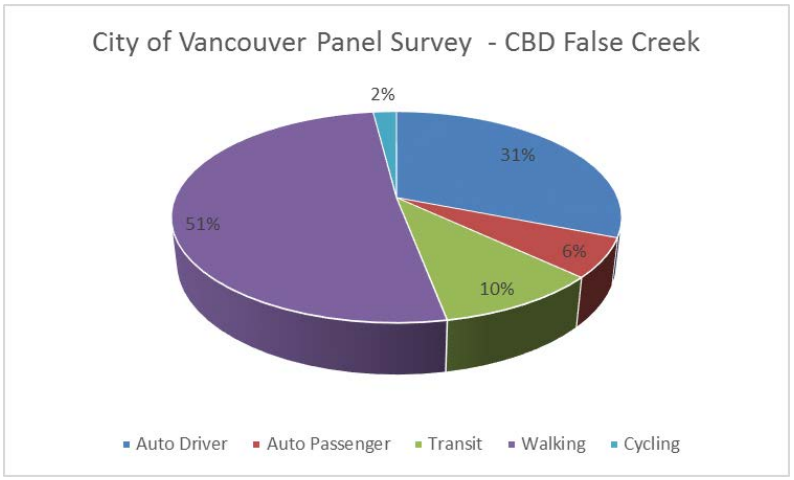
Given the City's recent successes in reducing vehicular traffic generation associated with population and employment growth, and the expected availability of high quality walking, cycling and transit infrastructure, the development trip generation approach adjusted the average trip rates sourced from the Institute of Transportation Engineers (ITE) Trip Generation Manual using observed modal split data from City of Vancouver panel surveys. The ITE rates, which are based on numerous observations of land use variables from sites across North America, are known to be oriented toward sites with low or limited alternatives to vehicular travel and would therefore greatly overestimate vehicle trips in the context of a multi-modal, high density, mixed use neighbourhood such as NEFC. For this reason, to allow for access to the wider database of ITE land use types while also accounting for the expected high level of multi-modal trip making, the base ITE rates were adjusted downward to reflect the much lower proportion of trips that will likely be made by vehicle. The adjusted rates were applied to all future development scenarios for consistency, recognizing that vehicle trip rates reflective of enhanced walking and cycling facilities in the replacement network scenarios could be even lower.

The vehicle trip adjustment factors were taken from recent surveys collected by TransLink and the City of Vancouver where information on travel behaviour over the course of a typical day is collected and summarized by neighbourhood or zone. The TransLink Trip Diary information is updated regularly for representative neighbourhoods across the region and is used for travel demand model development and strategic planning purposes.

Figure 4.1 summarizes the recently collected City of Vancouver panel data and compares this with the TransLink trip diary information. As shown, the City panel data shows slightly less vehicle traffic use than the TransLink data as well as a significantly greater proportion of walking trips in lieu of transit trips. Both surveys show a significant overall proportion of trips made by transit, walking or cycling. Note that for the Central Business District (CBD) area around False Creek, the proportion of trips made as an auto driver (31%) was third lowest in the entire City behind only the Downtown proper and West End.

Figure 4.1: Panel Survey Data versus Trip Diary Survey Data





The discrepancy in the transit / walk split between the two surveys may be explained by the differences in mode choice based on the trip destination. As shown in ***Figure 4.2***, metropolitan core trips that are destined to the metro core tend to be walking trips given the proximity and convenience of walking relative to walking to a transit station and waiting for transit. For trips destined to other centres or the rest of the region, the transit proportion of non-auto trips increases significantly due to the greater efficiency of covering longer distances by transit. As shown in ***Figure 4.3***, the majority of metropolitan core trips involve a trip internal to the metropolitan core or the rest of Vancouver / University Endowment Lands. It is therefore likely that the transit / walk mode split will be dictated by whether the trip end is also in the metropolitan core or not. For NEFC, the plan is create a community where all day-to-day trips can be met locally with a mix of residential, office, retail, and recreation / entertainment lane use. As such, a higher walking modal split is expected relative to transit.

Figure 4.2: Trip Distribution by Mode, Metropolitan Core (TransLink)

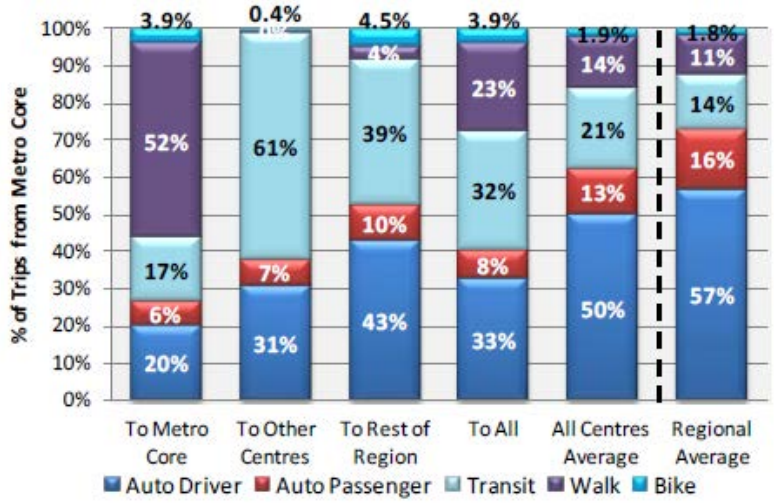
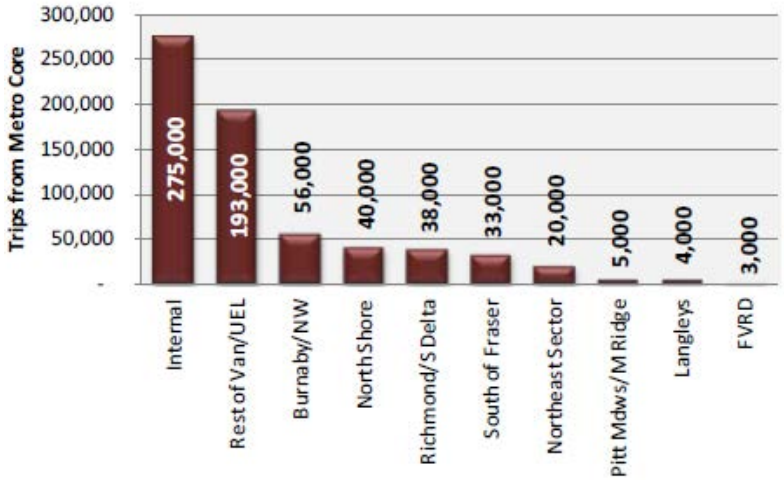


Figure 4.3: Trip Distribution Patterns, Metropolitan Core (TransLink)



Using the observed modal splits from the panel survey, the following percentages have been subsequently applied to the original ITE trip rates for all planned NEFC development zones:

- 31% vehicle drivers
- 6% vehicle passengers
- 10% transit passengers
- 51% walk trips
- 2% bike trips
- 100%

While the 10% of trips by transit initially appears low given the proximity to area SkyTrain stations and bus service, these values as derived from the City's panel survey are more reflective of an environment such as that planned for NEFC where most destinations are accessible within a short direct walk. A walk trip to adjacent destinations could take less time overall than walking to a transit station and waiting for service.

Despite the discrepancies between the proportion of transit and walking trips in the two surveys, the relatively low level of auto use is consistent and has been applied to generate future development traffic impacts.

Table 4.1 summarizes the base unadjusted trip rates as sourced from the ITE for each of the potential land use types within the NEFC area. The land use types and estimated density are based on current development applications and past traffic impact studies for individual sites.

Table 4.1: Base Unadjusted Trip Rates

Core Trip Generation Rates	ITE Rate Code	Variable	AM Peak Trip Rate			PM Peak Trip Rate		
			Total	Inbound	Outbound	Total	Inbound	Outbound
Residential	Land Use 230 (Residential Condominium / Townhouse)	Persons	0.19	16%	84%	0.24	67%	33%
Office/Commercial/ Retail	Land Use 710 (General Office Building)	Employees	0.48	88%	12%	0.46	17%	83%
	Land Use 310 (Hotel)	Rooms	0.56	61%	39%	0.59	53%	47%
	Land Use 473 (Casino / Video Lottery Establishment)	1,000 ft^2 GLA	0	0%	0%	13.43	56%	44%
	Land Use 495 (Recreational Community Centre)	1,000 ft^2 GLA	1.62	61%	39%	1.64	29%	71%
	Land Use 814 (Specialty Retail Centre)	1,000 ft^2 GLA	6.84	48%	52%	5.02	56%	44%

Table 4.2 shows the estimated development densities and assumptions used to produce the independent variables for trip forecasting. For ease of reference, these have been broken down by individual block.

Table 4.2: NEFC Block Development Assumptions

Block	Address	Land Use Variables	ITE Rate Code
5B West	998 Expo Boulevard	883 persons	230
		105 office employees	710
5B East	68 Smithe Street	674 persons	230
		44,993 ft^2 specialty retail	814
6B	750 Pacific Boulevard (Plaza of Nations)	3,346 persons	230
		287 office employees	710
		87 hotel rooms	310
		257,737 ft^2 specialty retail	814
		88,150 ft^2 recreational community centre	495
6C	n/a (Concord Pacific)	3,209 persons	230
		1,100 office employees	710
6D	Quebec – Gore Block	1,778 persons	230
7A	800 Griffiths Way	893 persons	230
		1,076 office employees	710
9	n/a (Waterfront Park)	n/a	n/a
10A	39 Smithe Street	616 hotel rooms	310
		213,700 ft^2 casino	473
		59,330 ft^2 specialty retail	814
10C	n/a (BC Place)	689 persons	230
		425 office employees	710
11	701 Expo Boulevard	110 office employees	710
DD-CD1	720 Beatty (Central Heat Plant)	484 persons	230
		2,297 office employees	710
Totals	5,379,532 ft^2 residential: 11,955 persons* 2,259,490 ft^2 non-residential: office**, casino, hotel, specialty retail, recreational community centre		

*Assumes approximately 1 person per 450 ft^2 consistent with overall NEFC planning assumptions
**Assumes approximately 1 employee per 200 ft^2 for office development

Following application of the panel survey modal split adjustment factors, ***Table 4.3*** summarizes the resultant NEFC peak hour trips and trips by mode.

Table 4.3: Forecast NEFC Development Trips

Block	Address	AM Peak Hour Trips			PM Peak Hour Trips		
		In	Out	Total	In	Out	Total
5B West	998 Expo Boulevard	71	147	218	150	110	260
5B East	68 Smithe Street	168	268	436	235	153	388
6B	750 Pacific Boulevard (Plaza of Nations)	1,186	1,542	2,728	1,354	1,070	2,425
6C	n/a (Concord Pacific)	562	575	1,138	602	674	1,276
6D	Quebec – Gore Block	54	284	338	286	141	427
7A	800 Griffiths Way	482	204	686	228	482	709
9	n/a (Waterfront Park)	0	0	0	0	0	0
10A	39 Smithe Street	405	346	751	1,967	1,565	3,531
10C	n/a (BC Place)	200	134	335	144	217	361
11 and DD-CD1	701 Expo Boulevard and 720 Beatty (Central Heat Plant)	1,032	216	1,248	266	958	1,224
Totals		4,161	3,716	7,877	5,231	5,369	10,601
Vehicle Trips (31%)		1,290	1,152	2,442	1,622	1,664	3,286
Vehicle Passengers (6%)		250	223	473	314	322	636
Transit Trips (10%)		416	372	788	523	537	1,060
Walk Trips (51%)		2,122	1,895	4,017	2,668	2,738	5,406
Bike Trips (2%)		83	74	158	105	107	212

The NEFC development blocks are forecast to generate up to 3,286 vehicles per hour in the PM peak hour. The majority of trips are anticipated to be walking trips given the mix and density of land uses and the convenience of making local trips between individual blocks.

As the new vehicle trips will impose the most significant negative impact on the transportation network, the distribution of these trips is a key factor in the analysis. Previous license plate surveys have indicated that at least 2/3rds of the traffic on Expo and Pacific Boulevards have an origin or destination within the City of Vancouver boundaries as shown in ***Figures 4.4 and 4.5***. The Dunsmuir Viaduct also derives 44% of its AM peak traffic from Vancouver, with up to 78% coming from Burrard Peninsula

municipalities as shown in ***Figure 4.6***. It is also expected that much of the future local vehicle traffic could be derived from taxis, couriers and delivery vehicles with core-area trip orientations.

Figure 4.4: Origins of Expo / Pacific Boulevard Vehicle Traffic (2014)

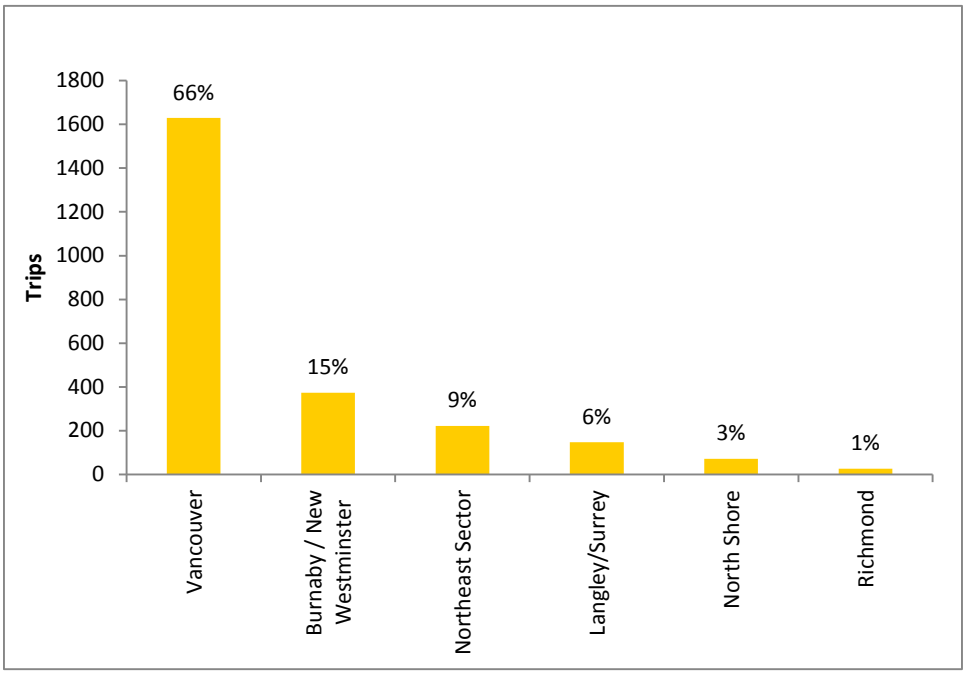


Figure 4.5: Origins of Expo / Pacific Boulevard Vehicle Traffic (2014)

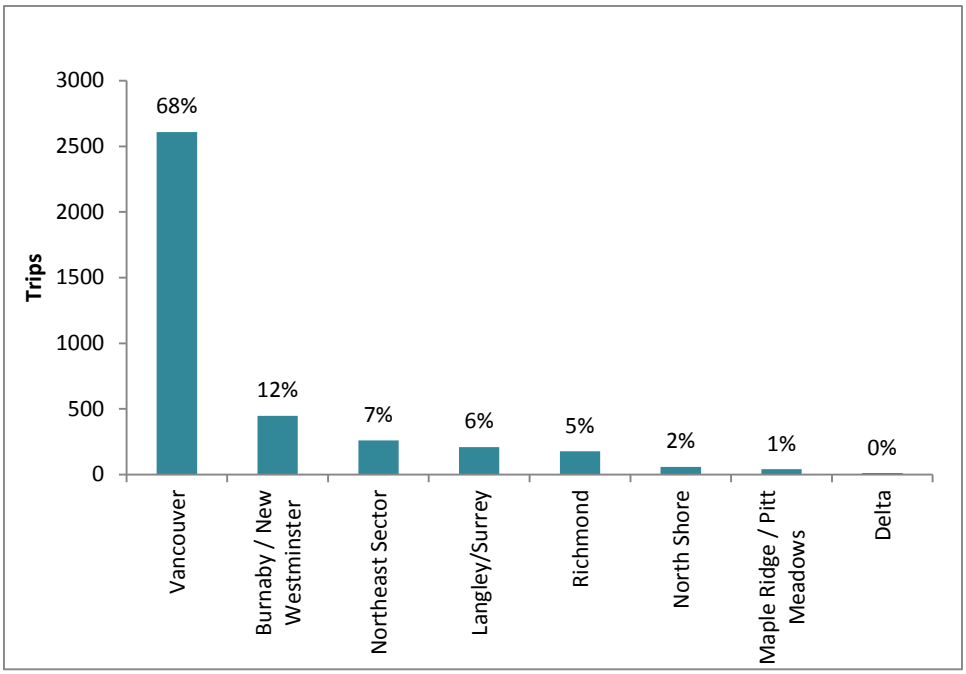
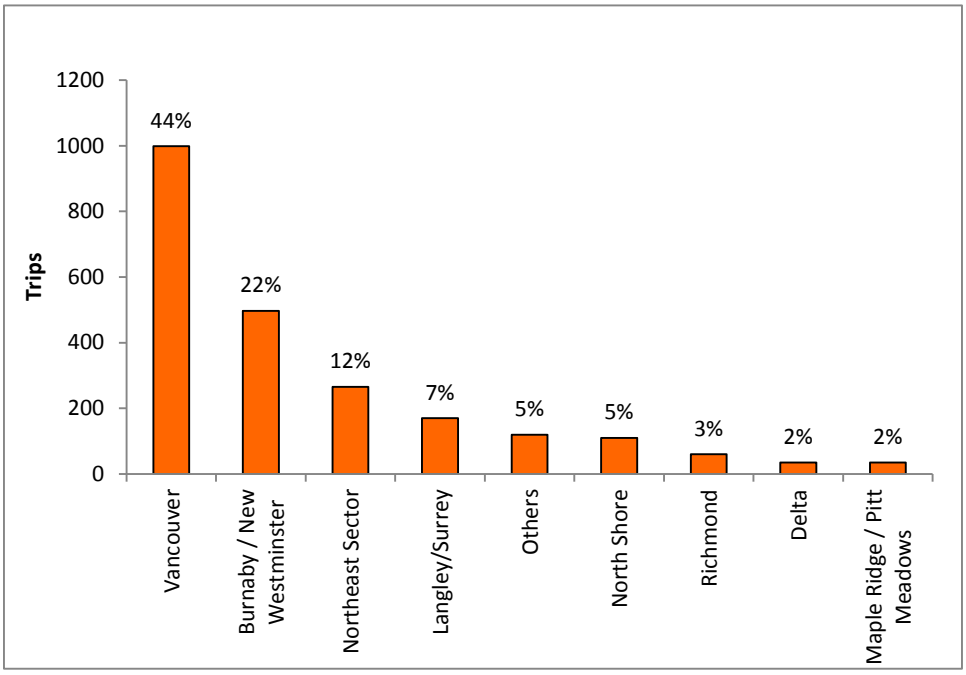


Figure 4.6: Origins of AM Peak Dunsmuir Viaduct Traffic (2011)



Based on these observations, the availability of road links to / from the east / west and north / south, and the general distribution of existing traffic flows, an approximate 50 / 50 east / west distribution was applied to new NEFC traffic as follows:

To/from

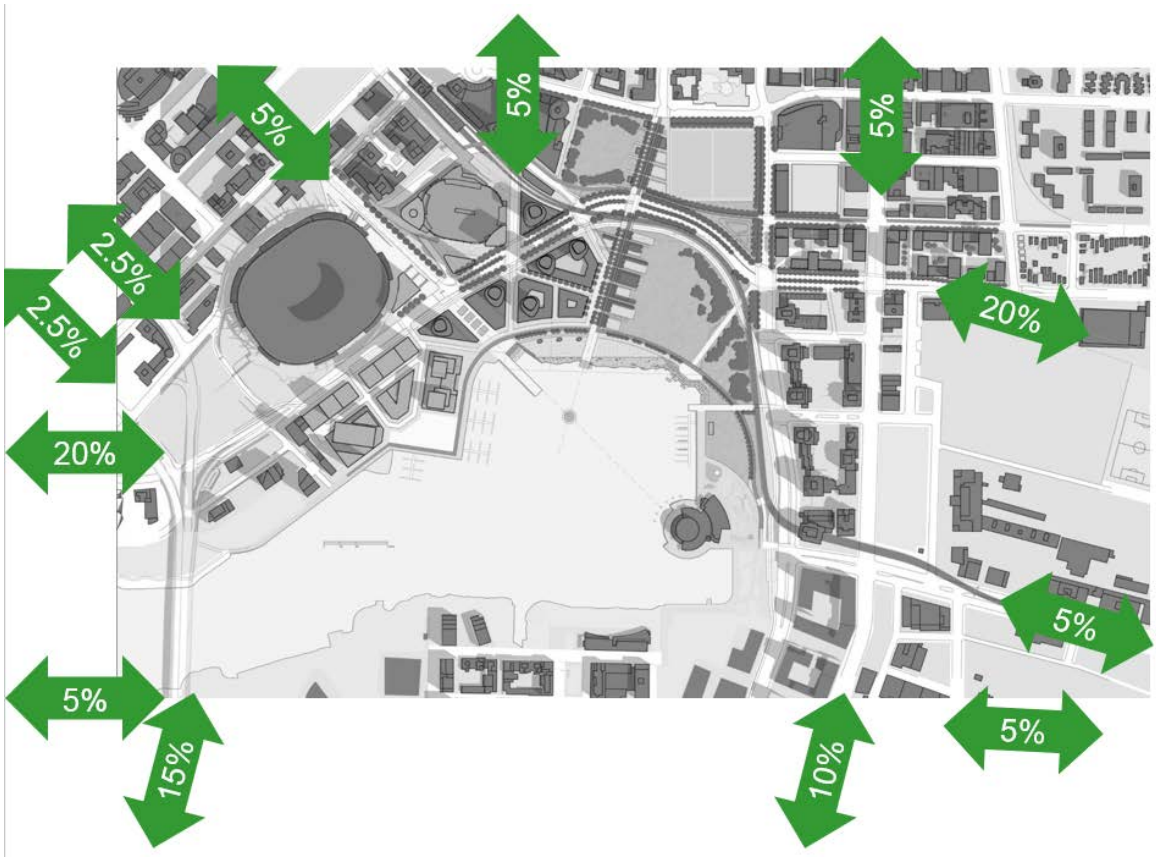
- Cambie Street south 15%
- 2nd Avenue west 5%
- Pacific Boulevard west 20%
- Nelson Street west 2.5%
- Smith Street west 2.5%
- Georgia Street west 5%
- Abbott Street north 5%
- Main Street north 5%
- Malkin Avenue east 20%
- Terminal Avenue east 5%
- Great Northern Way east 5%
- Main Street south 20%

100%

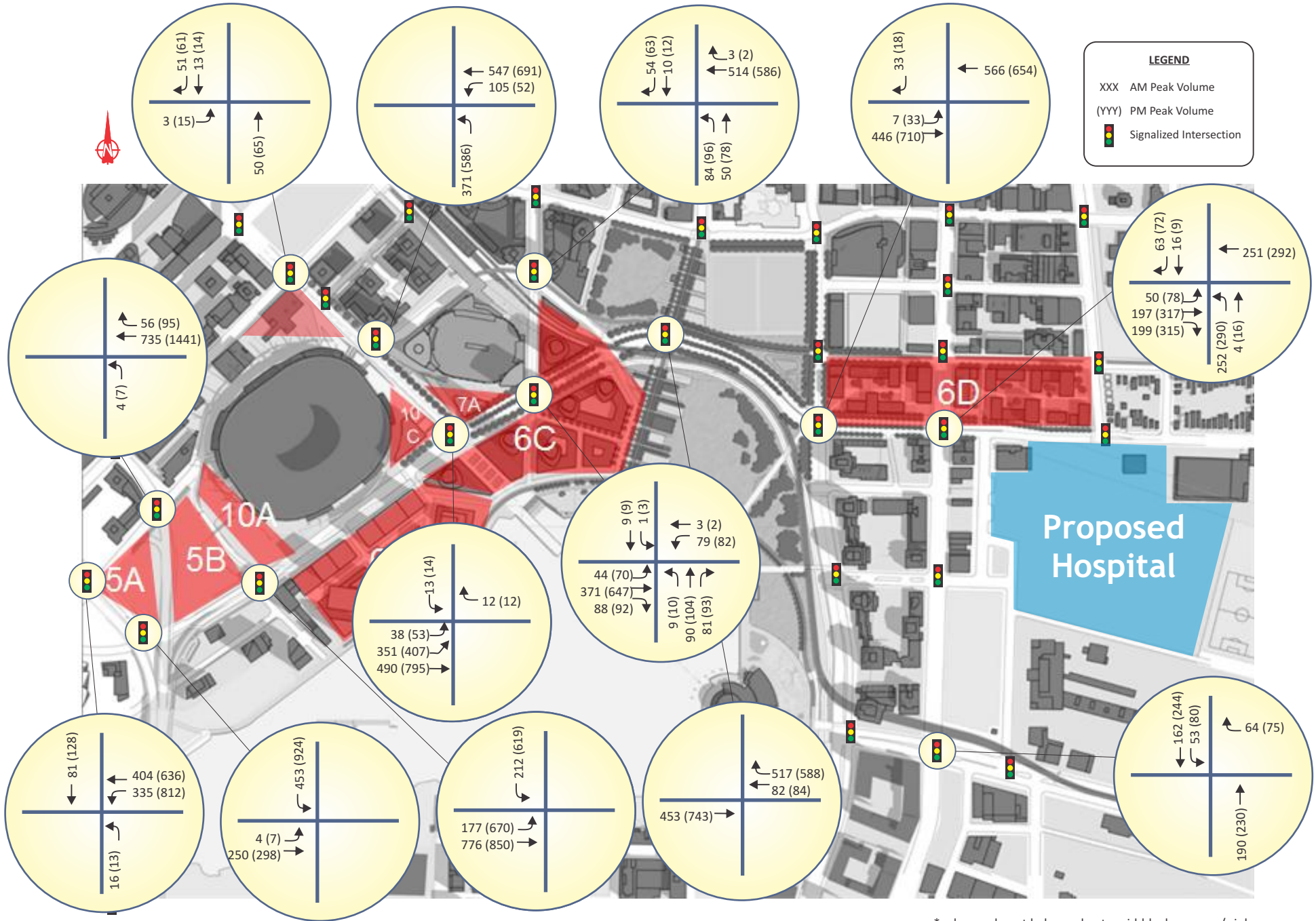
The three largest expected distributions (Pacific Boulevard west, Malkin Avenue east, and Main Street south) are influenced by the reorientation of the at-grade road network to connect Prior Street east and Pacific Boulevard more directly, as well as the significant residual interactions with Main Street which currently occur between the Georgia / Dunsmuir Viaduct ramps and Main Street. The 20% distribution to Malkin Avenue is predicated on the future provision of the Malkin Avenue connection from Prior Street to Clark Drive. This link would allow traffic to bypass the current congestion along Terminal Avenue and Prior Street and would therefore be an attractive eastern connection for NEFC development traffic.

Figure 4.7 shows the overall assumed distribution of new NEFC development traffic graphically. Background traffic will be distributed based on the combination of the macro and micro-simulation model results.

Figure 4.7: NEFC New Development Traffic Distribution



Figures 4.8 through ***4.9*** shows the schematic distribution of new site traffic to the future NEFC road network as well as the total combined background plus site traffic.

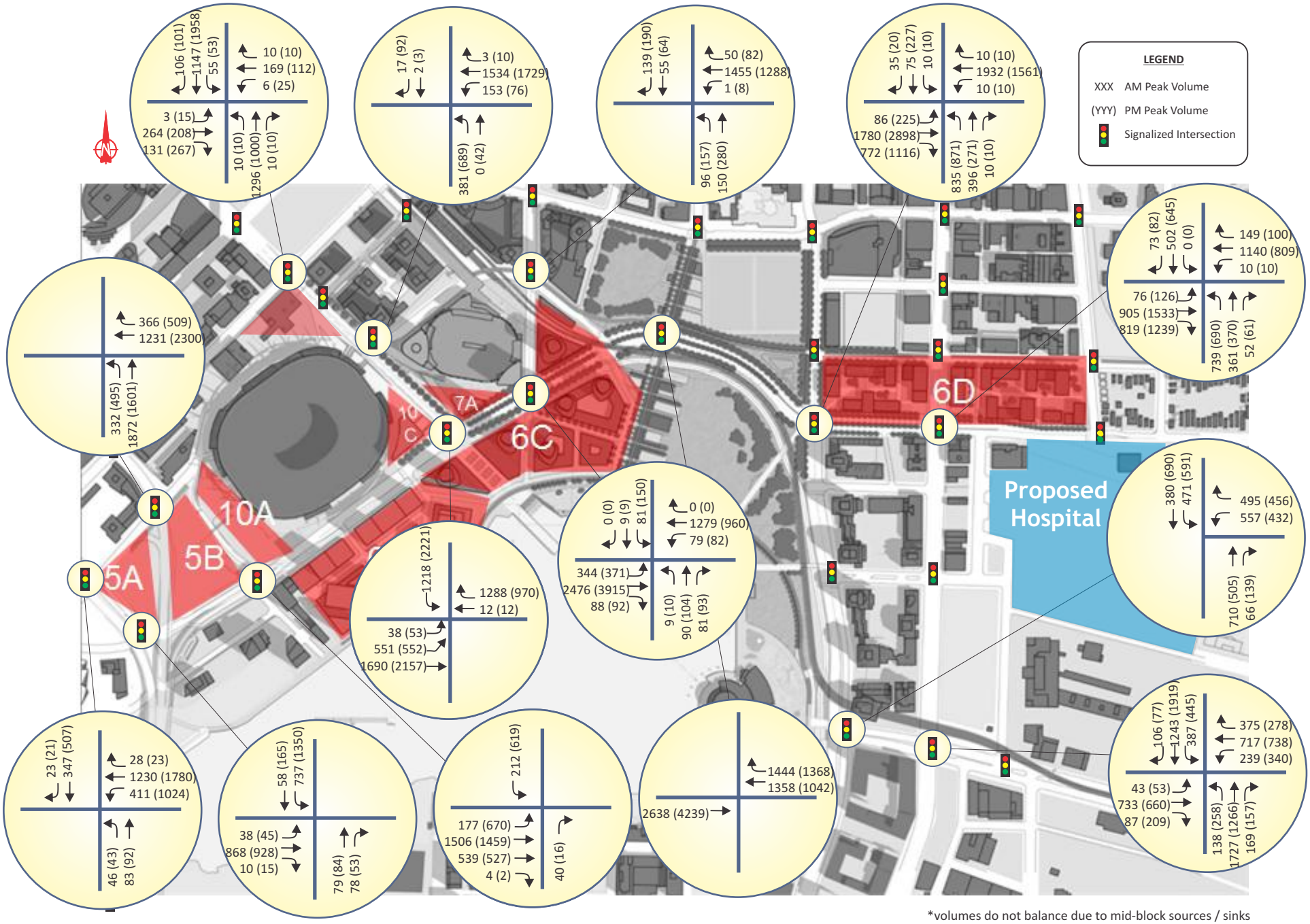


*volumes do not balance due to mid-block sources / sinks

PARSONS

New Site Generated Traffic Volumes
(2045 Viaducts Replacement Network Full Traffic Growth)

Figure 4.8



*volumes do not balance due to mid-block sources / sinks

PARSONS

Total Combined Background Plus New Site Traffic Volumes (2045 Viaducts Replacement Full Traffic Growth)

Figure 4.9

5.0 MODEL RESULTS

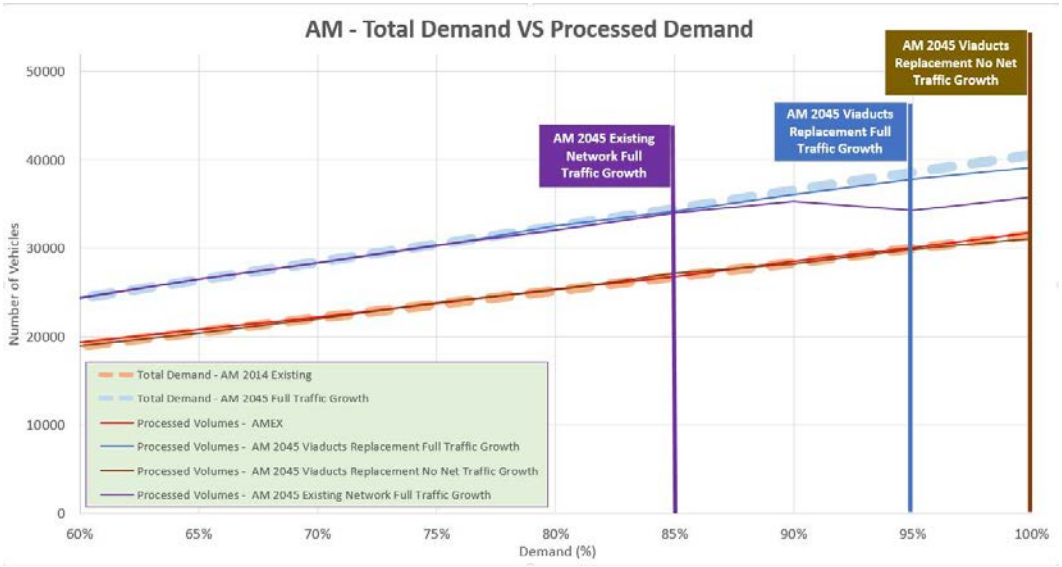
Using the scenarios developed in Section 3.0, the PARAMICS model was run to generate a variety of descriptive traffic performance statistics. Of particular interest were the following metrics:

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.

Figures 5.1 and ***5.2*** show the total model demand plotted against the actual processed demand for each of the four scenarios in the AM and PM peak, respectively. Note that each model was run using three randomly generated "seeds" to ensure consistency and avoid statistical outliers in the reporting.

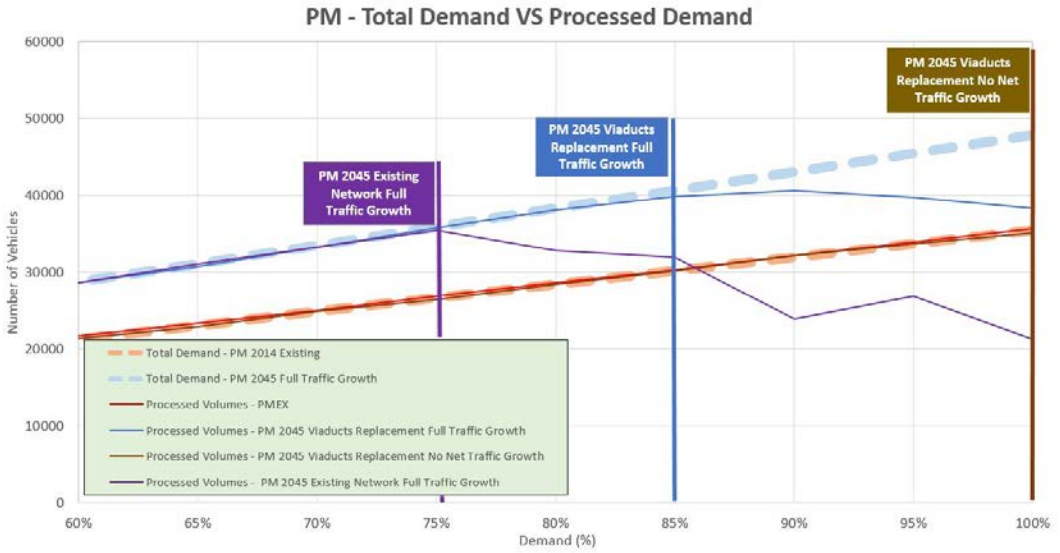
Figure 5.1: AM Peak Scenarios Vehicle Processing Comparison



As shown, for the AM peak scenarios the 2045 Viaducts replacement network no net traffic growth and 2045 Viaducts replacement network full traffic growth models are capable of processing between 95% and 100% of assigned demand before divergence

between assigned and processed demand is evident. The AM 2045 existing network full traffic growth model processes between 10% and 15% less traffic than the other scenarios 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 Prior Street / Malkin Avenue due to the location of the Viaducts ramp footprint in the vicinity of Main / Union. The Viaducts replacement scenarios allow this easterly oriented traffic to distribute more equally between Terminal Avenue and Prior Street / Malkin Avenue thereby reducing network delays.

Figure 5.2: PM Peak Scenarios Vehicle Processing Comparison



For the PM peak scenarios the 2045 Viaducts replacement no net traffic growth and 2045 Viaducts replacement network full traffic growth models are capable of processing between 85% and 100% of assigned demand. The PM 2045 existing network full traffic growth processes 10% to 25% less traffic than the other scenarios 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 Prior Street / Malkin Avenue due to the location of the Viaducts ramp footprint in the vicinity of Main / Union. The Viaducts replacement scenarios allow this easterly oriented traffic to distribute more equally between Terminal Avenue and Prior Street / Malkin Avenue 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 the following sections.

5.1 Scenario A – 2045 No Net Traffic Growth

The model results and statistics for the 2045 no net traffic growth travel demand scenario are presented below.

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 5.1*** and ***5.2***. 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 5.1: 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	5.1
Percent Difference from Base	N/A	+26 %

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.

Table 5.2: 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	35,115
Average Network Travel Time Per Vehicle (Minutes)	4.7	5.2
Percent Difference from Base	N/A	+10 %

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

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.

Figures 5.3 through ***5.6*** shows the comparative point to point travel times between the western and eastern extents of the NEFC network. ***Figure 5.3*** shows the comparative westbound AM peak travel times by scenario for trips along the Expo Boulevard surface street network. ***Figure 5.4*** 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 5.5*** shows the comparative eastbound PM peak travel time by scenario for trips along the Pacific Boulevard surface street network. ***Figure 5.6*** 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 5.3: AM Peak Westbound – Expo Boulevard with Viaducts Replacement

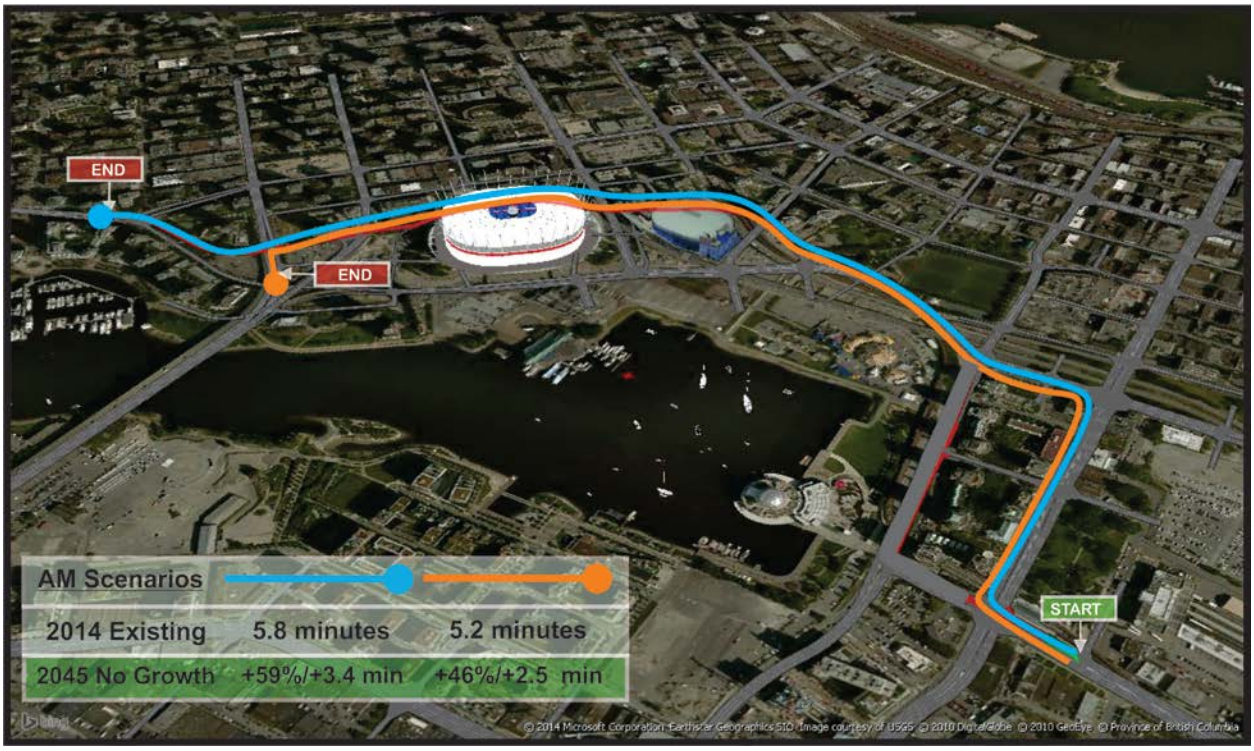


Figure 5.4: AM Peak Westbound – Dunsmuir Street with Viaducts Replacement

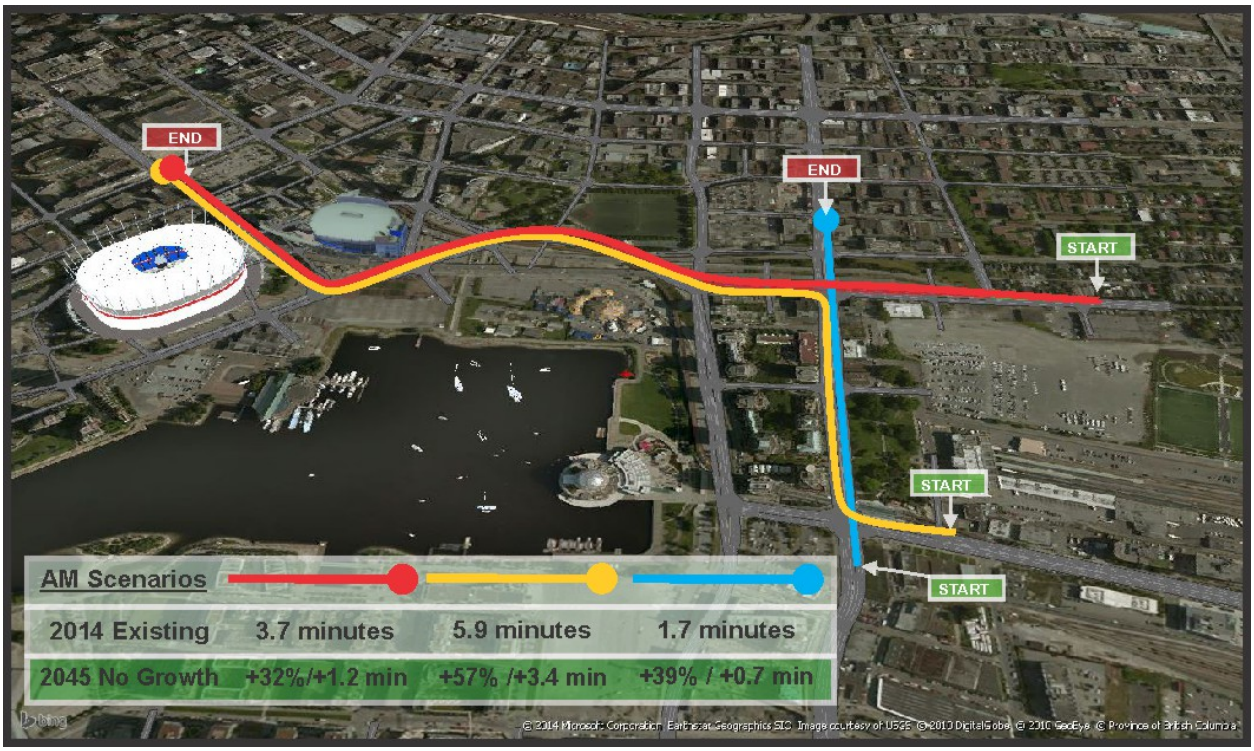
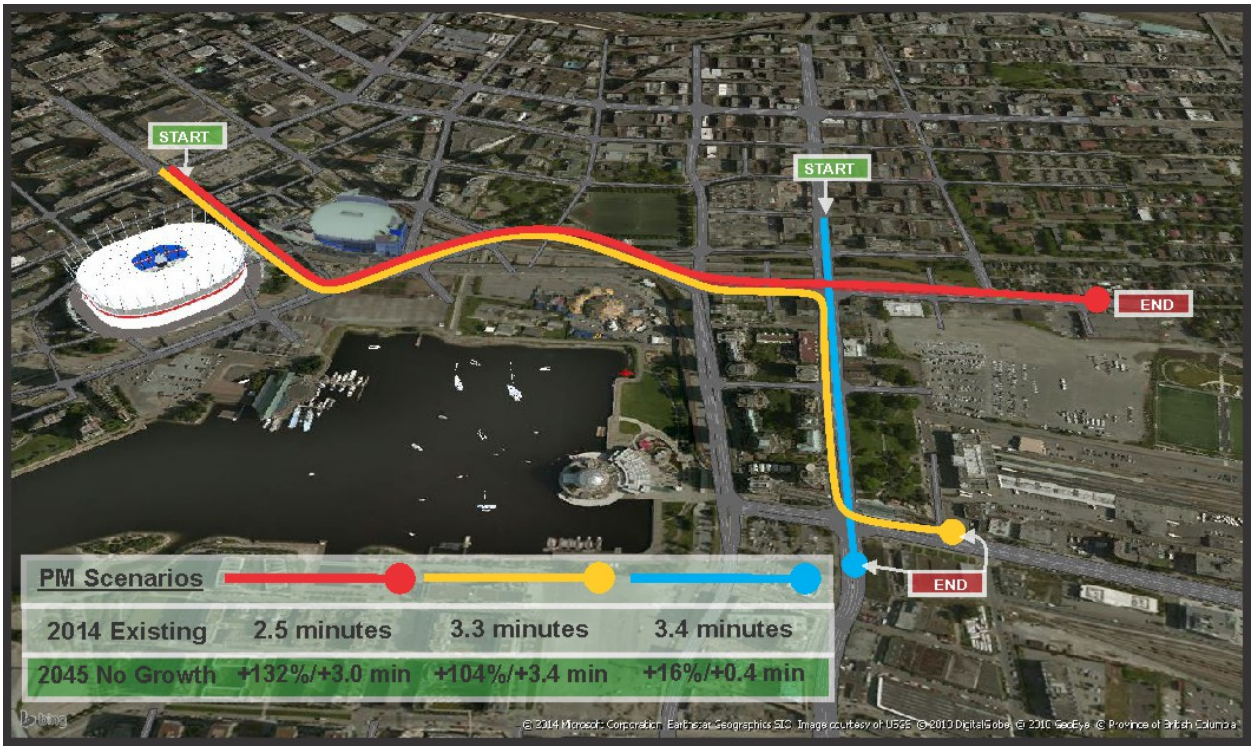


Figure 5.5: PM Peak Eastbound – Pacific Boulevard with Viaducts Replacement

Figure 5.6: PM Peak Eastbound – Georgia Street with Viaducts Replacement



Generally speaking, travel times increase by one to three 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 signal along the travel route.

A travel time increase of one to three 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.

Figures 5.7 and ***5.8*** show the comparative link flows for the no net vehicle growth compared with observed existing conditions. These flows are bundled as two-way totals.

Figure 5.7: AM Peak Hour Volume Comparison

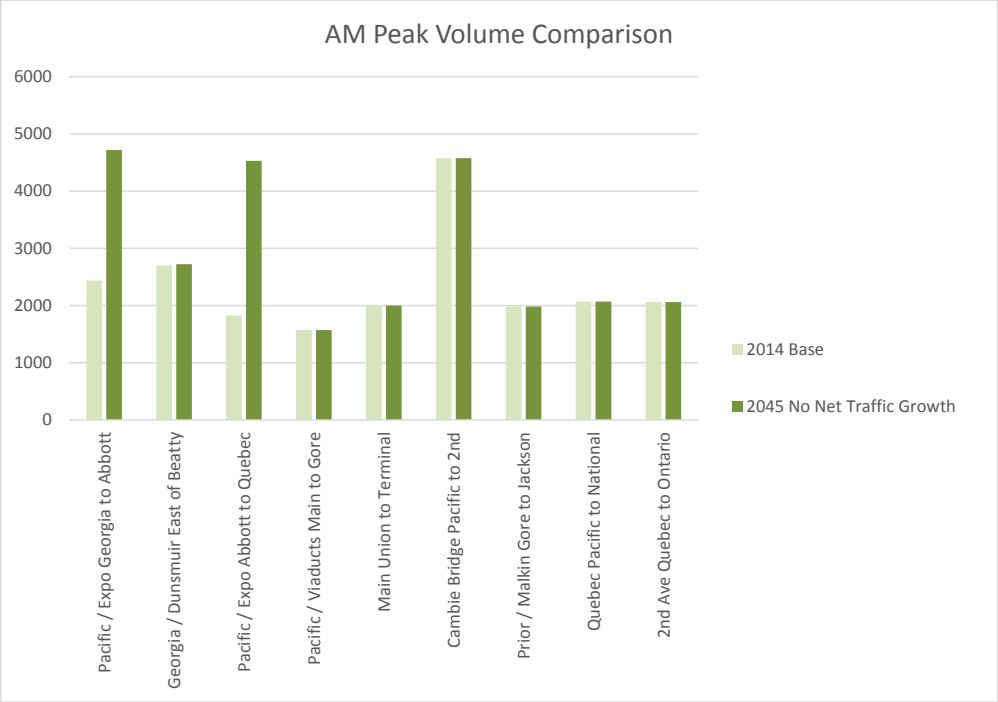
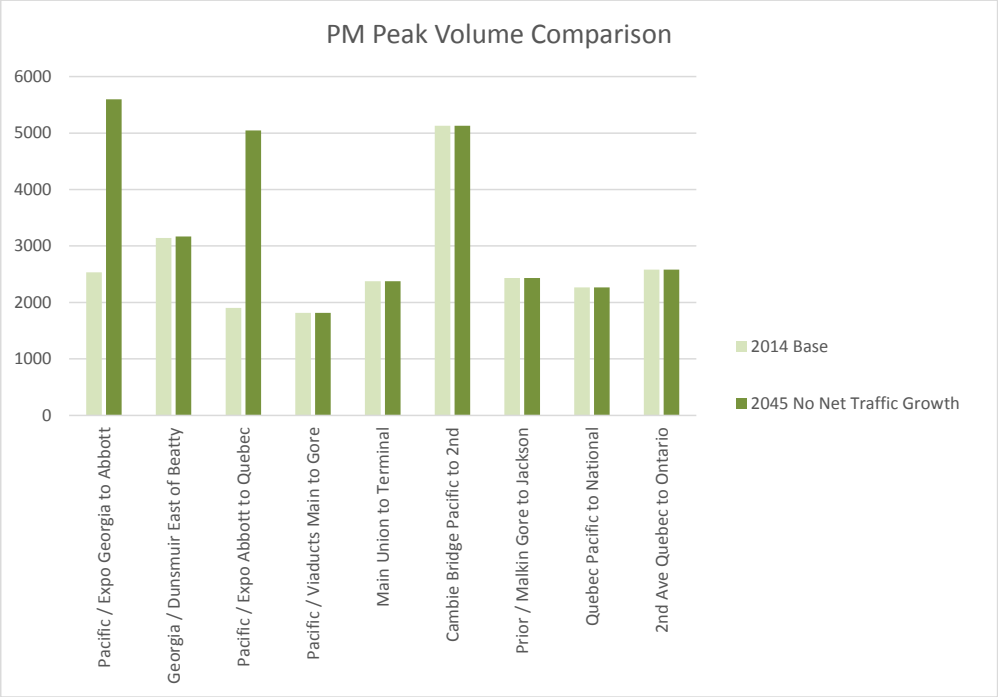


Figure 5.8: PM Peak Hour Volume Comparison



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 5.3 summarizes the resultant daily traffic volumes. Daily traffic volumes were calculated using a peak to daily factor of 12 as observed through baseline counts. Light and heavy truck proportions are also shown, which have been estimated using sample classification counts at key intersections.

Table 5.3: 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	3876	158	323	2	2
Expo	Abbott to Griffiths	12864	1038	1072	1.2	1.2	12864	1038	1072	1.2	1.2
New Pacific	Georgia to Abbott	n/a	n/a	n/a	n/a	n/a	54324	3681	4527	2	2
Pacific (Current)	Griffiths to Abbott	17544	1400	1462	2	2	n/a	n/a	n/a	n/a	n/a
Georgia	South of Beatty	23160	1252	1930	2.2	2.2	37728	2698	3144	2.2	2.2
Dunsmuir	South of Beatty	14568	1446	1214	2.2	2.2	312	26	26	2.2	2.2
Quebec	Pacific to National	27204	2070	2267	2	2	27204	2070	2267	2	2
Pacific	Abbott to Quebec	13344	841	1112	2	2	60552	4528	5046	2	2
Expo	Quebec to Abbott	9480	989	790	1.2	1.2	n/a	n/a	n/a	n/a	n/a
New Pacific	Quebec to Main	n/a	n/a	n/a	n/a	n/a	37620	2740	3135	2	2
New Pacific / Prior	Main to Gore	n/a	n/a	n/a	n/a	n/a	21792	1571	1816	2	2
Viaducts	Main to Gore	21792	1571	1816	2	2	n/a	n/a	n/a	n/a	n/a
Main	Union to Terminal	28500	2002	2375	2	2	28500	2002	2375	2	2
Main	Union to Pender	13284	949	1107	2	2	13284	949	1107	2	2
Pacific	Cambie to Nelson	17988	1350	1499	2	2	17988	1350	1499	2	2
Cambie Bridge	Pacific to 2nd	61548	4575	5129	2	2	61548	4575	5129	2	2
Terminal	Main to Station	29556	2503	2463	2	2	29556	2503	2463	2	2
Prior	Gore to Jackson	29196	1985	2433	2	2	29196	1985	2433	2	2
2nd Ave	Quebec to Ontario	30960	2061	2580	2	2	30960	2061	2580	2	2

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 have been assumed based on a maximum 85 second cycle length and fixed-time operation for new signals to account for significantly increased pedestrian activity, except at the new Pacific / Griffiths intersection where the cycle length was increased to optimize operations.

Intersection capacity analysis results presented in ***Table 5.4*** were developed by first manually assigning forecast traffic volume to the background road network. This is a worst case estimate of future Level of Service ratings as the intersection demand is not controlled or constrained due to upstream or downstream capacity issues in the Synchro program. The 2045 Viaducts replacement network no net traffic growth scenario was analyzed using existing Viaducts traffic superimposed onto Expo / Pacific boulevard traffic flows. This reflects a scenario where no net traffic growth would be encountered within the NEFC network and is consistent with the City's broader goals of limiting vehicular traffic usage to current levels.

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 delay per vehicle) are highlighted in red as these exceed typical performance standards.

The intersection performance statistics are summarized in ***Table 5.4***, 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.

Table 5.4: 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*	*96.2*	*F*	*1.44*	*103.2*	*F*	*1.33*
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	*75.3*	*E*	*1.27*	*223.8*	*F*	*1.69*
Gore / Prior	*72.5*	*E*	*1.16*	*153.2 WB*	*40.0*	*D*	*1.02*	*146.2 EB*	17.1	B	0.82	19.8	B	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
New Pacific / Main	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	24.6	C	0.66	*36.0*	*D*	*0.99*
Main / Union	18.9	B	0.65	41.7 WB	20.0	C	0.69	45.1 WB	17.6	B	0.35	18.1	B	0.38
Pacific / Carrall	2.6	A	0.24	22.0 EB	3.2	A	0.33	15.0 SB	15.9	B	*1.03*	*110.1*	*F*	*1.28*
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	*122.6*	*F*	*1.07*	*87.5*	*F*	*1.00*
Expo / Abbott	7.0	A	0.42	13.9 NB	9.6	A	0.34	31.2 NB	12.1	B	0.58	10.3	B	0.34
Pacific / Nelson	14.6	B	0.70	64.3 SB	*53.1*	*D*	*1.16*	*125.1 SB*	14.6	B	0.70	*53.1*	*D*	*1.16*
Pacific / Smithe Mews	15.5	B	0.57	67.4 EB	21.0	C	0.78	62.6 EB	17.2	B	0.58	19.5	B	0.79
Expo / Griffiths	5.1	A	0.42	12.7 WBT	9.6	A	0.53	19.8 WB	2.7	A	0.42	9.9	A	0.53
Expo / Smithe	22.5	C	0.63	62.8 WBR	17.1	B	0.85	98.1 WBR	21.9	C	0.63	16.8	B	0.85
Expo / Nelson	24.2	C	0.77	62.0 WBT	*45.5*	*D*	*1.05*	*101.9 WBT*	24.2	C	0.77	*45.6*	*D*	*1.05*
Beatty / Georgia	6.1	A	0.51	27.8 WB	14.0	B	0.85	47.7 NBR	41.1	D	0.79	*100.4*	*F*	*1.19*
Georgia / Cambie	12.0	B	0.50	43.1 EB	14.2	B	0.59	53.5 EB	9.6	A	0.72	14.5	B	0.71
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	*68.8*	*E*	*0.98*	*137.0*	*F*	*1.38*

5.2 Scenario B – 2045 Full Traffic Growth

The model results and statistics for the 2045 full traffic growth travel demand scenarios are presented below.

AVERAGE NETWORK TRAVEL TIME

The results of the average network travel time statistics are shown in ***Tables 5.5*** and ***5.6***. 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 5.5: 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%	95%
Total Number of Vehicles Processed	31,761	33,996	37,833
Average Network Travel Time Per Vehicle (Minutes)	4.0	4.5	5.1
Percent Difference from Base	N/A	+14 %	+27 %

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 Viaducts in the forecast scenario reduces average travel time increases; however, this network processes 10% less traffic volume than the Viaducts replacement network due to the limited accessibility and local traffic distribution flexibility.

Table 5.6: 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%	85%
Total Number of Vehicles Processed	35,605	35,425	39,758
Average Network Travel Time Per Vehicle (Minutes)	4.7	4.7	6.0
Percent Difference from Base	N/A	0 %	+26 %

Reviewing the PM 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. Provision of the Viaducts in the forecast scenario avoids average travel time increases; however, this network processes less traffic volume 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 the most significant 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.

POINT TO POINT TRAVEL TIMES

Figures 5.9 through ***5.12*** shows the comparative point to point travel times between the western and eastern extents of the NEFC network. ***Figure 5.9*** shows the comparative westbound AM peak travel times by scenario for trips along the Expo Boulevard surface street network. ***Figure 5.10*** 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 5.11*** shows the comparative eastbound PM peak travel time by scenario for trips along the Pacific Boulevard surface street network. ***Figure 5.12*** 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 5.9a: AM Peak Westbound – Expo Boulevard with Viaducts

Figure 5.9b: AM Peak Westbound – Expo Boulevard with Viaducts Replacement

Figure 5.10a: AM Peak Westbound – Dunsmuir Street with Viaducts

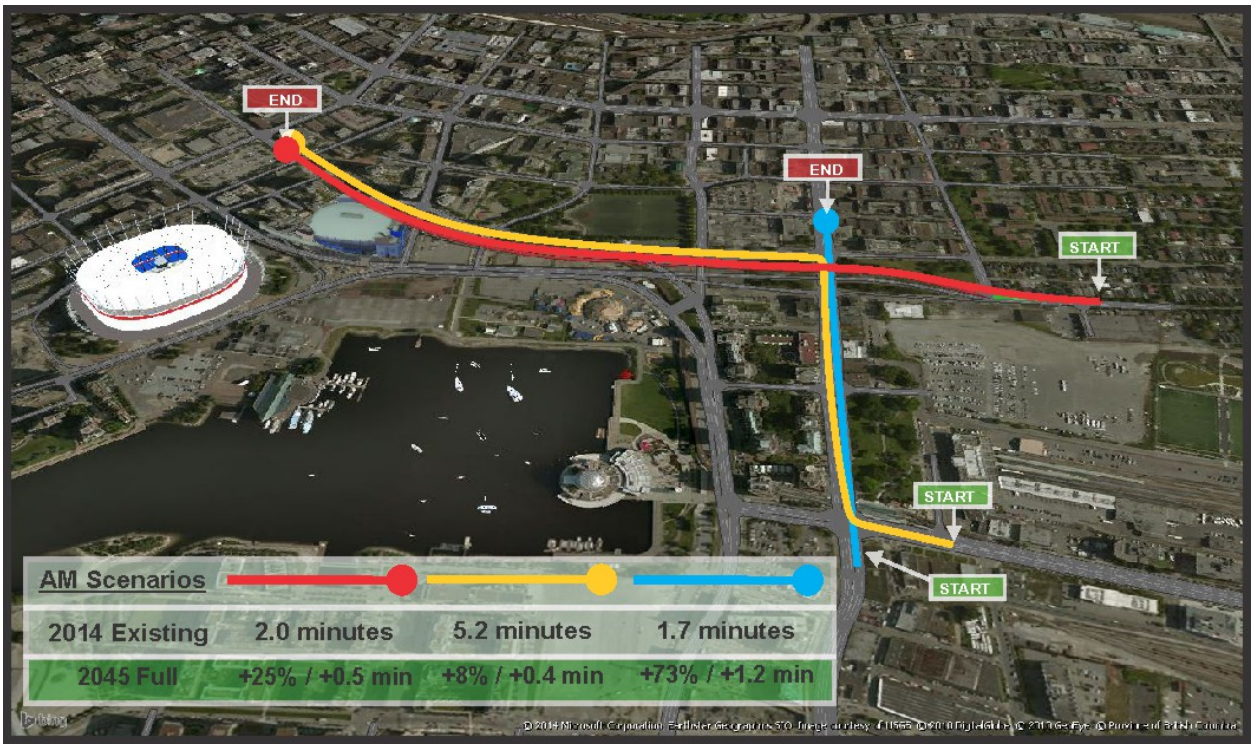


Figure 5.10b: AM Peak Westbound – Dunsmuir Street with Viaducts Replacement

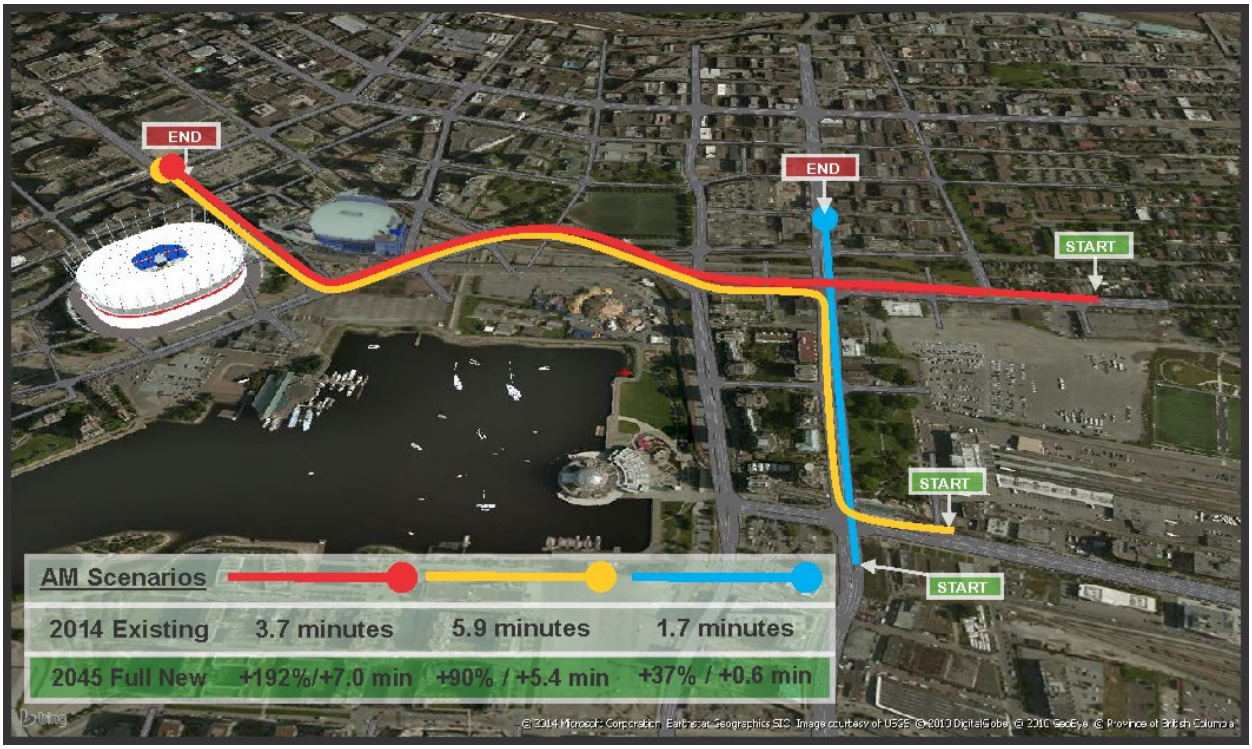


Figure 5.11a: PM Peak Eastbound – Pacific Boulevard with Viaducts

Figure 5.11b: PM Peak Eastbound – Pacific Boulevard with Viaducts Replacement

Figure 5.12a: PM Peak Eastbound – Georgia Street with Viaducts

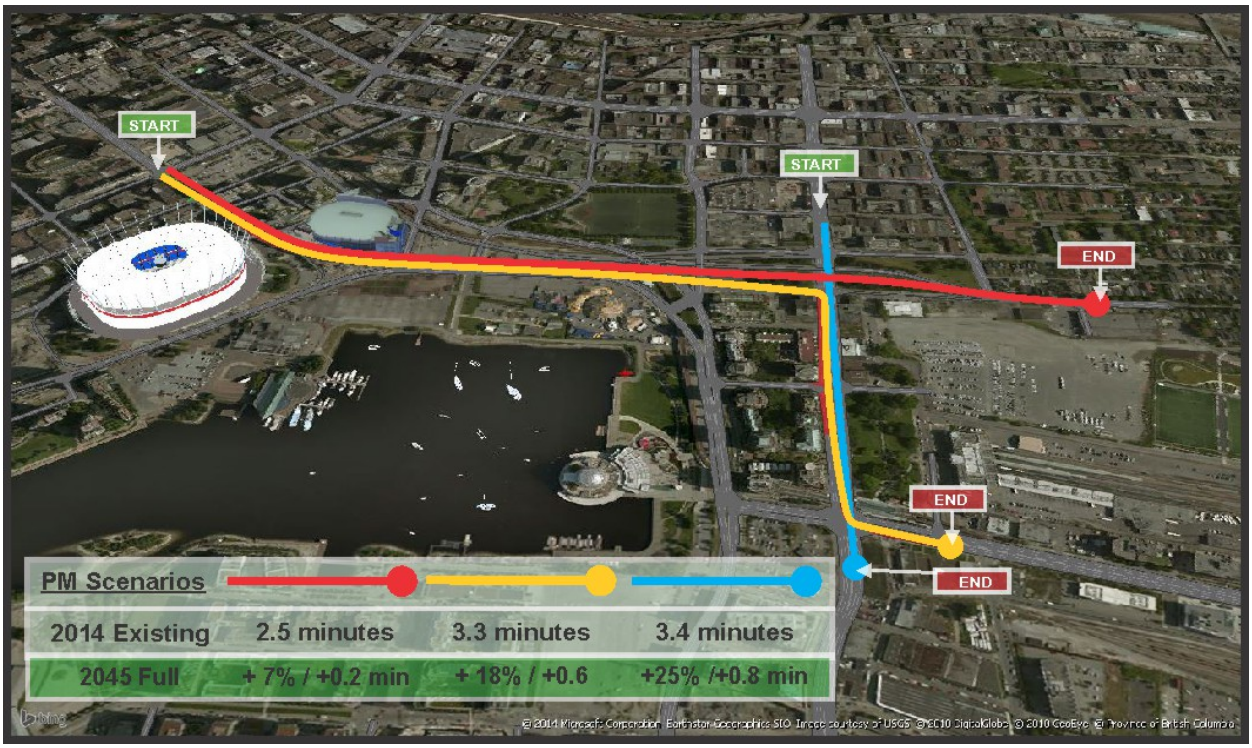
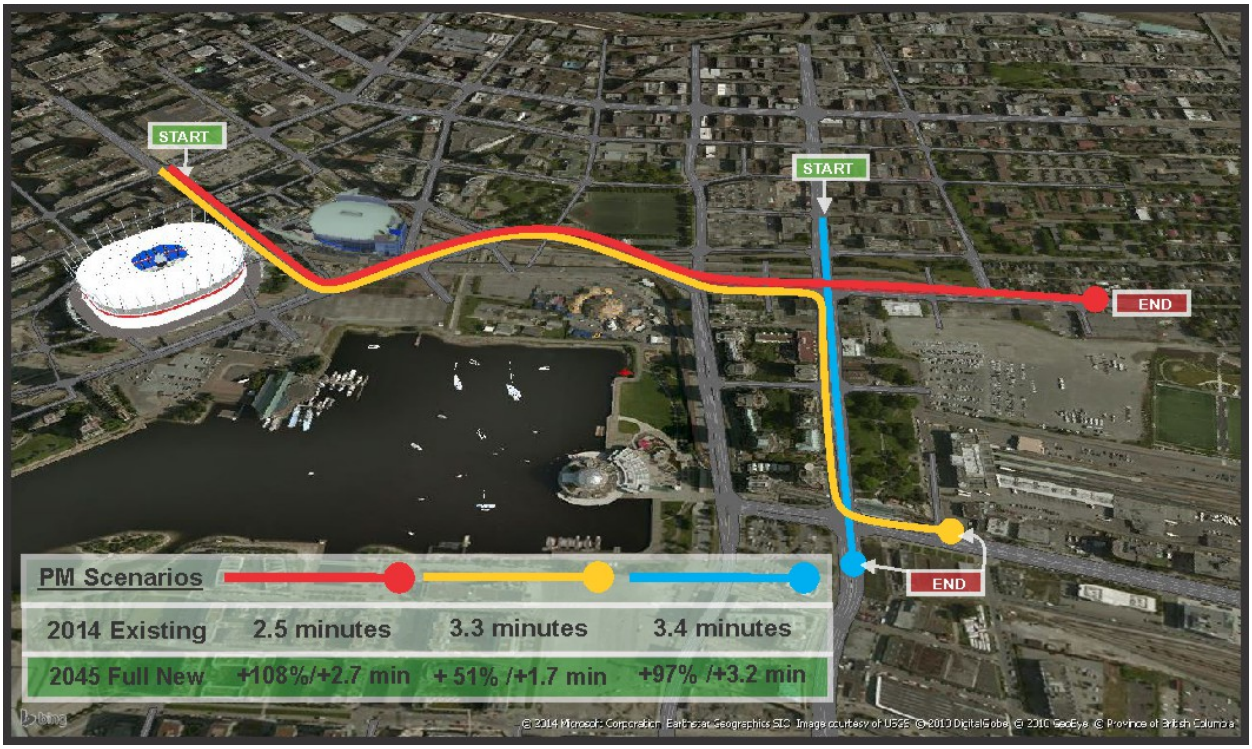


Figure 5.12b: PM Peak Eastbound – Georgia Street with Viaducts Replacement



On the whole, travel times increase by one to seven 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 85% of combined background and NEFC traffic demand during the peak hours.

Figures 5.13 and ***5.14*** show the comparative link flows for each of the scenarios as compared with observed existing conditions. These flows are bundled as two-way totals.

Figure 5.13: AM Peak Hour Volume Comparison

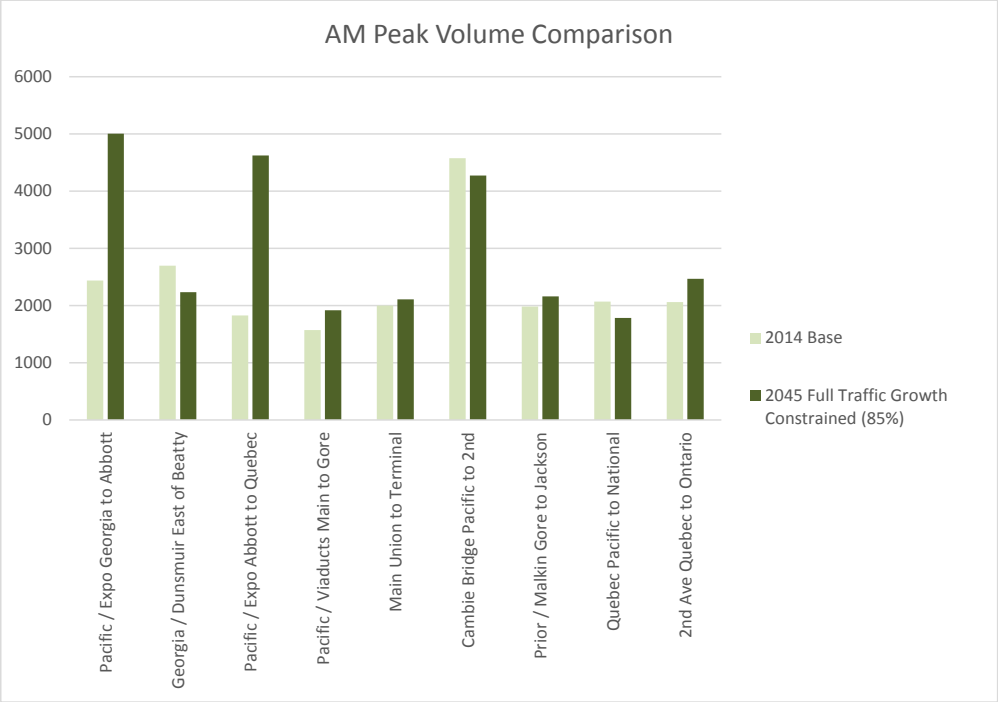
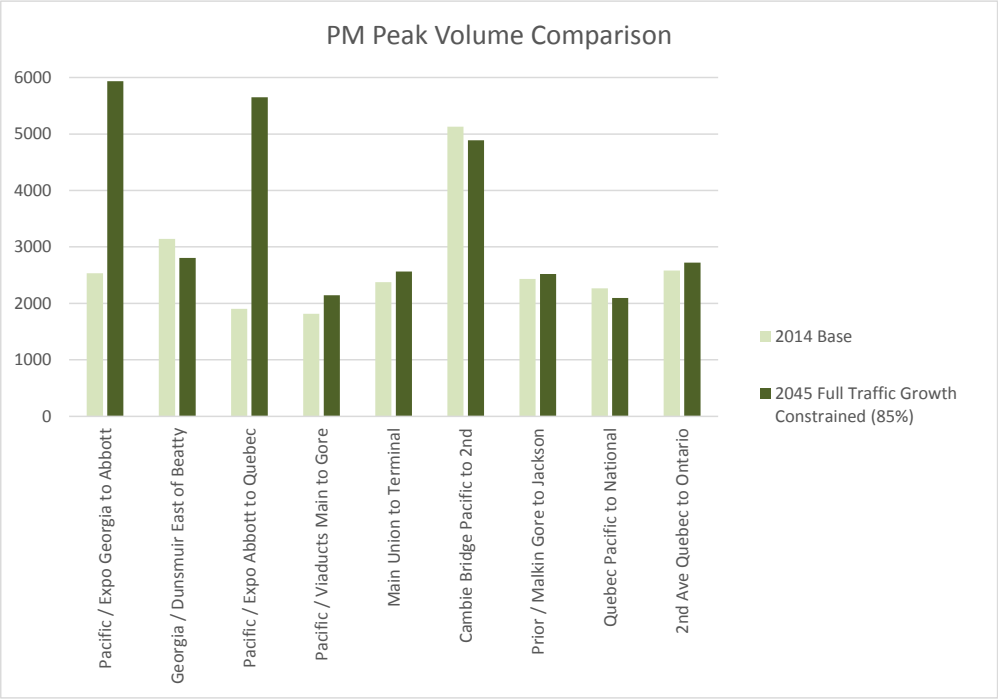


Figure 5.14: PM Peak Hour Volume Comparison



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 5.7 summarizes the resultant daily traffic volumes for the major analysis scenarios. Daily traffic volumes were calculated using a peak to daily factor of 12 as observed through baseline counts. Light and heavy truck proportions are also shown, which have been estimated using sample classification counts at key intersections.

Table 5.7: Daily Volume Comparison

Street	Representative Block	Current Volumes					Projected Volumes – 2045 Full New Constrained (85%)				
		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	6467	445	539	2	2
Expo	Abbott to Griffiths	12864	1038	1072	1.2	1.2	16677	1437	1390	1.2	1.2
New Pacific	Georgia to Abbott	n/a	n/a	n/a	n/a	n/a	54550	3567	4546	2	2
Pacific (Current)	Griffiths to Abbott	17544	1400	1462	2	2	n/a	n/a	n/a	n/a	n/a
Georgia	South of Beatty	23160	1252	1930	2.2	2.2	33354	2210	2780	2.2	2.2
Dunsmuir	South of Beatty	14568	1446	1214	2.2	2.2	306	26	26	2.2	2.2
Quebec	Pacific to National	27204	2070	2267	2	2	25123	1783	2094	2	2
Pacific	Abbott to Quebec	13344	841	1112	2	2	67820	4624	5652	2	2
Expo	Quebec to Abbott	9480	989	790	1.2	1.2	n/a	n/a	n/a	n/a	n/a
New Pacific	Quebec to Main	n/a	n/a	n/a	n/a	n/a	45686	3189	3807	2	2
New Pacific / Prior	Main to Gore	n/a	n/a	n/a	n/a	n/a	25724	1918	2144	2	2
Viaducts	Main to Gore	21792	1571	1816	2	2	n/a	n/a	n/a	n/a	n/a
Main	Union to Terminal	28500	2002	2375	2	2	30753	2111	2563	2	2
Main	Union to Pender	13284	949	1107	2	2	12974	906	1081	2	2
Pacific	Cambie to Nelson	17988	1350	1499	2	2	25000	1720	2083	2	2
Cambie Bridge	Pacific to 2nd	61548	4575	5129	2	2	58650	4275	4888	2	2
Terminal	Main to Station	29556	2503	2463	2	2	26704	2227	2225	2	2
Prior	Gore to Jackson	29196	1985	2433	2	2	30243	2161	2520	2	2
2nd Ave	Quebec to Ontario	30960	2061	2580	2	2	32640	2469	2720	2	2

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 have been assumed based on a maximum 85 second cycle length and fixed-time operation for new signals to account for significantly increased pedestrian activity, except at the new Pacific / Griffiths intersection where the cycle length was increased to optimize operations.

Intersection capacity analysis results presented in ***Table 5.8*** were developed by first manually assigning forecast traffic volume to the background road network. This is a worst case estimate of future Level of Service ratings as the intersection demand is not controlled or constrained due to upstream or downstream capacity issues in 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 delay per vehicle) are highlighted in red as these exceed typical performance standards.

It was observed through a manual analysis of the unconstrained Full Development forecast traffic volumes that significant congestion could potentially occur. Almost all major intersections would operate at Level of Service F with high average delays and would have at least one movement with a volume to capacity ratio greater than 1.00. This worst case scenario would represent a condition whereby all traffic demand is assigned directly to the affected intersections, regardless of whether an upstream or downstream constraint will actually serve to meter the traffic flow that can be delivered to the network as a whole. Recognizing that peripheral intersections that affect traffic flow rates into and out of the NEFC area will continue to serve as volume controls, as well as the maximum practical volume that can be processed by the Viaducts replacement network, the forecast volumes were therefore capped at 85% of their combined totals before rerunning the Synchro program with the following mitigation options:

- 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 a westbound left-turn bay at the Pacific / Abbott signalized intersection which will allow for direct left-turns to the 6C development site. With the provision of a local connecting link, the left-turn bay can also service westbound trips to the adjacent 6B site without having to circulate around the Expo / Pacific one-way couplet.
- Provision of eastbound and westbound left-turn bays and protected signal phasing at the Pacific / Quebec signalized intersection. This would provide better access to the 6D development block, the Chinatown parkade, and Andy Livingstone Park. To provide room for the eastbound left-turn bay, the eastbound right-turn bay to Quebec Street southbound would be converted to a shared through / right-turn.
- Prohibition of eastbound and westbound left-turns at the Pacific / Main signalized intersection. This would shift turning movements to the Pacific / Quebec intersection as per the above modifications and free up signal time to be allocated to other movements.
- 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.
- Application of a sensitivity test to shift 50% of the forecast turning traffic between Pacific Boulevard and Quebec Street to Pacific Boulevard and Main Street. This measure would reflect the new improved continuity along Pacific Boulevard and allow for removal of a dual northbound left-turn signal phase at Pacific / Quebec, a dual southbound left-turn signal phase at Quebec / Terminal and a dual westbound right-turn movement at Quebec / Terminal.
- Optimizing signal timing and phasing along the Viaducts replacement network, while respecting existing maximum cycle lengths (65 to 85 seconds).

Other mitigation measures were explored such as split signal phases and dual left-turn movements for the Nelson Street, 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 5.8***. 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.

Table 5.8: 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*	*82.2*	*F*	*1.43*	*80.8*	*F*	*1.42*
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	*40.0*	*D*	*1.73*	*239.7*	*F*	*1.50*
Gore / Prior	*72.5*	*E*	*1.16*	*153.2 WB*	*40.0*	*D*	*1.02*	*146.2 EB*	16.5	B	0.80	19.9	B	0.72
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
New Pacific / Main	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	*48.6*	*D*	*1.10*	*125.4*	*F*	*1.62*
Main / Union	18.9	B	0.65	41.7 WB	20.0	C	0.69	45.1 WB	17.6	B	0.31	18.5	B	0.36
Pacific / Carrall	2.6	A	0.24	22.0 EB	3.2	A	0.33	15.0 SB	*31.4*	*C*	*1.21*	*133.5*	*F*	*1.32*
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	*175.8*	*F*	*1.49*	*197.6*	*F*	*1.28*
Expo / Abbott	7.0	A	0.42	13.9 NB	9.6	A	0.34	31.2 NB	13.4	B	0.67	13.1	B	0.58
Pacific / Nelson	14.6	B	0.70	64.3 SB	*53.1*	*D*	*1.16*	*125.1 SB*	22.2	C	0.79	*230.1*	*F*	*1.69*
Pacific / Smithe Mews	15.5	B	0.57	67.4 EB	21.0	C	0.78	62.6 EB	15.0	B	0.68	*59.1*	*E*	*1.09*
Expo / Griffiths	5.1	A	0.42	12.7 WBT	9.6	A	0.53	19.8 WB	*41.9*	*D*	*1.04*	*86.3*	*F*	*1.19*
Expo / Smithe	22.5	C	0.63	62.8 WBR	17.1	B	0.85	98.1 WBR	16.7	B	0.72	20.6	C	0.79
Expo / Nelson	24.2	C	0.77	62.0 WBT	*45.5*	*D*	*1.05*	*101.9 WBT*	24.4	C	0.67	*59.6*	*E*	*0.94*
Beatty / Georgia	6.1	A	0.51	27.8 WB	14.0	B	0.85	47.7 NBR	9.5	B	0.67	*30.7*	*C*	*0.88*
Georgia / Cambie	12.0	B	0.50	43.1 EB	14.2	B	0.59	53.5 EB	17.4	B	0.79	*31.8*	*C*	*0.99*
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	*51.1*	*D*	*0.87*	*111.2*	*F*	*1.19*

6.0 SUMMARY OF VEHICLE NETWORK ISSUES, OPPORTUNITIES & CONSTRAINTS

Combining the results of the travel time analysis, intersection capacity analysis and operational model outputs and observations, a summary of key vehicular traffic network issues, opportunities and constraints can be provided. These issues are broken down into overall, network specific, and intersection specific categories.

OVERALL

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 fails at approximately 85% of the theoretical network demand. The 85% threshold reflects the practical upper limit of volume that can be processed given the network constraints up and downstream of the study area which serves to ensure the NEFC study area will never need to accommodate the 100% demand. To account for this, a reasonable upper limit growth scenario for modelling and designing the replacement network is a constrained growth scenario representing 85% of modelled demand. Even this 85% forecast is likely to be conservative, considering the City's policy of prioritizing road space to active modes and transit City wide as the recent success in reducing vehicular traffic volume while continuing to accommodate population and employment growth.

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

- Nelson Street southbound left-turn to Pacific Boulevard eastbound;
- Expo Boulevard westbound through at Nelson Street;
- Prior Street eastbound and westbound at Gore Avenue; and
- Main Street northbound and southbound at Terminal Avenue.

Acknowledging the above, as well as the City’s goals for accommodating forecast additional trips through active transportation and transit growth, helped to establish two sets of traffic volumes for analysis:

- Unconstrained NEFC vehicle traffic generation rates superimposed on background traffic volumes for comparative purposes only; and
- Constrained volumes reflecting approximately 85% of combined NEFC and background forecast traffic demand. These volumes would represent vehicle traffic growth higher than current Transportation 2040 targets and are intended to be a more realistic reflection of what the upstream and downstream transportation network can actually process.

As the NEFC develops over many years and improvements to transit, cycling and pedestrian networks are brought online, it may take time for vehicle trip generation rates to stabilize and fall toward City targets. Early developments in particular 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.

The presence of the Georgia and Dunsmuir Viaducts is incompatible with attaining full build out of the NEFC development blocks, and 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.

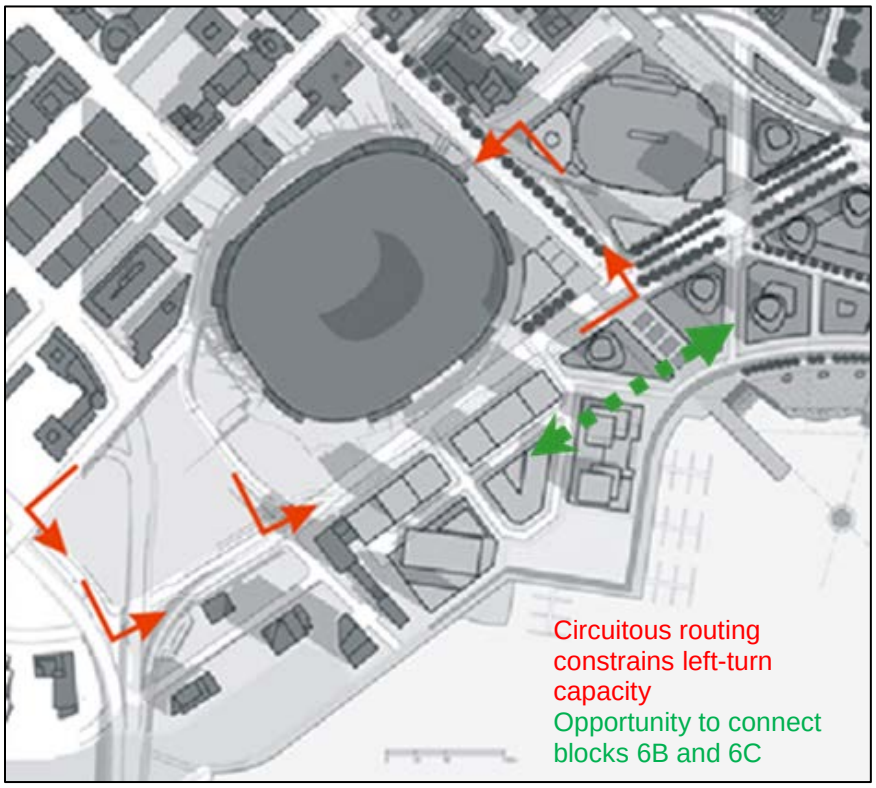
NETWORK

While the Viaducts replacement network as proposed is superior to the existing network in terms of its ability to accommodate the anticipated future development in the area, there are optimizations and refinements that could further increase benefits. The most significant constraints within the NEFC network are observed at either end of the Stadium blocks due to the one-way couplet system which restricts local block access and requires circuitous and overlapping directional traffic flows.

The issue can be illustrated in ***Figure 6.1*** and is particularly evident at the following locations:

- Expo Boulevard westbound left-turn at Nelson Street;
- Nelson Street slip 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 6.1: One-way Pair Local Circulation Issues



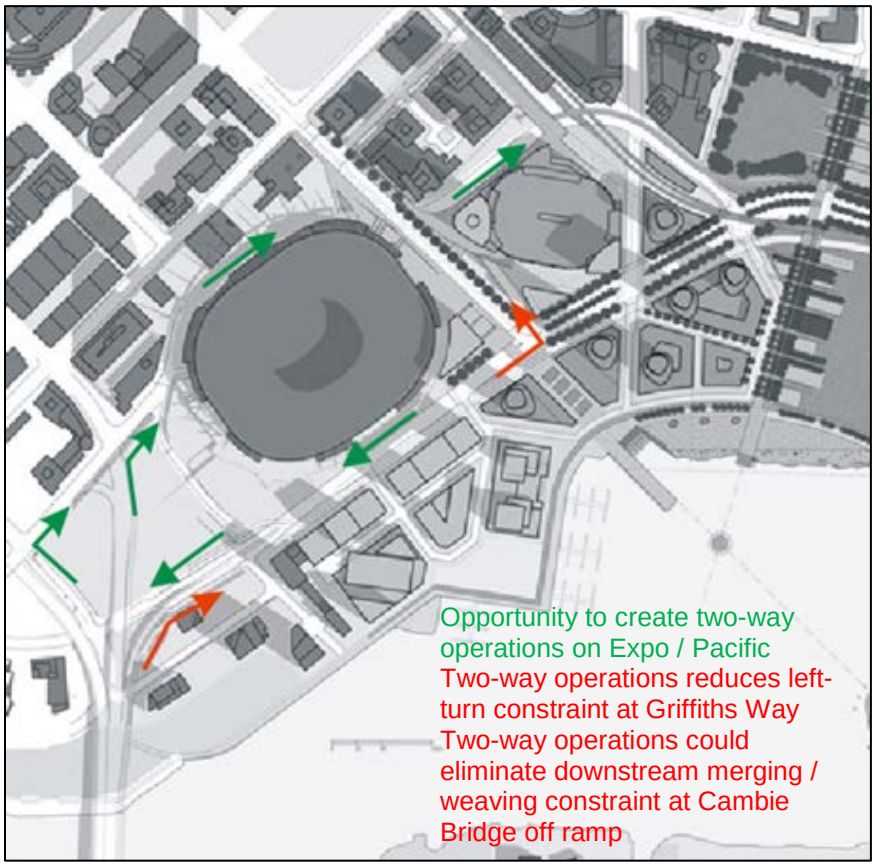
The local circulation issues may be illustrated by focusing on the 10A (adjacent to the west side of BC Place) and 7A (southwest corner of Rogers Arena) development blocks. For traffic exiting block 10A adjacent to BC Place and destined to points west, a vehicle must exit to the left on Pacific Boulevard heading eastbound, make a left at Griffiths Way, and make a left at Expo Boulevard before heading in its desired direction. For traffic exiting block 7A adjacent to Rogers Arena and destined to points east, a vehicle must exit to the left on Expo Boulevard heading westbound, make a left at Nelson Street, and make a left at Pacific Boulevard before heading in its desired direction. These movements overlap with inbound and outbound traffic from adjacent development blocks to create significant queuing and congestion.

There is the opportunity to enhance accessibility for the 6B and 6C blocks on the south side of Pacific Boulevard by providing a local street connection. This local street connection would allow eastbound traffic destined to the 6C block to access the block without entering the Georgia / Pacific or Pacific / Abbott signalized intersections. The connection would also allow traffic from the 6B block to travel east, west or northbound without entering the Georgia / Pacific signalized intersection. Traffic to the 6B block from the east would avoid a circuitous route around the Stadia via the Expo / Pacific one-way couplet.

A potential network wide mitigation measure would be to consider a conversion to two-way operations for the Pacific / Expo pair as part of a second phase of Viaduct replacement. As shown in ***Figure 6.2***, provision of a two-way street network between Nelson Street and Abbott Street would greatly improve local access / egress options for all blocks along this segment. More importantly, the two-way conversion would eliminate 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 be the most congested in the NEFC, any redirection of traffic or operational flexibility achieved by removing conflicting turning movements would reduce delays and increase capacity. A separate operational study is underway to quantify the potential impacts and benefits of the two-way conversion as described.

The two-way operations concept could also be compatible with a long term removal of the northbound to eastbound off-ramp from the Cambie Bridge. If this traffic were shifted to the Expo / Smithe intersection as a northbound right-turn, the merging and weaving issues associated with its operation as it enters New Pacific Boulevard could be avoided.

Figure 6.2: Two-way Operations Concept



A key question to be addressed in the eastern segment of the NEFC network is how to treat left-turn movements from the new at-grade signalized intersections at Pacific / Quebec and Pacific / Main. Due to the volume of through and/or left-turning traffic and the number of oncoming lanes, any left-turn operations at these signals would require a separate protected signal phase. As each left-turn phase increases cycle times and hence overall delays, left-turn operations should be implemented judiciously. Based on a review of signal operations, local access requirements, and new route continuity, it is recommended that alternating left-turn phasing be provided at these adjacent intersections. This implies that at the Pacific / Quebec intersection, separate left-turn lanes and protected phasing would be provided for the eastbound and westbound movements, while the northbound and southbound left-turn movements would remain permissive only. At the adjacent Pacific / Main intersection, east-west left-turn movements would be prohibited while separate protected left-turn phases would be provided for the northbound and southbound left-turn movements.

This configuration allows for access to the 6D development block, the Chinatown parkade and Andy Livingstone Park via Quebec Street and would facilitate a shift in the flow of traffic from the current Pacific – Quebec orientation to the New Pacific – Main orientation. By prohibiting east-west left-turn movements at Pacific / Main, more capacity can be freed up to service the redistributed Pacific – Quebec trips and allow for a reallocation of capacity along Quebec Street between New Pacific Boulevard and Terminal Avenue.

INTERSECTION SPECIFIC

Intersection specific considerations are provided for each of the following major locations.

Pacific / Nelson

Due to heavy forecast southbound left-turn movements and the impracticality of providing dual left-turn lanes or split signal phasing, opportunities to improve operations at this location are limited.

In its current configuration there may be an opportunity to slightly improve operations by formally designating a southbound left-turn lane and an adjacent through lane. Parking could also be stripped along the western side of the street to increase the effective storage of this lane.

A switch to two-way operation along Expo Boulevard and Pacific Boulevard would redistribute local and through traffic flows and eliminate the need for non-local block traffic to make a southbound left-turn at this location.

Expo / Nelson

As with the Pacific / Nelson intersection, this intersection will experience heavy forecast left-turn movements (in the westbound direction) due to the combination of local and through traffic flows. A switch to two-way operation along Expo Boulevard and Pacific Boulevard would redistribute local and through traffic flows and eliminate the need for non-local block traffic to make a westbound left-turn at this location.

Pacific / Smithe

This intersection will experience heavy forecast left-turn movements in the southbound direction as there are no other outlet points for this local block traffic. This intersection also features a complex geometric configuration due to the introduction of the northbound to eastbound off-ramp from the Cambie Bridge to Pacific Boulevard. The Pacific Boulevard and future Smithe Street development traffic flows will be physically separated from the ramp traffic and Smithe Mews traffic flows. This sets up a merge downstream of the intersection which may be complicated by a new weave for the eastbound Pacific Boulevard traffic attempting to access development block 6B on the south side of Pacific Boulevard.

A switch to two-way operation along Pacific Boulevard would redistribute local outbound traffic as right and left-turn movements and reduce the need for all local traffic to enter the block as an eastbound left-turn.

Expo / Smithe

The Expo / Smithe intersection is forecast to operate over capacity in the PM peak hour assuming full build out. With mitigation measures such as improving direct westbound access to the 6B block (which avoids excessive circulation around the stadium blocks) and capping combined background growth and development traffic at 85% of demand, the intersection can operate acceptably. The future geometrics assumed take into account the recent provision of an east side cycle track and lane reduction, as well as the prohibition of westbound right-turns on red.

Expo / Griffiths

This intersection will experience heavy forecast left-turn movements in the northbound direction as there are no other outlet points for this local block traffic and recirculating westbound traffic from the 5B, 10A, and 6B is forced to use the Pacific Boulevard to Griffiths Way connection to complete their trip.

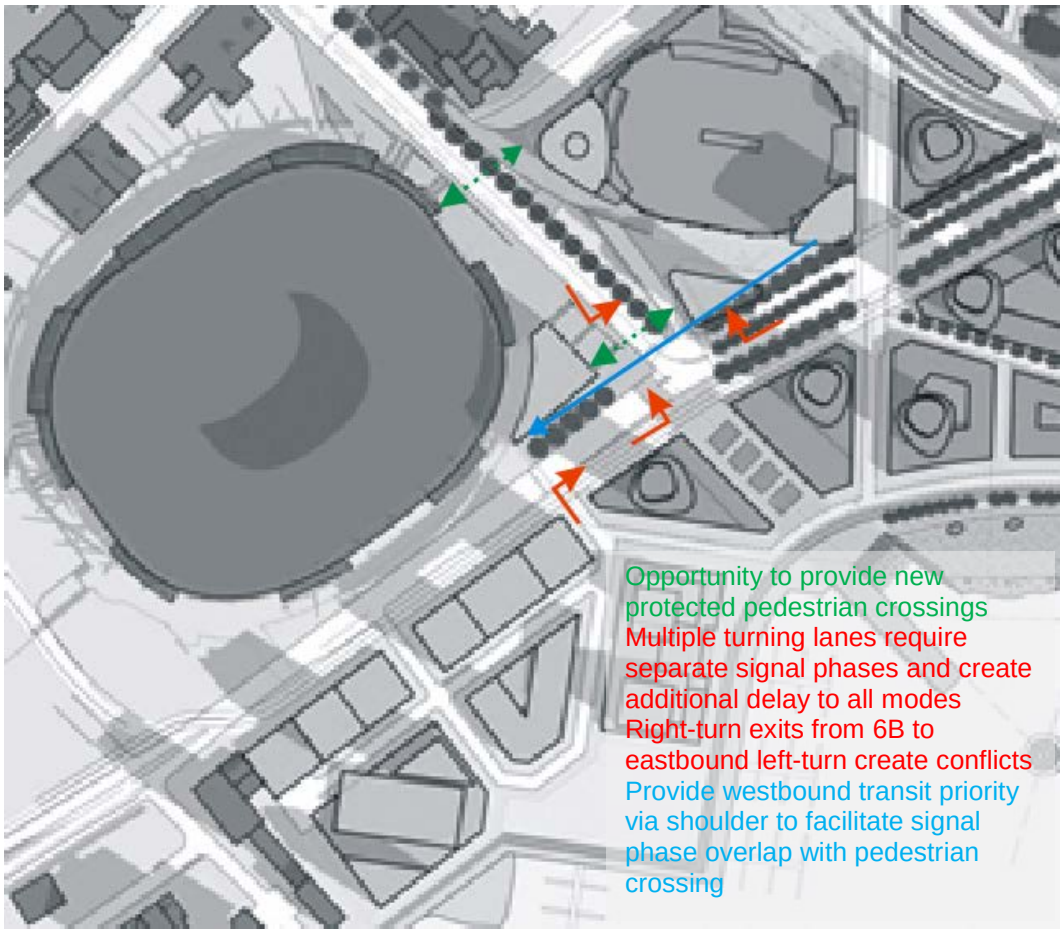
A switch to two-way operation along Expo Boulevard would redistribute local outbound traffic as right and left-turn movements, create a cul-de-sac of Griffiths Way to eliminate through traffic and reduce the need for all local traffic to enter the block as a westbound left-turn.

Georgia / Pacific

This new intersection is forecast to be the most congested in the NEFC network under any of the analysis scenarios. The intersection is constrained by multi-lane turning movements and pedestrian crossings which require separate signal phases, and heavy combined through traffic and local traffic circulation movements. Although a dual eastbound left-turn bay has been provided, this bay has uneven utilization as the lighter Georgia Ramp traffic will be concentrated in the inside lane and the heavier Griffiths Way local access and turnaround traffic will be concentrated in the outside lane. For traffic exiting the 6B development block wishing to travel westbound, a weave across heavy through traffic flows on Pacific Boulevard is required before entering the outside left-turn bay and accessing Griffiths Way northbound. Although a crossing signal between the Georgia Ramp and Smithe Mews is being contemplated to supplement the eventual removal of the pedestrian overpasses at BC Place, this signal would be oriented to pedestrian movements and would not necessarily provide reliable gaps for turning traffic to utilize. This creates a potential safety and congestion issue to be addressed as the forecast volume for the westbound traffic movement from 6B would be in the order of 200 vehicles per hour crossing over 1,500 vehicles per hour in three lanes eastbound on Pacific Boulevard. One alternative would be to direct these movements to Abbott Street via channelization upstream of the Georgia Ramp signal. Although the eastbound left-turn at Abbott Street would not be able to accommodate this additional volume, there is capacity forecast to be available on the south leg of Abbott Street through the 6C site. As described in the Network Issues above, the provision of a local street connection between blocks 6B and 6C is therefore strongly recommended not only to improve local access and circulation, but to mitigate forecast safety and congestion issues at the Georgia / Pacific intersection.

As delays at this intersection could significantly affect the reliability of transit service, a form of transit priority is needed, particularly in the westbound direction. An overlap with the adjacent westbound dual right-turn phase was investigated via a median queue jump lane, however, this would require that the nearest upstream and bus stops be located at a sufficient distance to permit the bus to change lanes twice before accessing the queue jump. As an alternative the queue jump lane can be installed in the shoulder adjacent to the dual right-turns which will allow an overlap with the north side pedestrian phase. On the west side of the intersection, a bus stop could be located adjacent to development block 10C and be served via the counterflow bus lane.

Figure 6.3: Georgia / Pacific Opportunities and Constraints



The section of the Georgia Ramp between Citadel Parade and Pacific Boulevard will experience heavy pedestrian flows, particularly during special events at Rogers Arena and/or BC Place. For this reason, a mid-block crossing is desirable along this section of the ramp. Based on the required signal timing and phasing of the Georgia / Pacific signal, a mid-block pedestrian signal is viable provided it is coordinated with or run on a similar cycle length to this controlling intersection. The mid-block pedestrian phase should be coordinated with the north side pedestrian phase at Georgia / Pacific as during this phase no eastbound left-turn or westbound right-turn movements will be directed up the Georgia Ramp. The current Georgia Ramp design incorporates a mid-block crossing as described above.

Georgia / Beatty

The Georgia / Beatty signalized intersection will be the main interface between the existing downtown street grid and the NEFC Viaducts replacement network. By

converting Georgia Street to two-way operation, there will be a potential for eastbound and westbound left-turning traffic to create delays to through traffic. Given the volume of oncoming traffic and conflicting pedestrian crossings, there will be limited safe gaps for eastbound and westbound turns. To provide for delay reduction and safety, it is recommended that these movements be banned and accommodated at the adjacent Georgia / Cambie intersection. In conjunction with this modification, the Citadel Parade signal would be removed. Although a cul-de-sac of this movement and redirection to Dunsmuir Street would be ideal given its close proximity to Georgia / Beatty, there is limited width on Citadel Parade to provide the cul-de-sac and therefore a right-in / right-out only will be required. The prohibition of the westbound left-turn from Georgia Street to Beatty Street will eliminate the safety risk of vehicles exiting from Citadel Parade and weaving across to attempt a left-turn movement at Beatty Street.

Georgia / Cambie

As with the Georgia / Beatty signalized intersection, there will be a potential for eastbound and westbound left-turning traffic to create delays to through traffic. Given the volume of oncoming traffic and conflicting pedestrian crossings, there will be limited safe gaps for eastbound and westbound turns. To provide for delay reduction and safety, it is recommended that signalized protected left-turn bays provided within the available five lane cross-section.

Dunsmuir / Beatty

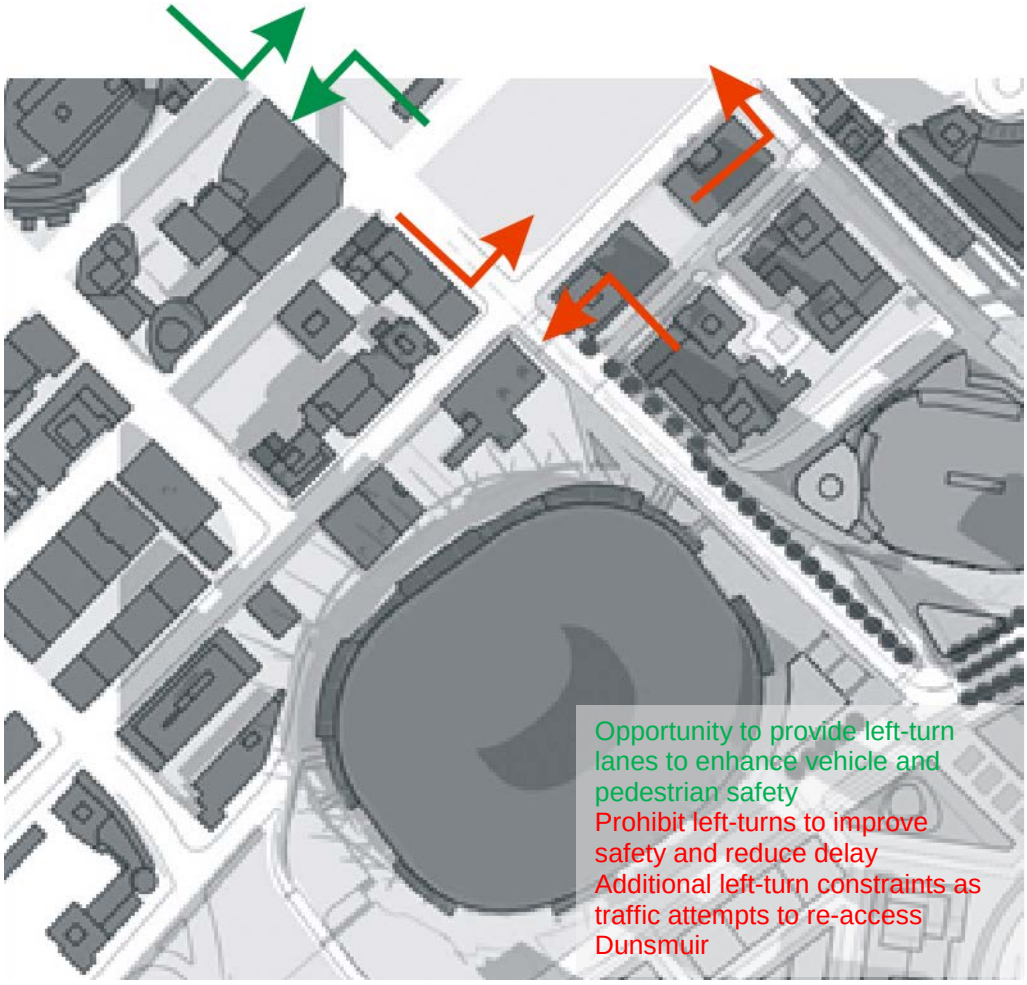
At Dunsmuir Street westbound, there will be a significant reduction in traffic volume due to the shift to Georgia Street. This reduction will improve safety and comfort for the adjacent Dunsmuir Street cycle track as right-turn conflicts will be significantly reduced. There will, however, be an increase in northbound left-turns from 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 to the shift to Georgia Street. This reduction 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.

Figure 6.4 shows some of the opportunities and constraints associated with the Georgia Street and Dunsmuir Street network.

Figure 6.4: Georgia / Dunsmuir Opportunities and Constraints



New Pacific / Abbott

The New Pacific / Abbott intersection will be a major transition point and local development access. Given the heavy east-west flows, three lanes in each direction are required, as well as east-west left-turn bays with protected signal phasing. Provision of a westbound left-turn bay will allow direct access to the 6C development block without affecting westbound through traffic. When coupled with a local connection to the 6B development block, all westbound traffic to these blocks could avoid forced circulation via the congested Expo / Pacific couplet system.

The Abbott Street cross section will function adequately with its current four lane configuration. Shared left and right-turn lanes will allow for full movement egress from blocks 6B and 6C.

With regards to the alignment of the intersection, the current design concepts create a normalized 90 degree intersection by bending Abbott Street to the southeast. This normalization is recommended to reduce the skew angle of the intersection. Intersections with significant skew angles are not desirable due to higher vehicle turning speeds on the obtuse angle which increase pedestrian conflicts. The skew can also result in longer pedestrian crossing distances and geometric conflicts for turning movements.

Expo / Abbott

Even with the addition of the full development traffic, the Expo / Abbott signalized intersection operates at a good level of service due to its one-way operation and limited conflicting turning movements. Should the two-way cycle track along Expo Boulevard be extended westerly, a separate westbound right-turn lane will be required at Abbott Street to reduce vehicle-cyclist conflicts. Similarly, the southbound right-turn from Abbott Street to Expo Boulevard will need to be prohibited on red lights.

New Pacific / Carrall

The New Pacific / Carrall intersection serves only north-south active transportation movements and east-west through movements, limiting turning conflicts between these modes. The intersection will experience congestion in the westbound direction due to the downstream lane drop to Expo Boulevard. It will be critical to adequately sign and mark this transition as it represents an opportunity for westbound vehicles to continue directly to the stadium blocks and Pacific Boulevard west / Yaletown / West End destinations without being diverted up the Georgia Ramp.

New Pacific / Quebec

As described in the mitigation measures, provision of east-west left-turn bays and protected signal phasing would serve to increase local block access to 6D, the Chinatown parkade and Andy Livingstone Park. The additional of an eastbound left-turn lane would require the conversion of the eastbound right-turn lane to a shared through / right lane. In conjunction with this measure, the dual northbound left-turn lanes could be converted to a single left-turn lane with permissive phasing to reduce overall cycle time.

Union / Quebec

Union Street is a component of the Dunsmuir-Adanac cycling route and is forecast to carry heavy bicycle traffic flows. Local vehicle access will be required, however, for the 6D development block on the south side of Union Street between Quebec Street and Gore Avenue. A possible solution to accommodate a protected All Ages and Abilities

(AAA) cycling facility and local traffic access would be to provide a two-way cycle track along the north side and a two-way roadway on the south side, however, further detailed review will be required with the City's Active Transportation branch. Separate bicycle signal phases would be required at both the Quebec Street and Main Street intersections to avoid conflict with turning traffic.

Quebec / Terminal

With the modified continuity of the Viaducts replacement network, sensitivity testing of a 50% shift in traffic from the Quebec Street to the Main Street corridor indicates the double southbound left-turn at Terminal Avenue, as well as the double westbound right-turn from Terminal Avenue could be eliminated. These modifications would allow for a reduction in signal cycle time and reduce delays to and conflicts with pedestrian crossings between City Gate / Main Street station and the False Creek waterfront. It is recognized that such a shift would imply additional impacts on the Main / Pacific and Main / Terminal intersections and further study would be required to determine if additional mitigating measures would be required.

New Pacific / Main

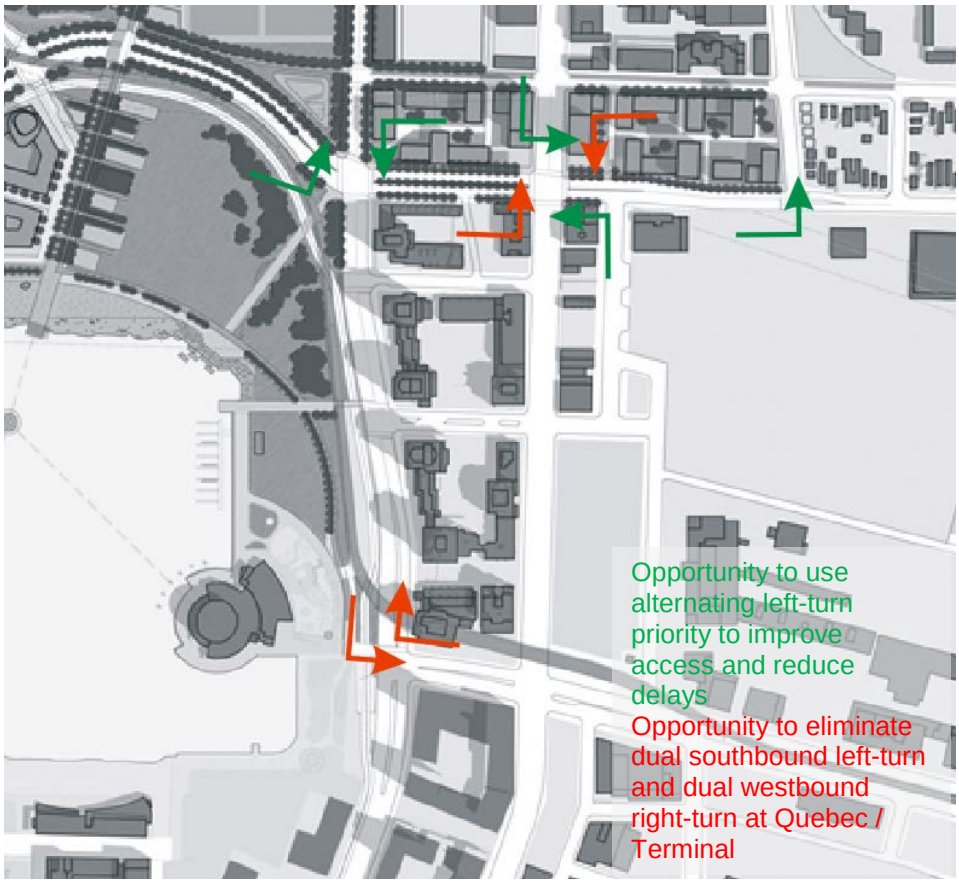
This intersection will be a primary conduit for east-west and north-south traffic flows. To reduce delays and cycle time to the extent practical, prohibiting east-west left-turns at all times, providing dual protected northbound left-turns, and providing a single protected southbound left-turn lane is recommended.

New Pacific / Gore

The New Pacific 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, an eastbound left-turn bay is required.

Some of the key opportunities and constraints for the Quebec Street, New Pacific Boulevard, Main Street and Terminal Avenue network are depicted in ***Figure 6.5***.

Figure 6.5: Quebec / Main / Terminal Opportunities and Constraints



7.0 ACTIVE TRANSPORTATION ASSESSMENT

The successful accommodation of proposed new developments with anticipated changes to the NEFC transportation network will rely heavily on providing a comfortable, convenient and connected walking and cycling network for both local and through trips. According to the City's Transportation 2040 Plan adopted by Council in 2012, by 2040 at least 2/3rds of all trips will be made by foot, bike or transit. This implies a significant increase in the current peak and daily pedestrian and cyclist volumes through the NEFC network.

7.1 Pedestrian Network

As documented in Section 4.0, a peak hourly volume of over 5,400 walking trips will be generated by the NEFC development parcels. Although the current background walking trips are relatively low within the Expo / Pacific Boulevard sections of NEFC, accommodation of these new trips will require a robust and accessible pedestrian network to be completed. It is anticipated that many of the walking trips will be contained within the NEFC area, due to the complementary nature and density of the mixed land uses. Trips between nearby residences and offices or between residences and retail / recreational facilities, for example, can be easily made on foot.

A key parameter for determining area walkability is the opportunity to access destinations within a 5 minute walk distance (approximately 400 m). This metric is an important input to an area's Walk Score which measures the walkability of any address using a patented system. For each address, Walk Score awards points based on the distance to amenities in a variety of categories. Amenities within a 5 minute walk are given maximum points. A decay function is used to give points to more distant amenities, with no points given after a 30 minute walk. Walkability is also scored based on average block length and intersection density. Using 750 Pacific Boulevard (Plaza of Nations site) as a proxy for the NEFC development blocks, the current Walk Score is 86 out of 100, which indicates a very walkable site where most errands can be accomplished on foot. While the proprietary Walk Score method cannot be applied to future transportation network and land use conditions at this time, it can be inferred that the combination of new access points, increased mix and density of land use types, and reduced physical barriers will increase the score for the Viaducts replacement network.

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 five 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 always convenient for trips across Pacific Boulevard.

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 high speed traffic in the tunnel.

Existing pedestrian facilities on the Viaducts provide poor connections to the NEFC area, parks, and future developments due to their grade separation. Furthermore, their clear width of approximately 1.2 m may pose issues for opposing wheelchair or stroller users. The proposed Viaducts replacement network will offer 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 a number of changes that will affect area walkability. The first aspect is the introduction of new crossing points along Pacific Boulevard and the second aspect is the consolidation of one-way street pairs into a single crossing point. The new crossing point at the Georgia Ramp / New Pacific Boulevard intersection will allow a protected crossing of all intersection legs, providing a new convenient crossing point between the Smithe Mews and Abbott Street 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 the Rogers Arena and BC Place stadia. Along Pacific Boulevard between Georgia Street / Griffiths Way and Smithe Mews an at-grade signalized pedestrian crossing is proposed to eventually replace the existing overpasses to BC Place.

As the transportation network evolves, design criteria have been established to guide minimum and desirable standards for pedestrian amenities. A number of these preliminary criteria, which were established in discussions with City of Vancouver staff, are summarized in ***Table 7.1*** below.

Table 7.1: NEFC Pedestrian Network Preliminary Design Criteria

Element	Minimum Dimension	Desirable or Maximum Dimension	Rationale
Walking Speed		1.0 m/s	For timing signalized crosswalks
Property line offset from back of sidewalk	0.35 m	0.5 m	To allow for maintenance and offset from buildings
Grade	5% no landings 8% with landings	4%	To reduce walking effort and impacts to mobility impaired individuals
Clear Unobstructed Sidewalk Width	1.2 m low volume street 2.0 m high volume street	2.0 m low volume street 3.5 m high volume street	To accommodate comfortable walking space for forecast pedestrian volume
Total Sidewalk Width (including utility boulevard)		5.5 m	To accommodate pedestrians and assorted street furniture
Standing / loading areas		2.0 m	To accommodate transit, taxi, and school pick-up / drop-off zones
Boulevard separators (not including curb)	Treed 1.2 m Grass 0.6 m		To provide suitable maintenance areas for landscaping

By following the above criteria, a high quality walking environment can be implemented for usage by all ages and abilities, and the non-auto modal split targets assumed in Section 4.0 may be met or exceeded.

7.2 Cycling Network

Forecast cycling trips for the NEFC were based on a review of existing peak volumes on area cycle tracks, forecast development activity levels and modal split, and contemplated Citywide network connections.

The City continually monitors cycle track usage on each of the major separated facilities by averaging Tuesday, Wednesday and Thursday volumes (excluding statutory holidays). As of 2014, the peak monthly activity was observed in July. During this time period, the following average weekday volumes were observed on NEFC area cycle tracks:

- Dunsmuir Viaduct 2,600 bicycles
- Union Street at Hawkes 4,000 bicycles
- Seawall at Science World (Terminal Avenue) 6,300 bicycles

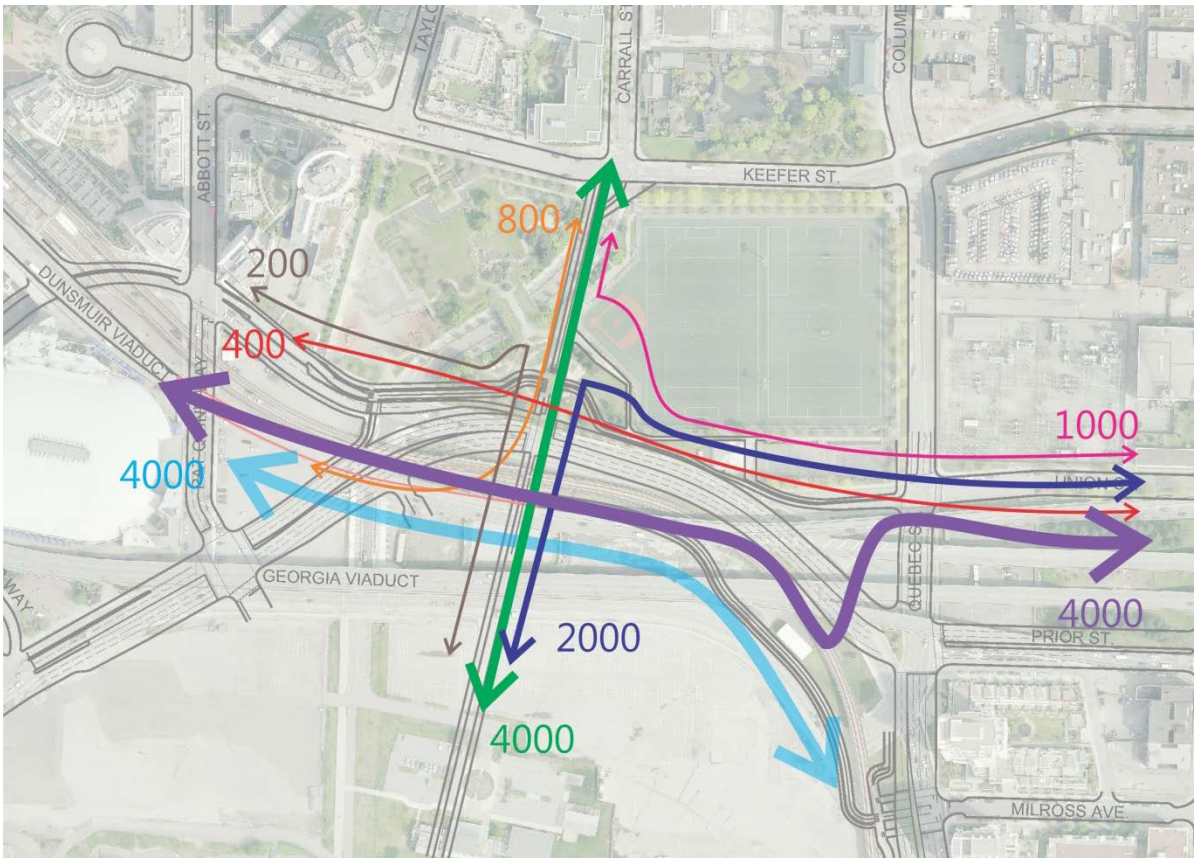
Using the above as current peak reference points, and noting that the highest volume cycle track in the City is on the Burrard Bridge over False Creek (6,800 peak weekday bicycles), forecast daily bicycle traffic flows were developed for the primary elements of the future NEFC cycling network. The flows were initially developed by the City of Vancouver's active transportation staff and reviewed / refined by Alta Planning + Design. ***Table 7.2*** summarizes the forecast daily bicycle flows, while ***Figure 7.1*** illustrates these flows at the critical Carrall / New Pacific junction.

Table 7.2: Forecast Daily Bicycle Flows

Route	Directional Orientation	Two-Way Daily Bicycle Traffic
Dunsmuir Street – Carrall Street	West - North	800
Dunsmuir Street – Quebec Street	West - South	4,000
Carrall Street - Seawall	North - South	4,000
Dunsmuir Street – Union Street	West - East	4,000
Carrall Street – Union Street	North - East	1,000
Expo Boulevard – Union Street	West - East	400
Seawall – Union Street	South - East	2,000
Expo Boulevard - Seawall	West - South	200
Segment	**Location**	**Two-Way Daily Bicycle Traffic**
Dunsmuir Street	At Beatty Street	8,800
Carrall Street	North of Expo / Pacific Boulevard	5,800
Carrall Street	South of Expo / Pacific Boulevard	6,200
Union Street	East of Carrall Street	7,400

As shown, volumes on the Dunsmuir Street segment of cycle track could more than triple from current volumes. The forecast volume along this network element has led it to a more focused analysis of options to retain a direct and efficient connection between the downtown core and east Vancouver.

Figure 7.1: Forecast Daily Cycling Flows



Separation of bicycle and vehicular traffic is typically considered when vehicle volumes exceed 5,000 vehicles per day and the operating speed is 50 km/h or higher. Based on the forecast volume of cycling trips, the speed of major roadways and the forecast volume of traffic, separated cycling facilities are recommended on the following NEFC network elements:

- Pacific Boulevard from Nelson Street to Quebec Street (speed 50 km/h, daily vehicle volume > 5,000);
- Expo Boulevard from Abbott Street to Nelson Street (speed 50 km/h, daily vehicle volume > 5,000);
- Quebec Street from Terminal Avenue to Union Street (speed 50 km/h, daily vehicle volume > 5,000);
- Carrall Street from Pender Street to Seawall (no motorized traffic, but provides an alternative to Abbott Street); and
- Dunsmuir Street to Adanac Street (no motorized traffic but provides essential east-west city wide cycling link).

For other NEFC network elements, separation is unlikely to be required given the short block lengths, low operating speeds, and/or relatively low traffic volume.

As with the pedestrian network, design criteria have been established to guide minimum and desirable standards for cycling infrastructure. A number of these preliminary criteria, which were established in discussions with City of Vancouver staff, are summarized in ***Table 7.3*** below.

Table 7.3: NEFC Cycling Network Preliminary Design Criteria

Element	Minimum Dimension	Desirable or Maximum Dimension	Rationale
Design Speed	10 km/h (absolute minimum to remain upright)	30 km/h (main route) 20 km/h (other)	For determining sight distance, horizontal and vertical curvature, and functional classification
Two-way cycle track	3.0 m	4.5 m	For sufficient operating and passing space
One-way cycle track	2.0 m for up to 150 bicycles / hour 1.5 m for local narrowing	3.0 m for up to 750 bicycles / hour	For sufficient operating and passing space
On-road cycling lane	1.5 m	2.0 m	For sufficient operating space
Additional clearance to lateral obstructions	0.6 m (wall) 0.3 m (fixed obstacles)		To reduce restrictive effects of shy distance
Radius	5 m	>20 m (main route) ≥10 m (connections)	For suitable maneuvering distance at turns or roundabouts
Stopping sight distance	20 m (at 20 km/h)	35 m (at 30 km/h)	To allow for perception reaction time and braking action on level but wet surface
Vertical clearance	2.5 m	3.6 m	To fit bicycle and rider height envelope
Underpass sideslopes		1:1	To provide suitable openness to avoid claustrophobic quality
Grade	0.5%	5%	For drainage and acceptable climbing effort
Grade for short height difference		8% for <2.5 m, low wind 7% for <1 m, medium wind	For comfort on climbing sections

By following the above criteria, a high quality cycling environment can be implemented for all ages usage, and the non-auto modal split targets assumed in Section 4.0 may be met or exceeded.

With the removal of the Dunsmuir Viaduct, a replacement cycle track is necessary given the forecast bicycle travel demand and the need for separation from high vehicle volumes and speeds. As part of a separate parallel study, a variety of options were developed for

the replacement cycle track and pedestrian link. The combined cycling and pedestrian facility, referred to as the Active Bridge could take one of three primary alignments and be incorporated with either a retention of, or a replacement and straightening of Carrall Street north of Pacific Boulevard. The three primary alignments are described as follows:

- North Side Active Bridge – connecting east end of Dunsmuir Street at Rogers Arena plaza, across SkyTrain guideway to land at a new intersection with Carrall Street, including connections to Union Street and across Pacific Boulevard to the Seawall.
- South Side Active Bridge – connecting east end of Dunsmuir Street at Rogers Arena plaza, following south side of SkyTrain guideway to land at grade east of Carrall Street, with an extensions to Quebec Street / Science World pathway and False Creek pathway.
- Switchback Option – connecting east end of Dunsmuir Street at Rogers Arena plaza, switchbacking down to grade at Expo Boulevard west of the Stadium SkyTrain station entrance. Connections to Carrall Street and Union Street would be via a two-way cycle track along the north side of Expo Boulevard.

A separate Multiple Account Evaluation is being prepared to weigh in detail the qualitative and qualitative aspects of the three alignments, however, the current planning study focuses on the operational performance of only the North Side and South side alignments. As part of a screening process with City of Vancouver department representatives a preliminary concept was developed for the North Side and South side alignments. These alignments, referred to as Option 1b (North Side) and Option 6 (South Side) both incorporate a realignment of Carrall Street along a more direct north-south routing. ***Figures 7.2*** and ***7.3*** show conceptual sketches for these alignments.

Figure 7.2: Conceptual Dunsmuir Cycle Track North Side Replacement Network

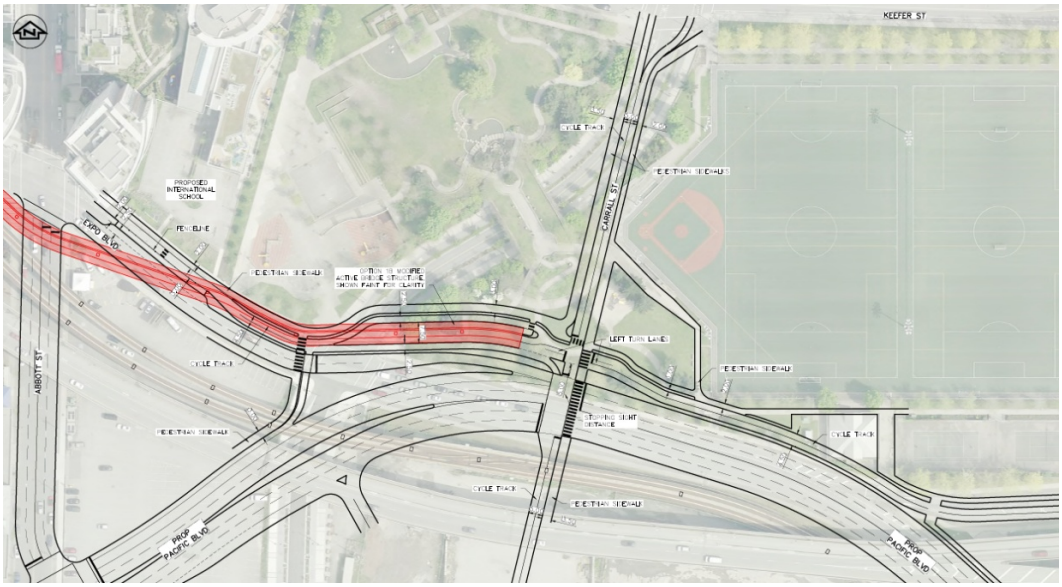
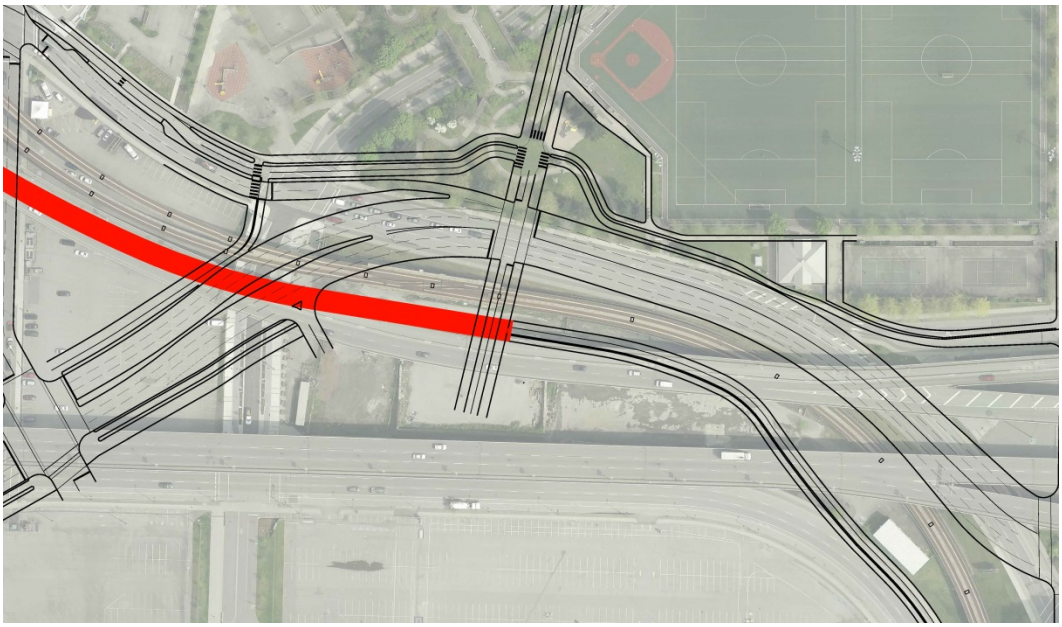


Figure 7.3: Conceptual Dunsmuir Cycle Track South Side Replacement Network



Of particular interest to the NEFC planning study is the anticipated operational performance of the major cycling network elements. Although tools for assessing capacity and level of service for active transportation links continue to evolve, the Shared Use Path Level of Service (SUPLOS) calculator is an application that has been developed by the U.S. Federal Highway Administration (FHWA) that can be utilized based on the available travel forecasts and geometric configurations.

Noting that most of the pathways depicted in the cycling network plans are separated (i.e. pedestrians have a separate path from bicyclists), SUPLOS may be applied for an exclusive cycling facility. SUPLOS uses a composition mix input for different ages of riders. It is assumed that the Seawall route paths will have 70% adults (more family oriented), while the east/west routes will be 90% adults (more commuter oriented). For this analysis, a peak hour factor of 10% has been used to convert daily volume to the peak hour.

Just as vehicular LOS is related to only one criterion of the driving experience (delay), the key criterion in SUPLOS is the freedom to maneuver and maintain desired speed. The six letter grades in SUPLOS are A to F corresponding to a user perception score of 5 (excellent) to 1 (poor) as shown in ***Table 7.4***.

Table 7.4: SUPLOS Scores and LOS Grades (source: FHWA, 2006)

Overall Perception Score, X	LOS
$X \geq 4.0$	A
$3.5 \leq X < 4.0$	B
$3.0 \leq X < 3.5$	C
$2.5 \leq X < 3.0$	D
$2.0 \leq X < 2.5$	E
$X < 2.0$	F

Using the forecast bicycle flows, the SUPLOS scores were calculated for critical elements. There are times (such as before / after a sporting event) when pedestrian volumes will be high enough to spill over into the separate bikeways, a situation that is basically unavoidable and therefore is not modeled. Accordingly, the SUPLOS calculator has been used with a pedestrian volume of zero. Commuter routes have been assumed to be 80% tidal flow (one-way travel during the peak hour) and recreational routes have been assumed to be equal flow in both directions during the peak hour. ***Table 7.5*** summarizes the SUPLOS results.

Table 7.5: SUPLOS Results

Segment	Location	Daily Volume	Assumed Width (m)	LOS
Dunsmuir Street	At Beatty Street	8,800	4.5	3.25 (C)
Carrall Street	North of Expo / Pacific Boulevard	5,800	5.0	3.94 (B)
Carrall Street	South of Expo / Pacific Boulevard	6,200	5.0	3.92 (B)
Pacific Boulevard / Union Street	East of Carrall Street	7,400	4.5	3.43 (C)
Pacific Boulevard / Quebec Street	South of Pacific Boulevard / Prior Street	4,000	4.5	3.82 (B)

As shown, the cycling network links appear to have sufficient width to allow a good LoS (C or better at peak times). With regards to intersections, SUPLOS cannot calculate intersection LoS; however, by reviewing anticipated arrival rates at the two primary cycling network intersections, an assessment as to suitable control type can be made.

Table 7.6 summarizes the estimated peak arrival rates for the North Side and South Side alignments using the peaking factors described above. The equivalent arrival rate per minute has also been provided.

Table 7.6: Peak Bicycle Arrival Rates – North Side Alignment

Location	Control Type	Maximum Hourly Arrival Rate (bph)	Maximum Arrivals per Minute (bpm)
Active Bridge landing at Carrall Street intersection	Stop with left-turn lanes on east and west legs	1,192	20

Assuming the 10,200 bicyclist flow at the signalized crossing of Pacific Boulevard and using peak hour and tidal flow factors previously mentioned, the maximum arrival rate of bicyclists in one direction at the Pacific Boulevard path crossing signals may be up to 12 bicyclists per minute. Assuming a 23 second effective crossing phase (7 seconds walk, 16 seconds flashing don't walk) and a cycle time of up to 90 seconds, the queue may reach up to 14 bicyclists. If these bicyclists remain on their side of the centreline in a two-abreast queue, the length of the queue would be about 12 metres long assuming a 0.85 metres average bicycle length. The North Side alignment only provides 6.0 metres of queuing space on the north approach to Pacific Boulevard, so there is a reasonable likelihood that queue spillback will block the east-west path movement. A potential solution would be to widen the path approach and/or separate the intersections more. A roundabout is an alternative configuration for this north side path intersection to clarify

right of way, manage conflicting movements, provide a path control that is more likely to be obeyed, and minimize travel time.

The south side Active Bridge avoids potential conflict with the existing building and tennis courts adjacent to Union Street. Further the south side option serves many of the major destination pairs by direct connections that do not require an at-grade crossing of Pacific Boulevard as shown in ***Table 7.7***.

Table 7.7: Direct Connections without At-Grade Crossing of Pacific Boulevard

Route Pair	Daily Volume	North Side Alignment	South Side Alignment
Dunsmuir / Expo – Union Street	4,400	✓	x
Dunsmuir / Expo – Quebec Street	4,000	x	✓
Seawall – Union Street	2,000	x	x

Table 7.7 shows that the South Alignment serves slightly more destination pairs without crossing Pacific Boulevard at grade and will therefore result in less overall delay and conflict.

SUPPLEMENTAL NETWORK ELEMENTS

In addition to the retention and enhancement of the Dunsmuir / Union cycle track linkage via a replacement Active Bridge, there are a number of supporting cycling network elements to be considered in the broader NEFC transportation network. Three primary linkages have been assessed based on forecast cycling volume and desire lines, existing bike network elements, and existing network gaps. These elements are described as follows and shown graphically in ***Figure 7.4***.

False Creek Loop

A bicycle / pedestrian priority route is recommended for the length of Carrall Street joining to cycle tracks on Water/Powell Street and/or a local street bikeway on Alexander Street. This link would be compatible with contemplated improvements to the Seawall on the north and south sides of False Creek, as well as a future All Ages and Abilities (AAA) route along Alexander Street connecting with the recently completed Powell Street overpass cycle track. The link would also allow for a linkage with the Coal Harbour Seawall and a bypass of the downtown street network.

Southeast Vancouver to Central Business District

This and several offshoots of this line - including Quebec Street, Ontario Street, the Central Valley Greenway and South False Creek Seawall - will follow this route around the eastern end of False Creek and along Carrall Street to Downtown. It is recommended to separate this commuter route from the largely recreational traffic using the Seawall via a two way cycle track/path on the west side of Quebec Street, as well as, a one way northbound cycle track on the east side of Quebec Street. This would be compatible with the recent AAA retrofit of Union Street east of Quebec Street, and the contemplated AAA upgrade of Ontario Street south of West 2nd Avenue.

Union Street / Adanac Street to Helmcken Street

This and several offshoots of this line - including those from south and southeast Vancouver will use this route as a link to Downtown and the West End, and as a potential short-cut to the Seawall at Helmcken Street or along Pacific Boulevard. All of these desire lines could be served by a two-way cycle track on Expo Boulevard that travels under the BC Place plaza from Abbott Street to Helmcken Street. This link would be compatible with the future AAA retrofit of Union Street and Adanac Street to the eastern City limits, the recently completed Comox-Helmcken AAA connection and the planned AAA retrofit of the Cambie Bridge between Beatty Street and West 2nd Avenue.

Figure 7.4: Supplemental NEFC Cycling Network Elements

7.3 Overall Assessment

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

- New signalized crossings for pedestrians at Georgia / Pacific, mid-block on the Georgia Ramp, 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.
- Updated design criteria for the pedestrian network will increase sidewalk space along reconstructed roadways and adjacent to new developments.
- Reduced separation footprint between established neighbourhoods and the False Creek waterfront area. The combined Viaduct and Expo / Pacific footprint is replaced with a more compact single facility on New Pacific which will reduce the pedestrian crossing barrier effect.
- Opportunity to reconfigure the intersection of Quebec Street at Terminal Avenue to remove dual left and right-turn lanes and reduce pedestrian conflict / delay.
- Potential for a new and more direct connection along Carrall Street to False Creek, along with a closure of Carrall Street to vehicular traffic.
- Provision of a wider, higher capacity, and more aesthetically pleasing active transportation linkage between downtown, the NEFC and existing historic neighbourhoods.
- Provision of new AAA infrastructure and protected bicycle facilities along Quebec Street from Union Street to Terminal Avenue, Pacific Boulevard from Nelson Street to Quebec Street, and Expo Boulevard from Abbott Street to Nelson 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.

8.0 TRANSIT NETWORK ASSESSMENT

Although three SkyTrain stations and three rapid transit lines will continue to serve the NEFC area at Yaletown-Roundhouse, Stadium-Chinatown, and Main Street-Science World, the core local bus service will require adequate capacity and service frequency to accommodate future users.

8.1 Bus Network

As part of TransLink's Downtown Bus Service review, the existing C21 and C23 shuttle route will be consolidated as a single C21 route connecting Beach Avenue and Main Street Station through NEFC.

Other nearby routes 5 and 6 are potentially affected by future permanent street closures being considered by the City. These include the 800 block of Robson Street and the 600 block of Cambie Street as shown in ***Figure 8.1*** below.

Figure 8.1: Contemplated Bus Routes, TransLink Downtown Bus Service Review

A1s described in Section 4.0, transit trips are anticipated to account for over 10% of the trips to / from NEFC development blocks. The resultant peak hour passenger demand would 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. While not all of the NEFC transit trips will use the area bus routes (many will opt for the three SkyTrain lines within 800 m or 10 minute walk time), the totals above do not account for existing usage of the route.

With the potential demand for 5 minute bus headways and significant congestion at signalized intersections, the need for transit priority through the NEFC network is essential to maintaining on-time performance and fleet efficiency.

Areas where the proposed C21 routing could experience significant delays include the following:

- New Pacific Boulevard eastbound left-turn to Abbott Street northbound;
- Quebec Street northbound and southbound crossing of New Pacific Boulevard;
- Quebec Street southbound left-turn to National Avenue eastbound;
- Terminal Avenue westbound through at Main Street; and
- Terminal Avenue westbound right-turn to Quebec Street northbound.

There will also be a need to consider the location of transit stops in the context of serving future high activity blocks. Additional stop locations to bring transit service closer to major NEFC development blocks include the following:

- New Pacific Boulevard between Nelson Street and Abbott Street (both directions to service the blocks on the south side of New Pacific Boulevard); and
- New Pacific Boulevard between Abbott Street and Quebec Street (both directions to better service the consolidated Andy Livingstone Park and Waterfront Park.

The above changes could result in a split routing or parallel nested routes in order to serve competing destinations. Currently, the westbound service is proposed to turn right on Expo Boulevard from southbound Abbott Street, proceeding along the north side of BC Place. A much more significant population and employment zone will be located on the south side of New Pacific Boulevard suggesting the route could be shifted accordingly via the proposed Pacific Boulevard counterflow transit lane. Similarly, the ability to service both Keefer Street and New Pacific Boulevard between Abbott Street and Quebec Street may be compromised by a single routing.

Should new stops be provided at the locations noted above, transit priority requirements should be incorporated into the design of the NEFC network at the following congestion areas:

- Transit queue jump / priority signal to facilitate a northbound left-turn from Quebec Street to New Pacific Boulevard;
- Transit queue jump / priority lane to bypass westbound right-turn congestion at the New Pacific / Georgia Ramp intersection and allow for counterflow bus service on New Pacific Boulevard between Georgia Ramp and Nelson Street; and
- Right-turn queue bypass for New Pacific Boulevard eastbound to Quebec Street southbound.

The above improvements could be coupled with a general reduction in vehicular traffic capacity along Quebec Street to shift traffic to Main Street and have Quebec Street function more effectively for transit and active transportation modes.

8.2 SkyTrain Network

With regards to planned rapid transit system improvements, a number of measures are contemplated for increasing the capacity of the existing system and providing new rapid transit services to serve long term growth and development.

NEFC is currently served by the Canada Line, Expo Line and Millennium Line SkyTrain lines. The Expo and Millennium Lines have an ultimate design capacity of 25,000 passengers per hour per direction (pphpd) based on full platform utilization and minimum headways between trains. The Canada Line's current capacity is limited to 6,100 pphpd due to platform and train length restrictions, however, it is expandable to 15,000 pphpd to meet future demand.

A key area of focus is the Stadium SkyTrain station and its connections with the surrounding NEFC network. There are three existing access points, at Beatty Street, Keefer Place, and Expo Boulevard. For day-to-day conditions, these access points adequately service demand, however, during major events at the adjacent BC Place and Rogers Arena stadia, there is a significant surge in passenger demand during the load-in and load-out periods. A dual event survey was completed on Saturday, September 13, 2014 that captured pedestrian flows at each of the three access points over the course of an afternoon. The events featured a Canadian Football League game at BC Place and a concert at Rogers Arena.

Table 8.1 shows the resultant peak pedestrian flows at Stadium-Chinatown SkyTrain station.

Table 8.1: Dual Event Peak Hour Pedestrian Flows Stadium-Chinatown (September 13, 2014)

Location	Peak Flow (pph)	% of Total
Beatty Street access	3,191	54%
Keefer Place courtyard	800	13%
Expo Boulevard access	1,934	33%
Total	5,925	100%

As shown, during the peak hour approximately 1/3rd of the station trips moved through the at-grade access at Expo Boulevard. The peak hour for this specific access point was as high as 2,612 pph. To manage this high volume of pedestrians crossing from Rogers Arena to the SkyTrain access, Expo Boulevard vehicle traffic is managed by the Vancouver Police Traffic Authority during peak outflow periods. Note that outside of these peak periods, pedestrians are directed to the Abbott Street signalized crossing which is approximately 40 m away from the station entrance. Fencing and regulatory signage has been provided to prohibit jaywalking across Expo Boulevard.

There is the potential to extend the existing upper level Stadium station platform to the east to allow an overhead crossing of Expo Boulevard and connect directly to the Rogers Arena block via a new stairway. This would significantly alleviate pedestrian and traffic congestion along Expo Boulevard during event periods, reduce the need for supplemental traffic control resources, and reduce crossing times for pedestrians travelling between the north and south side of Expo Boulevard throughout the day. In the context of the NEFC development and up to 1,000 peak transit users being generated per hour, the modifications to the existing SkyTrain station should be reviewed further in subsequent design planning.

The City's Transportation 2040 plan has established three future rapid transit corridors of interest to the NEFC study. These include the City's priority Broadway Line, as well as conceptual transit priority enhancements along the Hastings Street corridor and the Main Street / Fraser Street corridor.

Broadway Line Connection

Following completion of a Phase 2 evaluation of potential alternative transit scenarios between Commercial-Broadway SkyTrain station and the UBC campus, one shortlisted option is of particular pertinence to the NEFC area. This option, described as "Combo 1" includes a combination of Rail Rapid Transit (SkyTrain) and Light Rail Transit, with tunneled Rail Rapid Transit from VCC-Clark SkyTrain Station to Arbutus Street, and surface Light Rail Transit operating from Main Street-Science World to UBC.

Figure 8.2: Combo 1 Broadway Line Option

With a new connection between Main Street-Science World and UBC, this could service additional transit trips for the NEFC developments, with a shift toward the eastern study area. The Light Rail line terminating at Main Street-Science World could also be logically extended north and west to follow Quebec Street and New Pacific Boulevard as either bus rapid transit or future Light Rail.

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 reserved bus lanes and enhanced signal priority measures will need to be considered. Of particular note is the Main Street corridor between Union Street and Terminal Avenue, which could see additional vehicle trips due to NEFC growth and a diversion of Viaducts traffic to the replacement at-grade network. Curbside bus lanes will likely need to formalized along with peak parking restrictions to continue to deliver reliable service on this segment.

8.3 Overall Assessment

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

- Additional population and employment infill that will drive an increase in bus service frequency and capacity.
- Provision of the Broadway Line spur could bring a fourth rapid transit line within reach of NEFC residents, employees and visitors.
- Bus route adjustments could be made to consolidate split routes along the two-way network and better service adjacent activity and development centres.
- Transit priority measures will be provided to mitigate the effects of road traffic congestion on service reliability.

9.0 PARKING SUPPLY AND DEMAND

Parking supply is a primary factor affecting the generation of new vehicle trips. Of particular interest are the land parcels which are under the management of One West Holdings Ltd (formerly Concord Pacific). As development occurs, an agreement is in place between the City of Vancouver and One West Holdings Ltd. to replace a portion of the parking spaces either through new construction or cash-in-lieu payments. The current agreement pertains to 1,322 spaces in the area, of which an additional 300 spaces will be created with the Vancouver Urban Resort (VUR) and the remainder to paid as cash-in-lieu. It is also noted that additional parking may be provided on the Canadian Metropolitan site (Plaza of Nations) to offset the net loss of parking; however, the number of stalls to be provided is currently unconfirmed. ***Table 9.1*** summarizes the parking locations and replacement agreement.

Table 9.1: Existing Parking Space Locations and Replacement Agreement

Location	Total Stalls	Stalls to be Built as part of Future Development	Stalls to be Paid-in-Lieu
1. 900 Beatty Street	100	0	100
2. 858 Beatty Street	100	0	100
3a. Cambie Bridgehead West	48	0	48
3b. Cambie Bridgehead East	49	0	49
4. International Village	350	350	0
5. Costco Site	200	0	200
6. Rogers Arena / GM Place	250	150	150
7. Expo / Pacific / Carrall / Abbott block	225	0	225
8. Lands beneath Viaducts	0	0	0
Subtotal (Stadium Agreement)	*1,322*	*500*	*822*
Vancouver Urban Resort (Future)	300	300	0
Total	1,622	800	822

A significant reduction in physical parking spaces is anticipated as redevelopment occurs. During parking utilization surveys conducted by others in 2007 and 2008, selected parking areas within the NEFC were studied to identify peak utilization. ***Table 9.2*** summarizes results of the 2007 survey conducted by Bunt and Associates for a major concert event at BC Place.

Table 9.2: Peak Parking Occupancy (2007 BC Place Event)

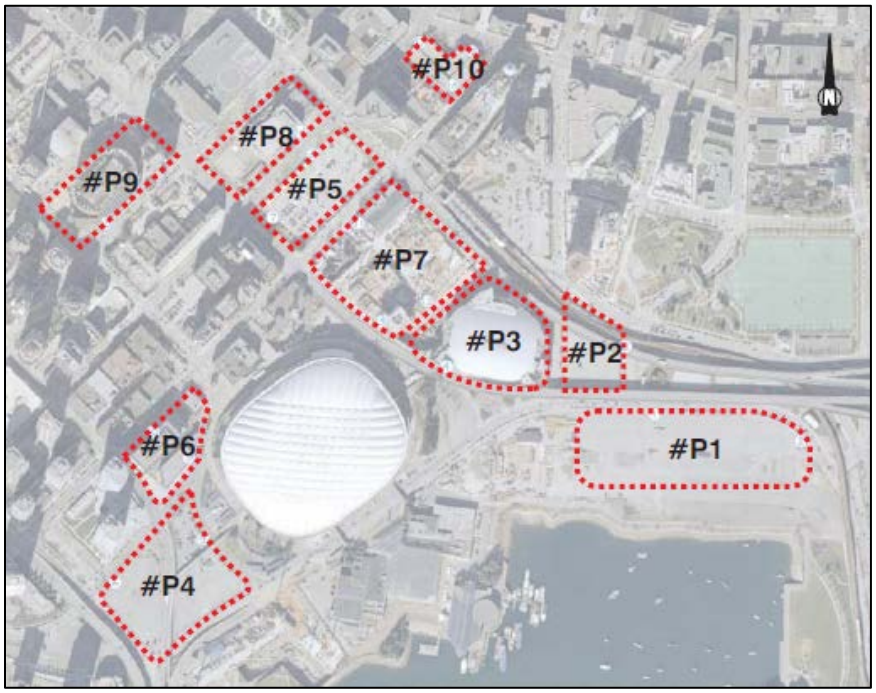
Parking Lot ID	Total Stalls	Peak Demand	% Occupancy
P1 – South of Pacific Boulevard, north side of False Creek	533	271	51%
P2 – Expo / Abbott / Carrall / Pacific block adjacent to Rogers Arena	276	276	100%
P3 – Rogers Arena	565	326	58%
P4 – Expo / Terry Fox / Nelson / Pacific block at north Cambie bridgehead	532	532	100%
P6 – Garage northwest of BC Place between Beatty / Smithe / Expo	205	205	100%
P7 - Costco	672	324	48%
Total – Immediate NEFC	2,783	1,934	69%
Total - 10 Sites	3,516	4,435	79%

Source: Bunt and Associates BC Place Concert Event Final Report

The overall utilization was 79% and the sites closer to the core of the NEFC were less utilized at 69%. A follow up study done in 2008 for a dual event day featuring events at both BC Place and Rogers Arena indicated full utilization of a smaller sample of spaces (2,800) serving the stadia and adjacent downtown core.

Figure 9.1 shows the areas that were studied in 2007.

Figure 9.1: Parking Lot Locations (2007 BC Place Event)



Source: Bunt and Associates BC Place Concert Event Final Report

Initial results of an updated Dual Event survey undertaken in September 2014 suggest that overall mode split for stadium events has not changed significantly since the 2007 survey. ***Table 9.3*** summarizes the mode split comparison as obtained from surveys conducted in and around the stadia during the dual event period.

Table 9.3: Dual Event Modal Split Comparison (2007 versus 2014)

Mode	2007	2014
Sample Size (# of Interviews)	303	464
Vehicle Driver	27.2%	33.9%
Vehicle Passenger	10.3%	10.1%
SkyTrain	25.5%	32.6%
Bus	11.6%	7.8%
SeaBus	0.3%	2.5%
Charter Bus / Taxi / Limo	6.6%	2.6%
Walked	17.2%	4.7%
Bicycle	0.7%	0.6%
Other / No Response	0.7%	5.1%
Total	100%	100%

The total vehicle driver percentage increased between 2008 and 2014, along with the proportion of SkyTrain trips and transit trips overall. Walking trips, bus trips and charter bus / taxi / limousine trips decreased and were possibly shifted to SkyTrain as a result of the availability of the new Canada Line. It is expected that with the continued improvements in transit, walking and cycling infrastructure (as described in Sections 7.0 and 8.0), as well as the infill of nearby residents and employees will serve to reduce vehicle traffic generated by stadium events and display a downward trend consistent with overall vehicle trips throughout the City.

As the majority of available parking lots are privately owned and operated, prices and rates will be set to ensure maximum practical utilization on event days and during off peak times. Previous studies have shown that reserve capacity can be made available to suit demand. If the total number of parking spaces decreases, the vehicular traffic impacts associated with stadium events can be reduced significantly. Attendees

displaced from vehicle travel can be accommodated through the existing and planned rapid transit, bus service, walking and cycling infrastructure.

While the planned reduction in parking supply may result in reduced vehicle traffic volumes for events in and around the Stadium area, there may be additional pressures outside of the immediate area for staging locations, as well as potential park 'n ride locations. Over time, messaging to visitors will need to be adjusted to reflect the reduced parking supply and the location of this supply, which will be increasingly focused away from Pacific Boulevard and Expo Boulevard and into the adjacent downtown and Chinatown neighbourhoods.

With regards to on-street parking, metered parking could be viable during off-peak hours along the following blocks to support street level retail and short duration stays:

- Nelson Street between Expo Boulevard and Pacific Boulevard (existing supply);
- Expo Boulevard between Nelson Street and Smithe Street (existing supply);
- Expo / Pacific between Cambie Street and Nelson Street (existing supply);
- Expo Boulevard between Abbott Street and Griffiths Way (existing supply);
- Abbott Street between Expo Boulevard and Pacific Boulevard (existing supply);
- New Pacific Boulevard between Abbott Street and Main Street (use curb lanes during off-peak hours);
- Quebec Street between New Pacific Boulevard and Terminal Avenue (existing supply plus southbound curb lane during off-peak hours); and
- Main Street between Union Street and Terminal Avenue (existing supply and time of day restrictions).

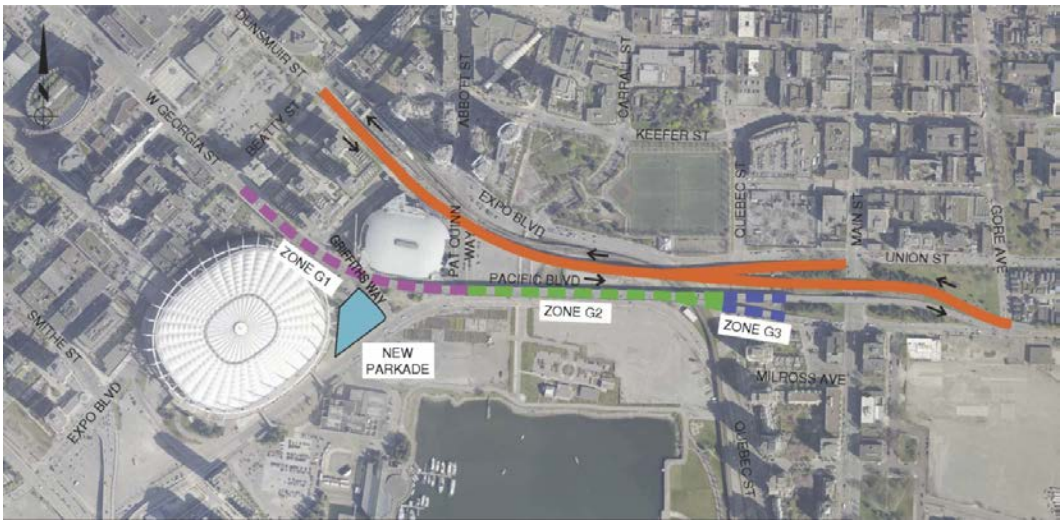
Pricing of parking is recommended to encourage turnover and to reflect the value of road space consumed by parked vehicles. The regulation of parking on new residential streets within NEFC blocks 6B and 6C should be developed to discourage long term storage of resident or employee vehicles on local streets, as well as to limit spillover parking during major stadium events.

10.0 CONSTRUCTION IMPACTS

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 second stage of construction was determined to have the greatest overall impact to traffic to carry forward for further detailed analysis, as shown in ***Figure 10.1*** below. 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 second phase of construction.

Pacific/Quebec/Expo are all open in this stage

Figure 10.1: Construction Phasing Stage Two Proposed Plan (MMM Group, 2014)



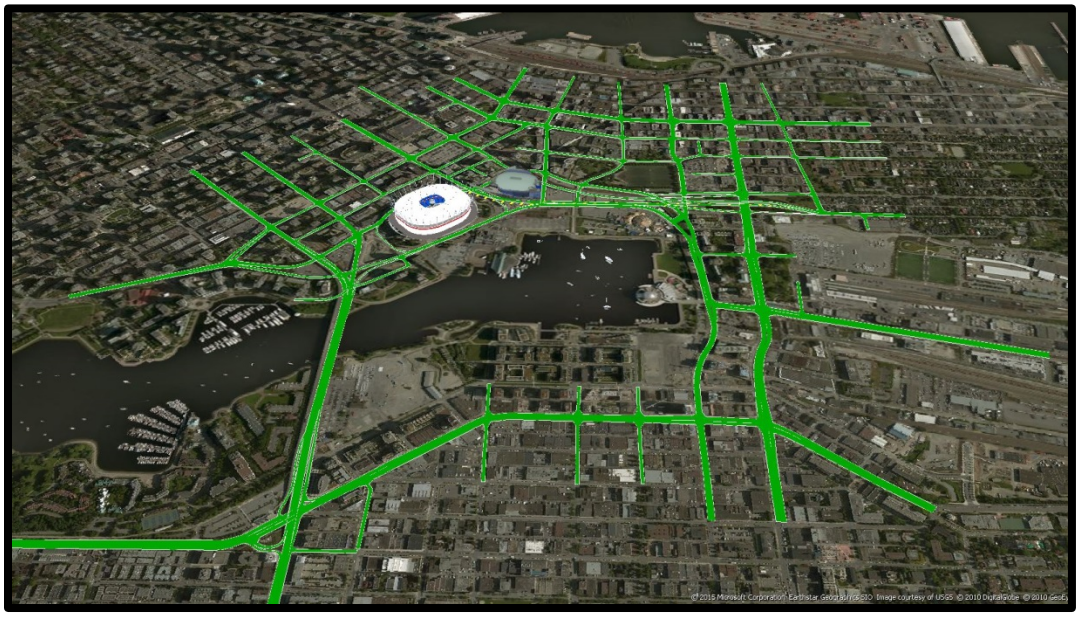
The removal of the Georgia Viaduct during stage two would necessitate approximately 1,900 vehicles, which previously used the Georgia Viaduct during the PM peak hour, to reroute through the network and use alternative streets. In addition, the conversion of one-way Dunsmuir to a two-way single lane road 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. Stage two 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.

10.1 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 10.2***.

Figure 10.2: 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 single lane in each direction. 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.

10.2 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 10.1***. 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 10.1 provides network statistics related to the proposed construction phase stage two plan compared to the existing base.

Table 10.1: 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.

Figure 10.3 shows the comparative eastbound PM peak travel time by scenario for trips along the Pacific Boulevard surface street network. ***Figure 10.4*** 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 red line indicates the stage two construction detour route for vehicles traveling eastbound from Georgia Street.

Figure 10.3: PM Peak Eastbound – Pacific Boulevard

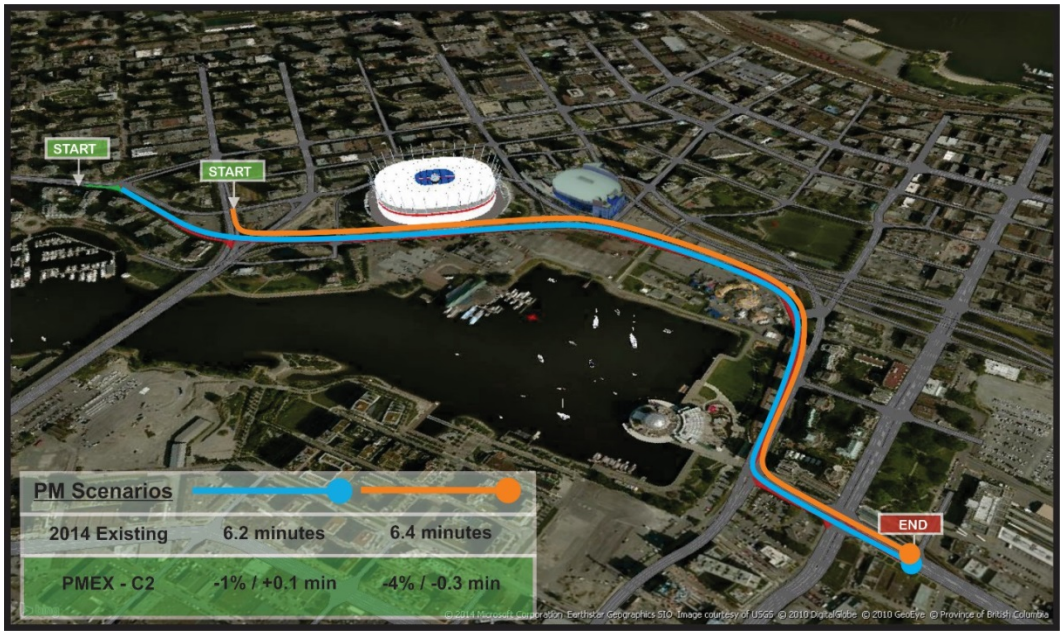
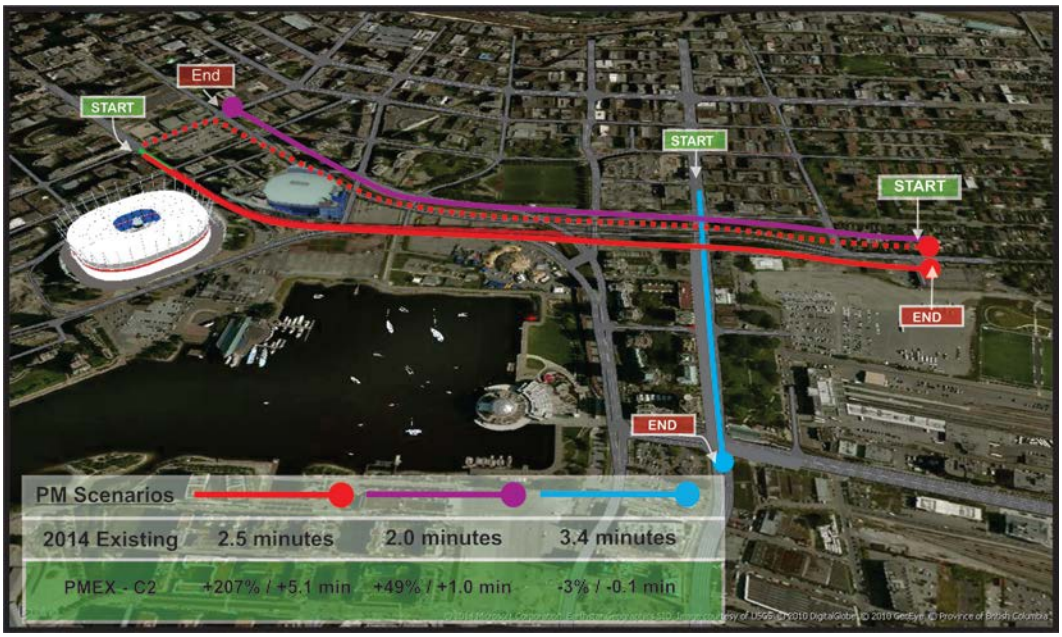


Figure 10.4: PM Peak Eastbound – Dunsmuir and Georgia Viaducts



No significant travel time increases were observed for westbound routes along Pacific Boulevard to Terminal Avenue. Travel times for eastbound trips which utilized the Georgia Viaduct connector 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 of from two lanes to one lane. No significant travel time differences were observed for southbound traffic on Main Street. The Georgia / Beatty to Main / Terminal route was not retained in this analysis because of their lack of a suitable route within the constraints of the micro-simulation model. In reality, most trips are likely destined to Highway 1 and would use an alternate route to reach their destination.

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 10.5*** 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 10.2*** shows the volume differences and percent change for key links within the study area.

Figure 10.5: Link Volume Differences (PM Base versus Construction Phase Stage 2)

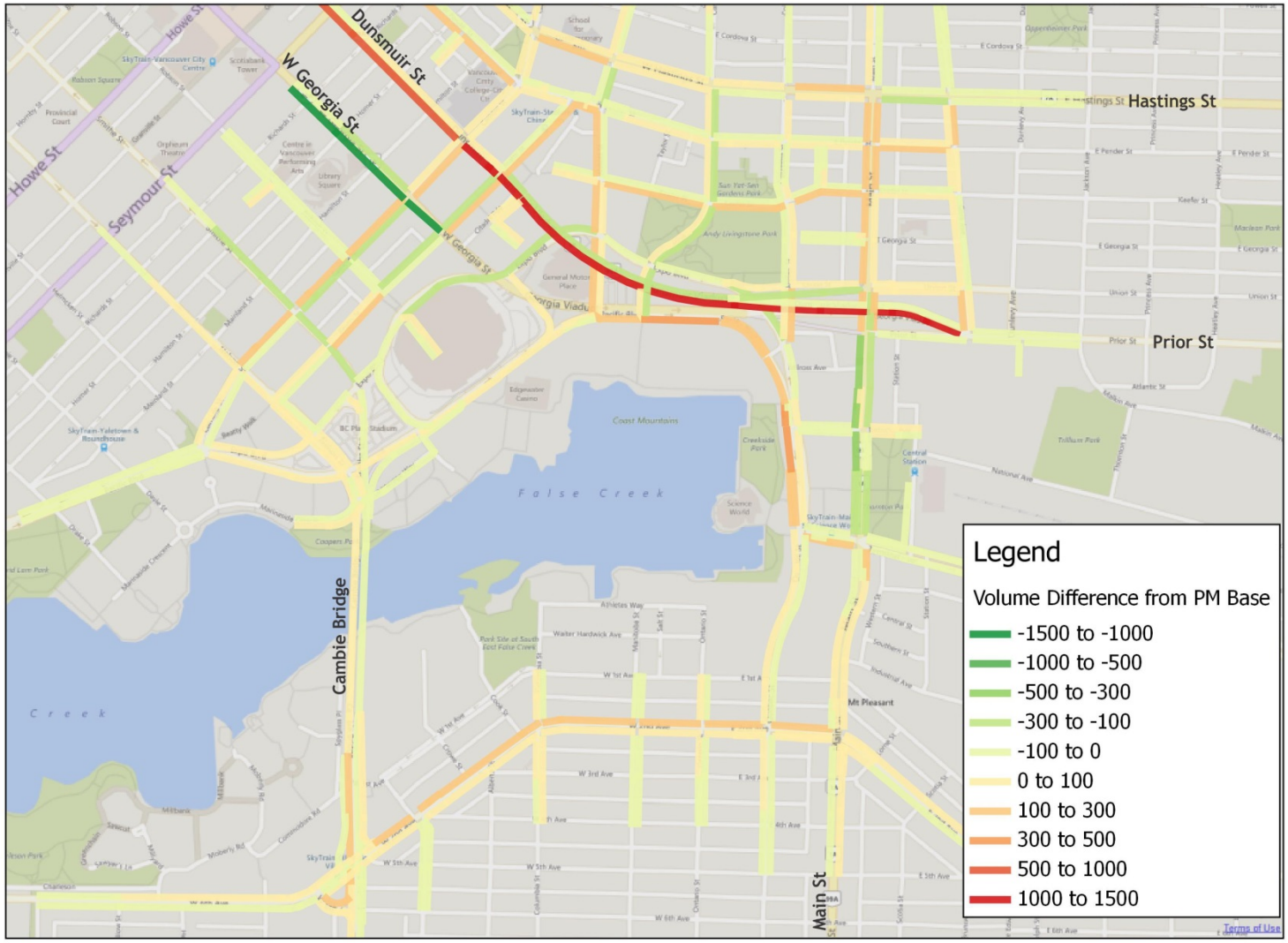


Table 10.2: Link Volume and Percentage Difference

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.

11.0 FINDINGS AND RECOMMENDATIONS

Based on the preceding analysis, the following findings and recommendations are provided.

1. In accordance with the NEFC goals and objectives, a multi-modal assessment has been completed to confirm the ability of the Viaducts Replacement transportation network to accommodate up to 5.4 M ft^2 of residential and 2.3 M ft^2 of non-residential development along with residual background traffic demands.
2. As an initial step, the TransLink Regional Transportation Model (RTM) was reviewed to confirm assumptions for existing and future population and employment totals. By 2045, the RTM assumes an additional 8,266 new population and 7,369 new jobs within the NEFC zones. Confirmation with current City of Vancouver planning direction indicated that these totals could be increased to 12,147 new population and 8,939 new jobs, respectively between 2011 and 2045.
3. The RTM Phase 2 model accounts for a 2045 regional population total of 4.01 M people, as well as network modifications such as the Viaducts replacement network, the Malkin Connector, and the Evergreen and Broadway rapid transit lines.
4. A macro-level assessment of potential network traffic growth between 2011 and 2045 using the RTM indicated a net peak directional growth of over 760 vehicles per hour across the east-west screenline comprising Terminal Avenue, Malkin Avenue, Prior Avenue, Hastings Street and Powell / Cordova Streets. On a north south screenline crossing Cambie Street Bridge, Quebec Street and Main Street, the RTM indicated a net peak directional growth of 490 vehicles per hour. These individual link changes average less than several vehicles per minute which can typically be accommodated without significant impact.
5. Notwithstanding the results of the RTM output, in order to meet the City's Transportation 2040 goals of no net increase in vehicular traffic on City streets, the net increases highlighted in the RTM forecasts will need to be addressed through increases in transit ridership, walking and cycling, and/or deferral of peak hour travel.
6. A traffic micro-simulation model was developed on the PARAMICS platform using AM and PM peak travel demand matrices output from the RTM as well as site-generated traffic from the individual NEFC blocks.
7. Four distinct analysis scenarios were developed for comparison including 2014 existing network, 2045 Viaducts replacement network no net traffic growth, 2045

existing network full traffic growth, and 2045 Viaducts replacement network full traffic growth.

8. To generate vehicle trips for the NEFC development zones, ITE trip generation rates for analogous land uses were adjusting using observed City of Vancouver travel behaviour from the most recent panel survey. This survey indicated over half of the trips generated with the Downtown – False Creek neighbourhood were walking trips, with only 31% of trips being made as vehicle drivers.
9. By applying the adjusted trip generation rates, the NEFC zones are conservatively forecast to generate over 5,400 two-way combined walking trips, 3,285 private vehicle trips, 1,060 transit trips, and 210 bike trips once full build out is reached.
10. New NEFC Vehicular traffic was distributed approximately equally to the east and west of the area using Pacific Boulevard west, Prior Street east and Main Street south for the primary origins and destinations of traffic given the enhanced network continuity planned between Pacific Boulevard, Prior Street and Main Street.
11. In travel demand Scenario A, no net traffic growth, the 2045 Viaducts replacement network was found to be capable of processing 100% of the assigned demand in the AM and PM peaks.
12. In travel demand Scenario B, full traffic growth, the 2045 Viaducts replacement network models were capable of processing 95% of the assigned demand in the AM peak and 85% in the PM peak before significant network congestion set in. The 2045 existing network models were capable of processing 85% of the assigned demand in the AM peak and 75% in the PM peak before significant network congestion set in. The 2045 existing network processes approximately 10% less traffic than the Viaducts replacement network due to compromised accessibility of certain development blocks within the Viaducts footprint and the limited ability of new development traffic to distribute to the surrounding network.
13. The 2045 Viaducts replacement network scenarios result in relatively minor travel time increases per vehicle (approximately one minute) due to the provision of the Viaducts replacement network. The 2045 Viaducts retained scenario results in reduced delay per vehicle, but limited capacity to process local site development traffic.
14. In travel demand Scenario A, the 2045 Viaducts replacement network showed increases in point-to-point travel times ranging from less than one minute to more than three minutes. For the AM westbound direction, trip times along Expo Boulevard would increase by 59% (over three minutes) and trips currently using the Dunsmuir Viaduct would increase by as much as 57% (over three minutes).

For the PM eastbound direction, trip times along Pacific Boulevard would increase by 18% (just over one minute) and trips currently using the Georgia Viaduct would increase by as much as 132% (three minutes).

15. In travel demand Scenario B, the 2045 Viaducts replacement network showed increases in point-to-point travel times ranging from less than one minute to seven minutes. For the AM westbound direction, trip times along Expo Boulevard would increase by 73% (just under four minutes) and trips currently using the Dunsmuir Viaduct would increase by as much as 192% (seven minutes). For the PM eastbound direction, trip times along Pacific Boulevard would increase by 24% (over 1.5 minutes) and trips currently using the Georgia Viaduct would increase by as much as 108% (over 2.5 minutes).

16. Estimated travel time increases for motorists with the Viaducts replacement network are not anticipated to extend to Emergency Service Providers, as they are given priority by general purpose traffic and have the ability to cross the directional dividing line to avoid congestion. Furthermore, an at-grade Pacific Boulevard provides emergency vehicles with better direct access to the two stadia and improved access to 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.

17. Assessment of forecast intersection operations indicated that if upstream or downstream capacity constraints were ignored and full vehicular traffic demand realized, almost all major intersections within the NEFC replacement network would operate at Level of Service F. In response, an alternative “constrained” volume scenario representing 85% of the combined background and NEFC development demand was used to test alternative mitigation measures.

18. Mitigation measures to consider in the subsequent development and refinement of the New Pacific and Georgia Ramps conceptual designs include the following:
    a. Provide eastbound and westbound left-turning bays at the Georgia / Cambie signalized intersection in conjunction with a prohibition of left-turns at the Georgia / Beatty intersection.
    b. Provide a westbound left-turn bay at the Pacific / Abbott signalized intersection.
    c. Provide eastbound and westbound left-turn bays and protected signal phasing at the Pacific / Quebec signalized intersection.
    d. Prohibit eastbound and westbound left-turns at the Pacific / Main signalized intersection.
    e. Provide an eastbound left-turn bay at the Prior / Gore signalized intersection.

19. Through a review of the operational micro-simulation model, a number of opportunities and constraints have been identified where the current replacement network could be further optimized. These include overall issues, network connectivity and accessibility issues, and intersection issues.

20. Overall, the volume capable of entering / exiting the NEFC network will continue to be controlled by signals on its periphery that are currently at capacity. Consistent with the City's Transportation 2040 target of no net new growth in vehicle traffic volumes, this means that either new trips will need to be shifted to walking, cycling or transit modes, or an equivalent amount of existing background traffic will need to be displaced to accommodate full NEFC build out.

21. The most significant constraints within the NEFC network are observed at either end of the Stadium blocks due to the one-way couplet system which restricts local block access and requires circuitous and overlapping directional traffic flows. These constraints are particularly evident at the following locations:
    a. Expo Boulevard westbound left-turn at Nelson Street;
    b. Nelson Street slip southbound left-turn at Pacific Boulevard;
    c. Smithe Mews southbound left-turn at Pacific Boulevard;
    d. Pacific Boulevard eastbound left-turn to Griffiths Way; and
    e. Griffiths Way northbound left-turn to Expo Boulevard.

22. A potential network wide mitigation measure would be provision of a two-way street network between Nelson Street and Abbott Street as this would greatly improve local access / egress options for all blocks along this segment and eliminate 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 be the most congested in the NEFC, any redirection of traffic or operational flexibility achieved by removing conflicting turning movements would reduce delays and increase capacity.

23. There is the opportunity to enhance accessibility for the 6B and 6C blocks on the south side of Pacific Boulevard by providing a local street connection. This local street connection would allow eastbound traffic destined to the 6C block to access the block without entering the congested Georgia / Pacific or Pacific / Abbott signalized intersections.

24. Due to the redirection of westbound traffic up the new Georgia Ramp, delays will increase to through traffic if left-turn movements are permitted from Georgia Street to Beatty Street and / or Cambie Street. The provision of left-turn bays or peak hour restrictions is recommended. At Dunsmuir Street, a significant reduction in right-turn conflicts with the Dunsmuir cycle track will result in safer cycling operations.

25. The NEFC's current Walk Score is 86 out of 100 which shows significant potential for improvement as residential, commercial and recreational amenities are brought on stream and new crossing signals are put in place along the Viaducts replacement network.

26. The NEFC area is the confluence of several major cycling connections. Given the need for safe, comfortable and convenient cycling facilities for local and City-wide trips, the Viaducts replacement network includes conceptual plans for a replacement bicycle and pedestrian bridge between Union Street and Dunsmuir Street.

27. Based on the forecast volume of cycling trips, the speed of major roadways and the forecast volume of traffic, separated cycling facilities are recommended on the following NEFC network elements:
    a. Pacific Boulevard from Nelson Street to Quebec Street;
    b. Expo Boulevard from Abbott Street to Nelson Street;
    c. Quebec Street from Terminal Avenue to Union Street;
    d. Carrall Street from Pender Street to Seawall; and
    e. Dunsmuir Street to Adanac Street.

28. Using forecast bicycle flows developed by the City, Level of Service was calculated for key segments of the future cycling network. Assuming full separation from pedestrians, the segments all functioned at Level of Service C or better based on the SUPLOS program results.

29. In addition to the replacement pedestrian and cycling bridge, there are a number of supporting cycling network elements connecting to or through the NEFC. These include the completion of the False Creek Loop, a Southeast Vancouver to Central Business District connection, and Union / Adanac to Helmcken / Yaletown connection.

30. As part of TransLink's Downtown Bus Service review, the existing C21 and C23 shuttle route will be consolidated as a single C21 route. To service future peak NEFC demand 12 to 13 full size buses per hour per direction and a schedule headway of five minutes could be required depending on the usage of the three area SkyTrain stations and the background ridership growth on the C21 outside of NEFC.

31. Should new bus stops be provided along New Pacific Boulevard between Nelson Street and Quebec Street, transit priority may be needed at the following locations to overcome delays:
    a. Transit queue jump / priority signal to facilitate a northbound left-turn from Quebec Street to New Pacific Boulevard;

b. Transit queue jump / priority lane to bypass westbound right-turn congestion at the New Pacific / Georgia Ramp intersection and allow for counterflow bus service on New Pacific Boulevard between Georgia Ramp and Nelson Street; and
c. Right-turn queue bypass for New Pacific Boulevard eastbound to Quebec Street southbound.

32. During the peak hour of a dual event at BC Place / Rogers Arena, approximately 1/3rd of the Stadium station trips moved through the at-grade access at Expo Boulevard. There is the potential to extend the existing upper level Stadium station platform to the east to allow an overhead crossing of Expo Boulevard and connect directly to the Rogers Arena block via a new stairway. This would significantly alleviate pedestrian and traffic congestion along Expo Boulevard during event periods, reduce the need for supplemental traffic control resources, and reduce crossing times for pedestrians travelling between the north and south side of Expo Boulevard throughout the day.

33. The City's Transportation 2040 plan has established three future rapid transit corridors of interest to the NEFC study. These include the City's priority Broadway Line, as well as conceptual transit priority enhancements along the Hastings Street corridor and the Main Street / Fraser Street corridor. With a new connection between Main Street-Science World and UBC as an optional component of the Broadway Line, this could service additional transit trips for the NEFC developments, with a shift toward the eastern study area. The Light Rail line terminating at Main Street-Science World could also be logically extended north and west to follow Quebec Street and New Pacific Boulevard as either bus rapid transit or future Light Rail.

34. Over time as off-street surface parking is replaced at a ratio of approximately one to three, messaging to visitors will need to be adjusted to reflect the reduced parking supply and the location of this supply, which will be increasingly focused away from Pacific Boulevard and Expo Boulevard and into the adjacent downtown and Chinatown neighbourhoods. A higher proportion of event trips will need to be made via transit, walking and cycling modes using the planned infrastructure improvements. Pricing of residual on-street parking will encourage turnover for street level retail and limit event-related parking on local streets.

35. A high level review was performed for the worst-cast construction phasing stage two was modelled to determine potential traffic impacts. This stage involves the closure of the Georgia Street Viaduct east of Beatty Street and converting the Dunsmuir Viaduct into a two-way facility with single lane in each direction. The network model was capable of processing the full demand. From a network perspective, the 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 in the PM peak for eastbound traffic via the two-way Dunsmuir Viaduct by 207% (over five minutes) and modest increases in other key routes. Due to these impacts, it is recommended that other concurrent construction projects in the vicinity be coordinated to minimize traffic disruption.