British Columbia Ministry of Transportation and Infrastructure

Township of Langley BC Est. 1873

Carvolth Traffic Study Report

Final

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PARSONS

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APPENDICES

1. Introduction

The Gateway area in the vicinity of the 200 Street interchange is still under development with the aim to create a sense of arrival to the Carvolth and Willoughby communities and to encourage development of landmark buildings at this high-profile location. With the increased development interest in these areas in the vicinity of the 200 Street interchange, there is a need to understand the performance of the transportation network for medium and long term horizon years as well as the impact caused by modifications to the restrictive covenant which currently limits the trip generation of specific quadrants around the 200 Street interchange. Currently, the maximum size of retail commercial uses within the Gateway area is limited to 1,000 sq. metres, with one store up to 3,000 sq. metres in each quadrant of the 200 Street interchange with select parcels constrained by restricted covenants rezoned as part of the construction of the 200 Street interchange. Modifications to the restrictive covenant may increase trip generation leading to additional vehicle demand on Township of Langley (ToL) and Ministry of Transportation and Infrastructure (BC MoTI) roadways. The transportation network adjacent to the restrictive covenant on the 200 Street interchange lands are particularly sensitive to changes to vehicle demands as the primary access and egress points adjoin the Highway 1 on and off-ramps at 200 Street.

This document provides an assessment of the existing (2016) and future (2035 and 2050) transportation networks by providing quantitative and qualitative measures of performance. It analyzes the potential traffic operations impacts caused by changes to the restrictive covenant and tests the effectiveness of several mitigation measures. This study will ultimately help to inform potential requirements associated with current and future development applications in the vicinity of the 200 Street interchange.

A two-pronged modelling approach has been adopted: one for macro-scopic analysis using the refined Regional Traffic Model (RTM) and another for micro-simulation traffic operations analysis performed through Aimsun. This two-pronged approach allows for flexibility in assessing both the broader study area performance as well as detailed operational performance of the road network adjoining the restricted covenants at the 200 Street interchange. Note that there are three horizon years (namely 2016, 2035, and 2050) used for the analysis which are based on Regional Transportation Model (RTM) horizon years. Hence, the existing base case is referred to as 2016 even though refinements have been made to bring it in-line with 2019 conditions.

1.1 Study Area

The study area is partitioned into two discrete analysis areas based on macro-scopic (RTM) or micro-scopic (Aimsun) levels. The macro-scopic analysis area encompasses a larger area bounded by 192 Street and 216 Street along Highway 1 and between 72 Avenue and 96 Avenue in the north-to-south direction, as shown in *Figure 1.1*. Within this macro-scopic study area, a refined micro-simulation traffic analysis area is centered on the 200 Street interchange and the adjacent restricted covenants as shown in *Figure 1.2*.

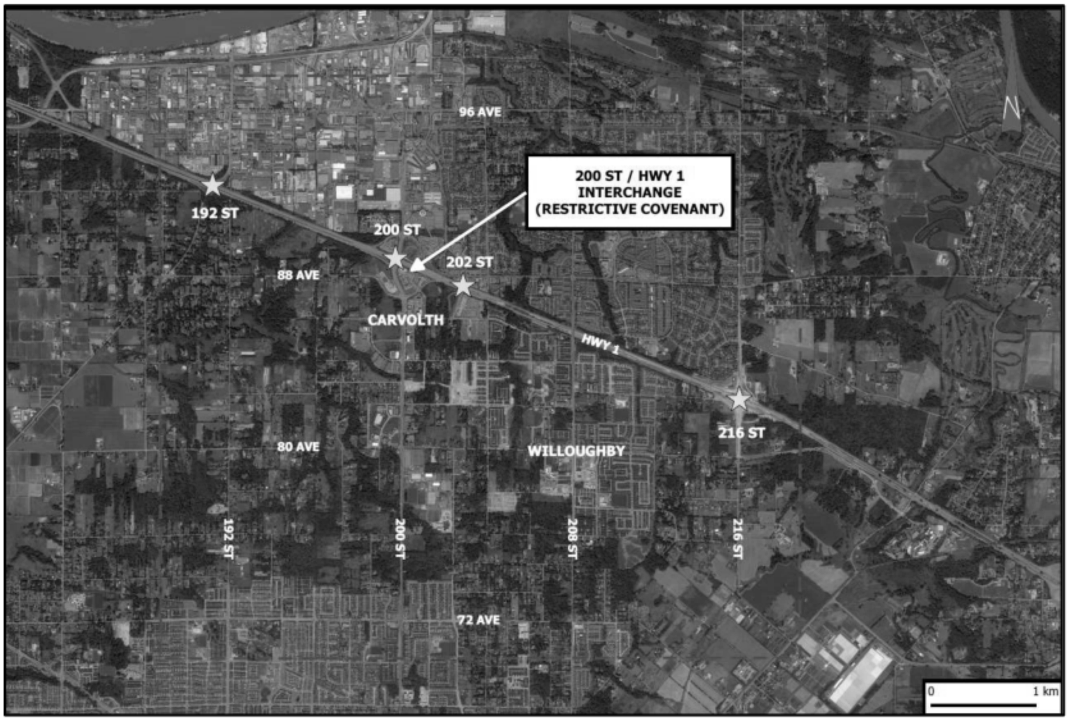


Figure 1.1: Macro-scopic Study Area (RTM)

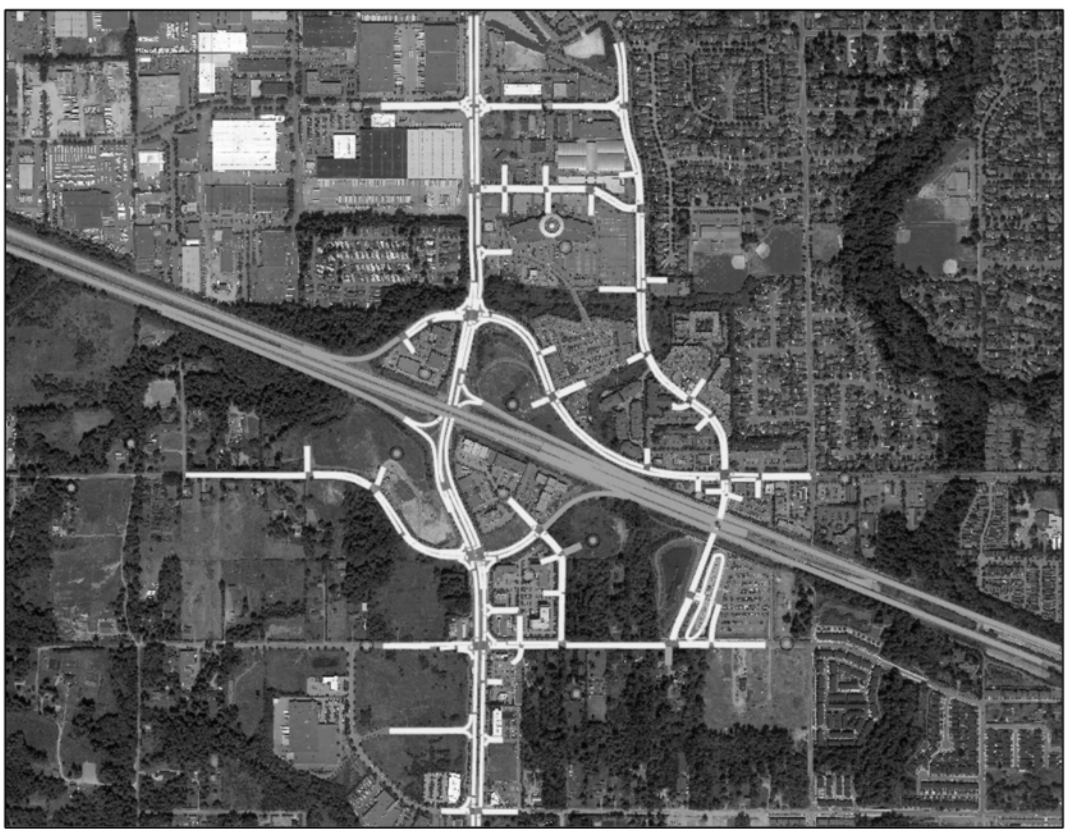


Figure 1.2: Micro-scopic Study Area (Aimsun)

1.2 Study Objectives

This document seeks to understand the transportation network impacts caused by removing or maintaining the restricted covenants within the 200 Street interchange lands. Analysis of the transportation network within the study area for three horizon years; namely, existing (2016) and future (2035 and 2050) provides quantitative evidence to support the findings. Traffic operations performance related to access points to and from the restricted covenant zones adjacent to the 200 Street interchange are analyzed and a sensitivity scenario examines the robustness of the network to accommodate trip generation within the restricted covenant parcels over the prescribed maximums. Finally, the effectiveness of several mitigation measures are tested.

The key objectives of this study include:

- Confirm the future base road and transit network and land use assumptions within the study area for each horizon year through discussions with the key study stakeholders and a review of pertinent background documentation. This will establish a baseline with which subsequent analysis will be compared against.
- Check and refine the Regional Transportation Model (RTM) for accuracy within the study area. This will involve incorporating feedback from the stakeholder engagement process to ensure the land use and road network assumptions reflect the existing and future base horizon years appropriately.
- Assess the transportation network for each horizon year with the restricted covenant in place. Analysis is carried out using the Regional Transportation Model and a detailed traffic operations micro-simulation model (Aimsun). Transportation network issues will be identified and documented along with quantitative metrics that capture changes to roadway usage, route travel time, network travel distance, volume-to-capacity ratio, delays, and level-of-service (LOS), amongst others.
- Assess the transportation network for each future horizon year (2035 and 2050) without the restricted covenant in place as part of a sensitivity analysis and compare the resulting traffic operations performance to the base transportation networks.
- Develop and evaluate mitigation measures to address the identified critical areas to the transportation network.
- Provide high-level recommendations supported by technical analysis whether the restricted covenants can be removed, modified, or must be maintained.

1.3 Document Layout

Following the introductory section, this document is segmented into nine key sections. The components of the report are as follows:

- Section 2 provides a summary of the review of the background documents including relevant neighbourhood and community plans. This process helped to identify changes to the land-use and the transportation network for each horizon year.
- Section 3 provides a summary of the process to bring the RTM and traffic operations micro-simulation model to a state that is fit-for-purpose and ready for implementation.
- Section 4 provides an overview of the transportation network characteristics including assumed land use, trip generation, and the potential physical and operational infrastructure for each horizon year;

- Section 5 provides an overview of the transportation network assessment criteria for both the macro-scopic and micro-scopic analysis.
- Section 6 presents the results of the traffic modelling analysis that was undertaken for the existing and future base conditions. Network performance is summarized for both the macro-scopic level using the refined RTM and the micro-scopic level using the calibrated Aimsun model.
- Section 7 examines the impact to the transportation network of modifying the restricted covenant trip generation limits and increasing overall trip making as part of a sensitivity analysis.
- Section 8 provides a summary of the identified mitigation measures and evaluates their performance for the future horizon years.
- Section 9 summarizes the key findings based on the quantitative and qualitative analysis.
- Section 10 provides several options and conclusionary remarks.

Supplemental analysis related to impact of the development of Site 8 into a proposed Hotel-Office-Casino complex can be found in *Appendix A.*

2. Review of Background Information

Prior to the analysis of the base transportation networks, it is important to understand the planned short-term, medium-term, and long-term changes to the study area. This section summarizes the findings of a review of pertinent documentation related to transportation and land use in the various community and neighbourhood plans. The information provided in these documents helped to inform the input assumptions used within the Regional Transportation Model and subsequent detailed traffic analysis. For more detail regarding the review of background information, please refer to the technical memorandum titled: *"477242_01000_Carvolth - Review of Background Information"*. Eight pertinent documents were reviewed and summarized with a focus on land use and the transportation network affecting the study area. The documents reviewed are as follows:

- Carvolth Neighbourhood Plan (No. 4995);
- Willoughby Community Plan (No. 3800);
- Township of Langley Official Community Plan (No. 1842);
- Walnut Grove Community Plan (No.1836);
- Latimer Neighbourhood Plan (No.5101);
- Yorkson Neighbourhood Plan (No. 4030);
- Williams Neighbourhood Plan (No. 5335); and
- Smith Neighbourhood Plan (No. 5265).

2.1 Summary of Background Documentation

The comprehensive review of relevant background documents has revealed several key findings as described below. In general, there was consistency between goals, land use assumptions, and transportation network improvements of the various neighbourhood and community plans. Key findings from the background documents are as follows:

- There was consensus between the land use and transportation network assumptions of the background documents and those within the Regional Transportation Model (RTM). Deviations from the prescribed land use were specifically identified by the Township of Langley. These discrepancies were noted and are accounted for subsequently.
- A common goal across the various plans is to create a complete and self-sufficient neighbourhood / community that provides a range of housing types, commercial services, employment sources, while preserving the surrounding rural areas for agriculture and conservation purposes. The Carvolth neighbourhood, in particular, is intended to be a highly urban and transit-oriented area that is also envisioned as a major employment node.
- There is emphasis on future improvements to transit and the pedestrian realm with expansion of vehicle capacity along key corridors and intersections. This includes the extension of 201 Street and 202 Street and widening of 80 Avenue and 88 Avenue.

- 200 Street is part of TransLink's Frequent Transit Network (FTN) and is identified as part of a Rapid Transit Network in TransLink's South of Fraser Transit Plan. A long-term vision exists to allow 200 Street to accommodate bus or light rail rapid transit service within a dedicated median.
- Within the study area, the main access routes are currently provided along 200 Street, 208 Street, and 216 Street in the north-south direction and 72 Avenue, 80 Avenue, 86 Avenue, and 88 Avenue in the east-west direction. The existing interchange at 200 Street experiences heavy usage as it is currently the only access to Highway 1. However, the soon to be completed interchange at 216 Street will provide additional access to Highway 1. An overpass also exists across Highway 1 along 208 Street and an underpass along 202 Street.
- The predominant land use characteristic in the Township of Langley is currently rural. In fact, approximately 75% of the Township's land base is in the Agricultural Land Reserve (ALR). However, there are pockets within the Township designated for urban development, including the study area, creating several urban centres and communities that are separated by large areas of agricultural land.
- The current transit network is less developed than the road network. Transit service within the study area is generally infrequent and only available along major routes, which is typical for a predominantly rural area. The main transit hub is the Carvolth Transit Exchange. HOV/ bus lanes also exist along Highway 1 for a rapid bus service connecting the Township of Langley to the SkyTrain line to the west.
- Each community or neighbourhood is planned to contain Town or Community Centres meant to provide local residents with access to commercial services. Higher density residential or commercial development is typically proposed surrounding these centres. Higher density development is also typically planned near transit facilities to create a transit and pedestrian oriented area.

3. Model Refinement and Validation

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. This section provides a summary of the refinement and validation process for the macro-scopic model using the RTM followed by the micro-scopic model using Aimsun.

For more information regarding the process to prepare the macro-scopic and microscopic models for application, please refer to the memorandums below:

- *477242-01000 Macro-scopic_Base_Year_Model_Refinement and Validation*
- *477242-01000 Traffic_Operations_Micro-simulation_ Refinement and Validation*

3.1 Macro-scopic Model (RTM)

As part of the Carvolth Traffic Study, the regional transportation network in TransLink's Regional Transportation Model (RTM) Phase 3.2 was updated in the Carvolth study area for a more accurate regional representation of travel patterns. A series of adjustments were made to update and refine various components of TransLink's RTM. These include adjustments to the following:

- Trip generation factors;
- Trip distribution K factors;
- Time Slicing Factors; and
- Auto Traffic Demand.

Following model refinement, the resultant comparisons of model data to observed data, which includes bar charts for visual comparisons, is provided below for link volumes and travel times.

Link Volumes

Modelled peak hour auto link volumes are compared to the observed data for all locations where traffic counts are available. *Figure 3.1* is a scatterplot comparing screenline model volumes and observed volumes for the three modelled peak hours. Also shown are the statistics for the best fit lines. *Table 3.1* is the same comparison of model volumes and observed volumes, with additional statistics such as percentage differences, GEH, and % Root Mean Square Error (RMSE).

The GEH Statistic avoids some pitfalls that occur when using simple percentages to compare two sets of volumes. This is because the traffic volumes in real-world transportation systems vary over a wide range. For example, the mainline of a freeway/motorway might carry 5,000 vehicles per hour, while one of the on-ramps leading to the freeway might carry only 50 vehicles per hour (in that situation it would not be possible to select a single percentage of variation that is acceptable for both volumes). The GEH statistic reduces this problem; because the GEH statistic is non-linear, a single acceptance threshold based on GEH can be used over a fairly wide range of traffic volumes.

RMSE is a measure of how concentrated the data is around the line of best fit. The closer the RMSE is to 1.0, the better the model reflects observed conditions.

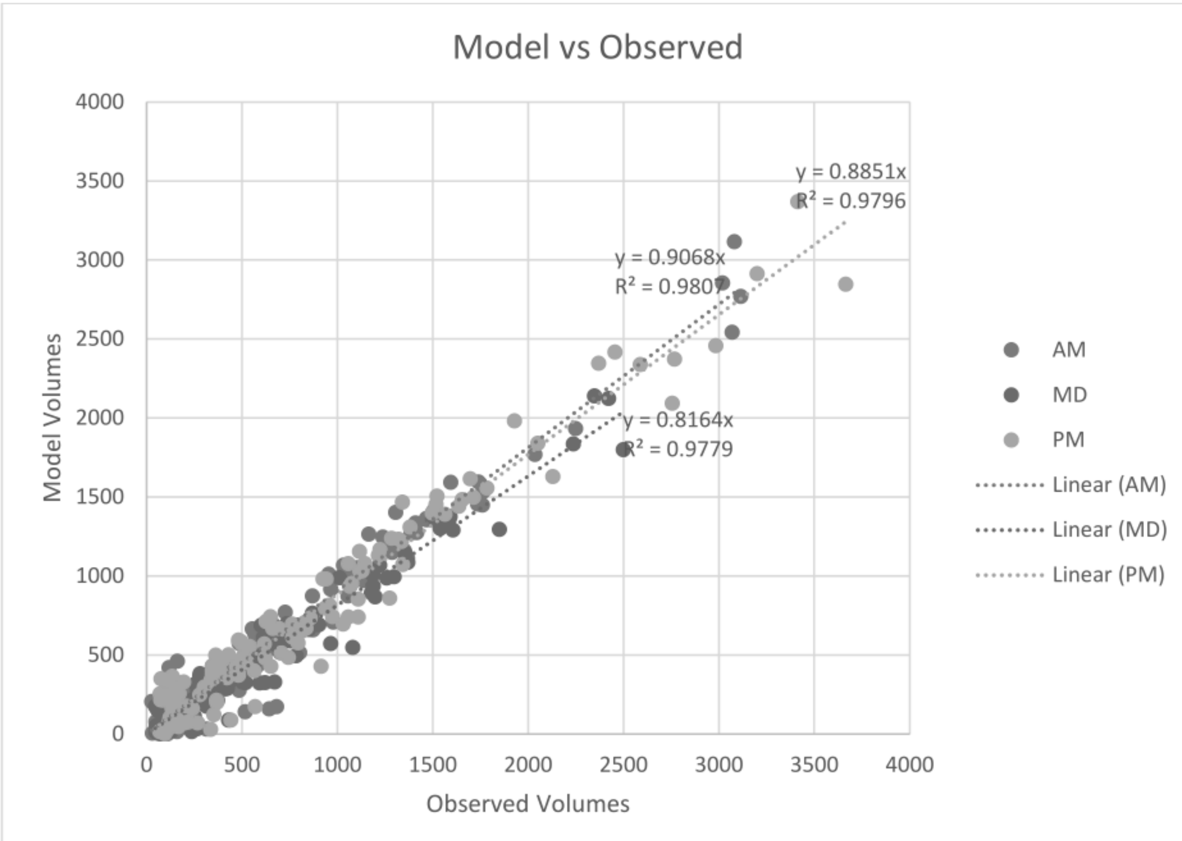


Figure 3.1: Model vs. Observed Auto Link Volumes

Table 3.1: Model vs. Observed Auto Link Volumes

STATISTIC	AM	MD	PM
All Link GEH<5	60%	46%	54%
All Link GEH<7.5	76%	66%	65%
All Link GEH<10	89%	80%	77%
All Link <700 diff within 100	70%	70%	60%
All Link 700-2700 diff within 15%	78%	33%	70%
All Link >2700 diff within 400	75%	n/a	50%
R Square	0.96	0.95	0.96
Line of Best Fit tolerance	0.09	0.18	0.11
% RMSE	22%	30%	23%

After the model refinements, links with GEH above 10 were reduced from 41% to 11% in the AM peak hour, and from 45% to 23% in the PM peak hour. Discrepancies for overall total traffic for roads within the study area during all peak hours noted previously were reduced. R-Square improved from 0.89 to 0.96 in the AM peak hour, and from 0.90 to 0.96 in the PM peak hour.

Travel Times

Modelled peak hour auto travel times are compared to the Google Maps API travel times for a selection of key origins and destinations as follows:

- Highway 1 at Highway 15 / Highway 17 (1W);
- Highway 1 at 232 Street (1E);
- Walnut Grove Neighbourhood Centre (G); and
- Willoughby Town Centre (W).

The bar charts in *Figures 3.2* and *Figure 3.3* illustrate AM and PM peak hour model versus observed auto travel times on key corridors.

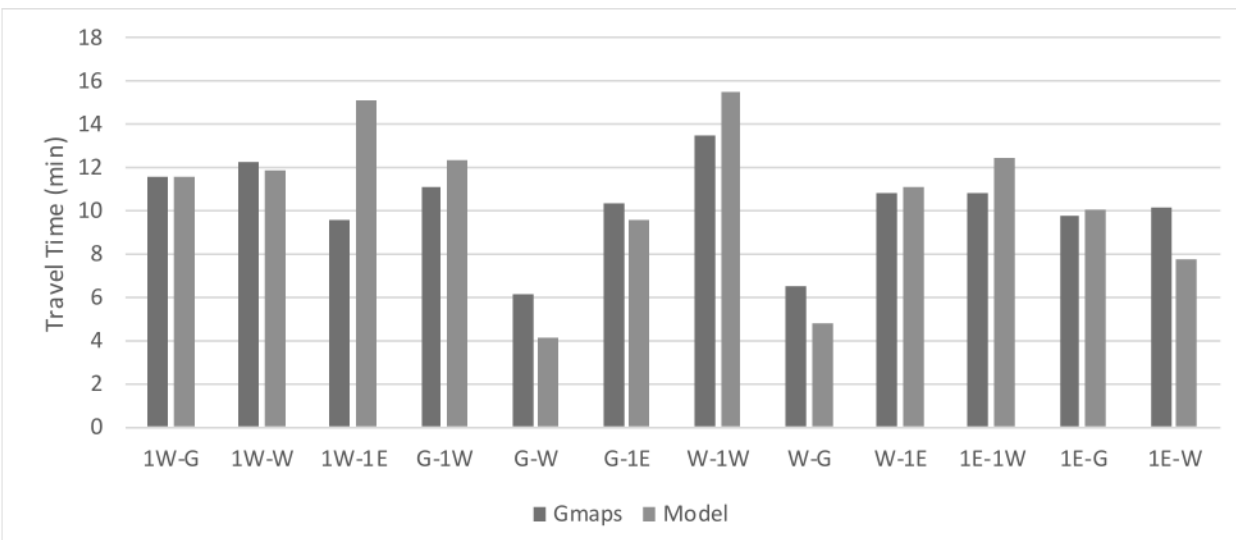


Figure 3.2: AM Peak Hour Model vs. Observed Travel Times on Key Origin-Destinations

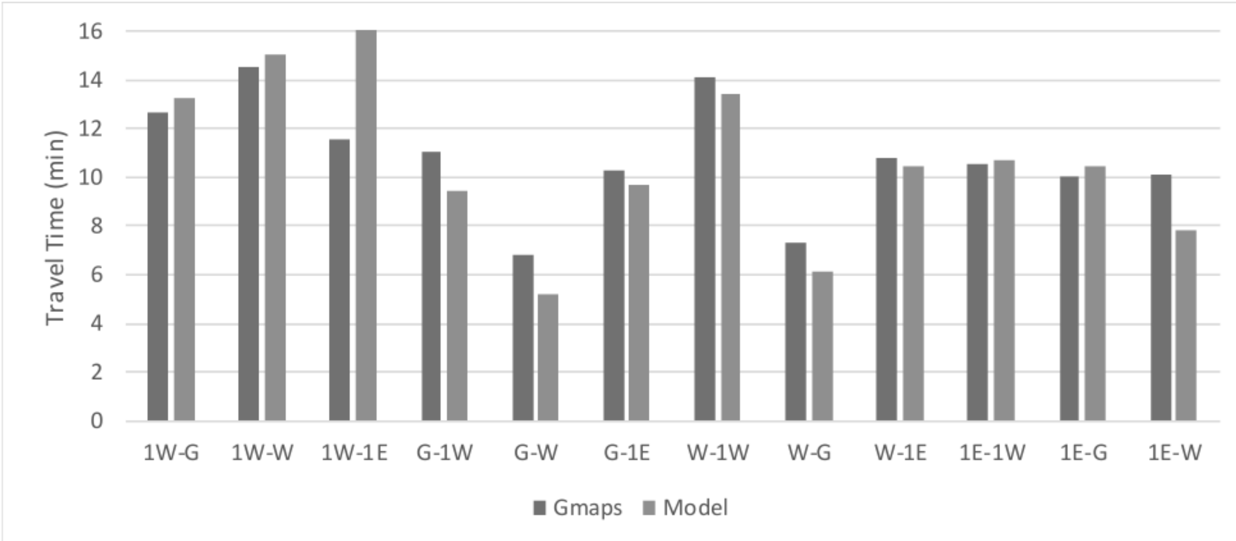


Figure 3.3: PM Peak Hour Model vs. Observed Travel Times on Key Origin-Destinations

In the AM peak hour, 67% of the key origins and destinations are within 20% differences. In the PM peak hour, 75% of the key origins and destinations are within 20% differences.

Based on current comparisons with the updated macro-scopic model, the model is fit-for-purpose and is ready for application.

3.2 Micro-scopic Model (Aimsun)

The second tool used for analysis is a traffic operations micro-simulation model (Aimsun). As part of the Carvolth Traffic Study, detailed analysis of traffic operations in the vicinity of the 200 Street interchange is required. The Aimsun model built for the study area 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 macro-level RTM for single occupant and high occupant (2+) passenger vehicles, light trucks, and heavy trucks;
- 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.
- 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.

Metrics were extracted based on the average of seven discrete micro-simulation model runs which were conducted to account for the impact of variability of vehicle arrival rates and volumes. In each run, the vehicle release rate and travel demand are varied slightly.

Three key metrics for the micro-simulation model were compared to observed data following adjustments to the model:

- Turning movement volumes;
- Route travel time for ten routes traversing 200 Street and 202 Street; and
- Qualitive link congestion comparison to Google Maps Traffic.

Turning Movement Volumes

In *Figure 3.4* and *Figure 3.5*, the modelled and observed vehicle volumes are shown graphically for the AM and PM peak period hours with each blue dot indicating volume data with the horizontal axis measuring observed volume and the vertical axis measuring modelled volume. As shown, there is a good fit between the observed and modelled datasets as evidenced by the R-Square value of 0.96 in the AM and 0.97 in the PM (whereby a R-Square of 1.00 indicates a perfect fit). There are some variations in the observed data which are to be expected as real-world volumes were sourced from multiple collection methodologies (signal downloads, manual counts, loop counts) and there are temporal and seasonal fluctuations which induce imbalances when comparing adjacent intersections.

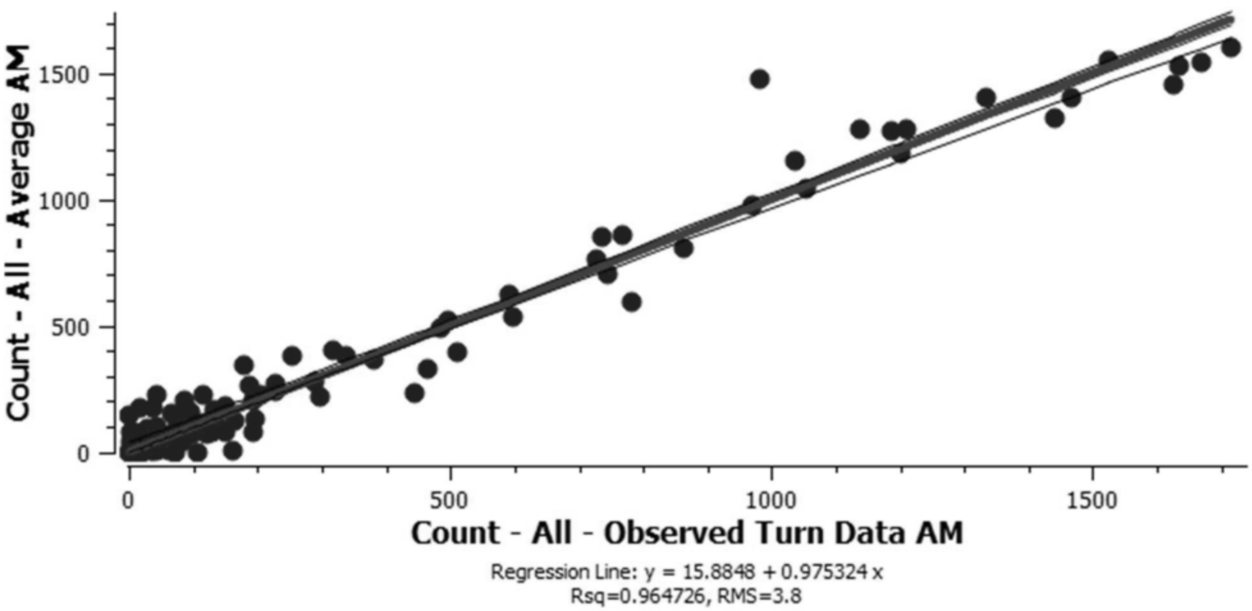


Figure 3.4: AM Peak Period Turning Movement R-Square Plot

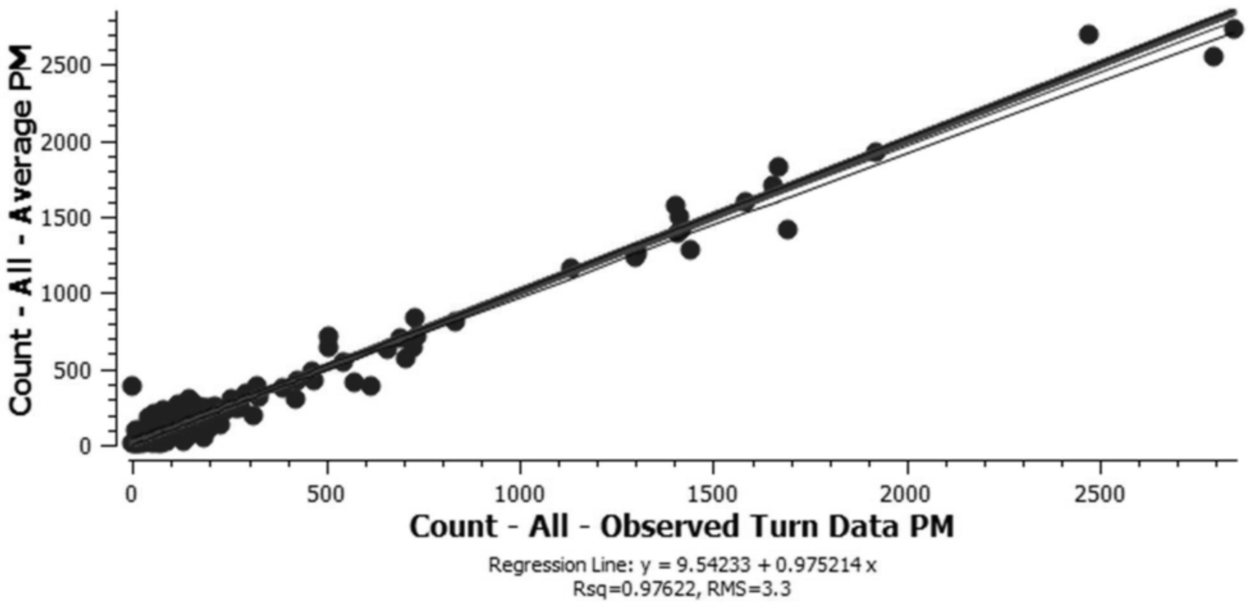


Figure 3.5: PM Peak Period Turning Movement R-Square Plot

Route Travel Time

Ten travel time routes were established to compare model travel times to observed travel times. Observed travel times were extracted from the Google Maps API for the AM and PM peak periods. The ten routes for comparison are as follows:

1. NB 200th Street from 84 Avenue to 92a Ave;
2. SB 200th Street from 92a Avenue to 84 Ave;
3. EB 88 Avenue E from 200 Street to 202 St;
4. WB 88 Avenue E from 200 Street to 202 St;
5. NB 202 Street from 86 Avenue to 91a Ave;
6. SB 202 Street from 86 Avenue to 91a Ave;
7. WB Hwy 1 Off-ramp to 92a Ave;
8. EB Hwy 1 Off-ramp to 84 Ave;
9. WB Hwy 1 Off-ramp to 84 Ave; and
10. EB Hwy 1 Off-ramp to 92a Ave.

A comparison of the modelled and observed travel times for the ten routes is shown in *Figure 3.6* and *Figure 3.7* below for the AM and PM peak hours, respectively. As indicated by the graphic, model travel times are close to observed travel times for both AM and PM peak periods.

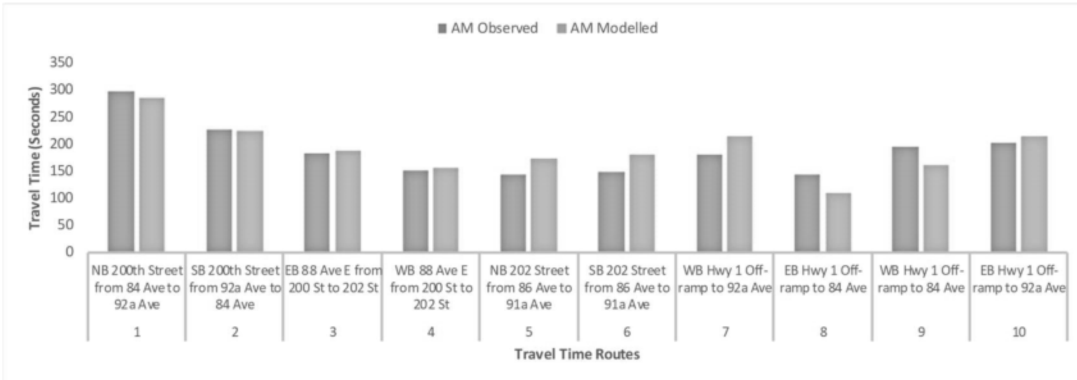


Figure 3.6: AM Peak Period Route Travel Time Comparison

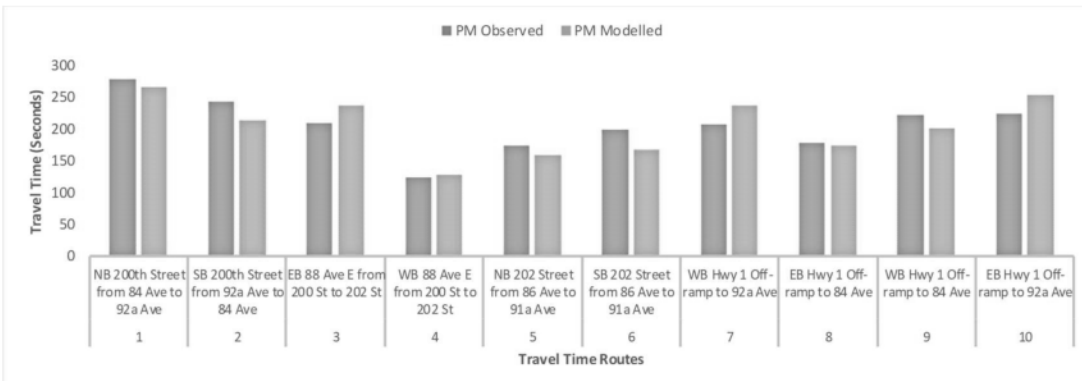


Figure 3.7: PM Peak Period Route Travel Time Comparison

Qualitative Comparison of Congestion

A comparison of the general traffic congestion between Google Maps Traffic conditions and the Aimsun model during the peak AM and PM peak hours is provided in *Figure 3.8* below. Dark red links indicate high delays above free-flow travel time while green links indicate minimal delays with travel speeds close to free-flow conditions. As shown, links with high traffic congestion such as northbound on 200 Street at the single-point interchange and the westbound off-ramp from Highway 1 have similar relative levels of congestion between the observed Google Maps traffic and the micro-simulation model.

It should be noted that construction downstream at the future 216 Street interchange was shown to affect Highway 1 operations, particularly in the eastbound direction. Therefore, while Google Maps traffic indicates significant congestion along eastbound Highway 1, this congestion was not as pronounced prior to construction activities related to the 216 Street interchange beginning.

Period	Google Maps Traffic	Aimsun Color-coded Link Delays
AM		
PM		

Figure 3.8: Qualitative Traffic Congestion Comparison

The existing conditions traffic model replicates most of the observed traffic patterns and behaviour. The process has verified turning movement count volumes, route travel times, and observed traffic congestion from Google Maps and a site visit. Based on the above data presented in this section, the traffic operations micro-simulation model is fit-for-purpose to conduct a traffic operations assessment of the study area and is ready for application.

4. Network Characteristics

This section describes the land use, trip generation, and transportation network characteristics including the physical and operational changes within the study area for each base horizon year (2016, 2035, and 2050).

4.1 Land Use

The land use assumptions in the study area are primarily based on the input provided by the Township of Langley to Metro Vancouver and TransLink regarding anticipated future development in this area. These assumptions are based on overall regional demographics / employment totals and therefore do not immediately account for specific development proposals. As part of this study, the Township of Langley has provided additional information related to residential and commercial increases above OCP/CP/NP density, which includes active applications and amendments (RO's) pre-building permit. The land use assumptions were revised accordingly based on this additional information.

The zones that constitute the study area are shown in *Figure 4.1*. The population and employment for these zones for the 2016 base year, the 2035 and the 2050 forecasting horizon are shown in *Figure 4.2* and *Figure 4.3*. Population within the study area increases from 43,500 to 80,200 to 102,900. Employment within the study area increases from 19,900 to 30,000 to 37,900. The combined growth is 74% from 2016 to 2035, and 48% from 2035 to 2050.

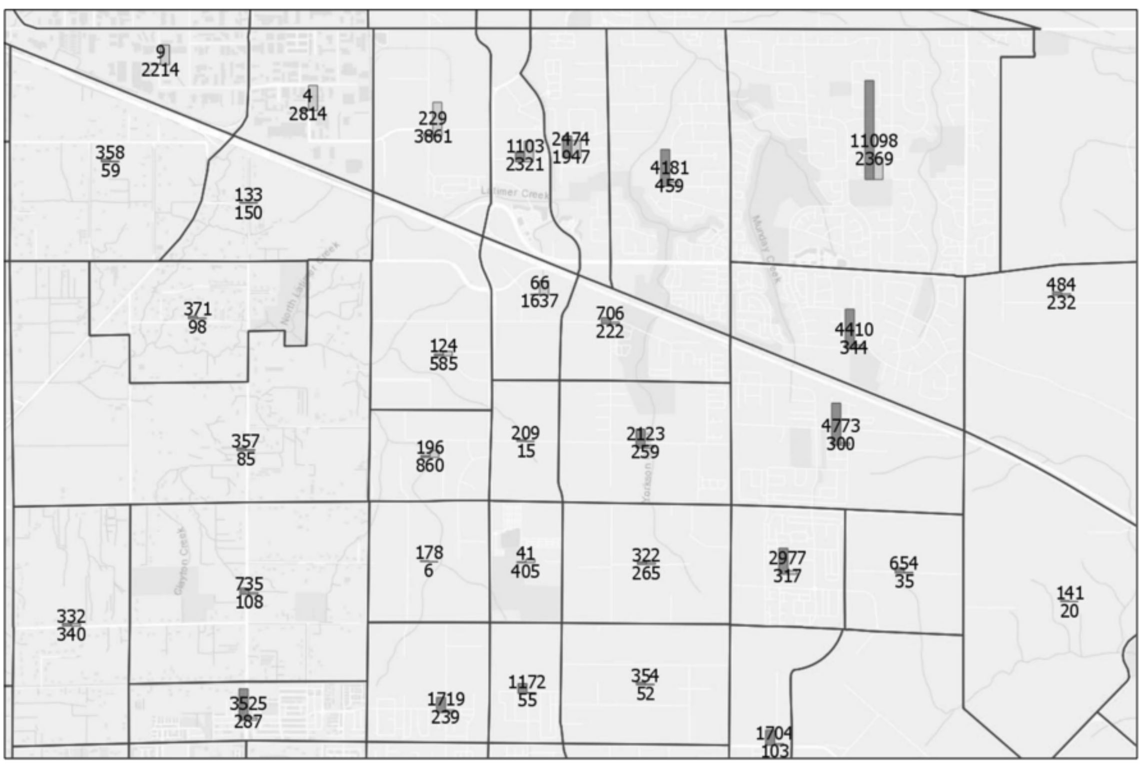


Figure 4.1: 2016 Population and Employment

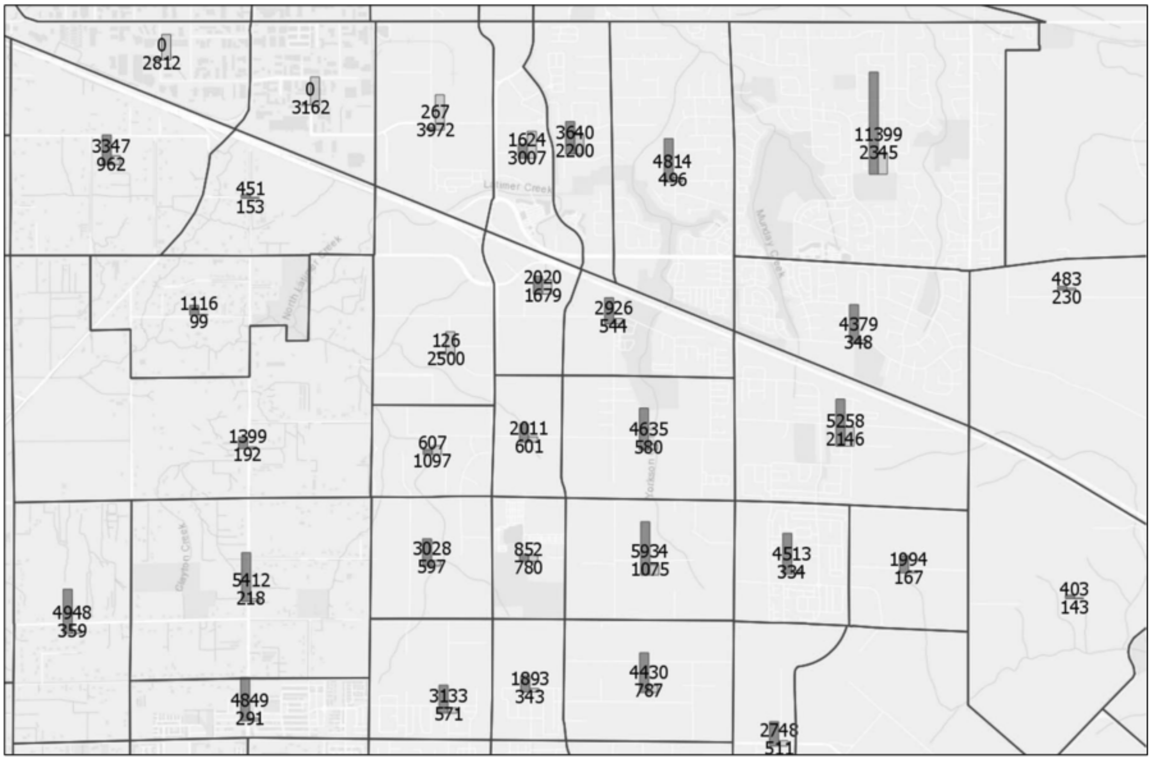


Figure 4.2: 2035 Population and Employment

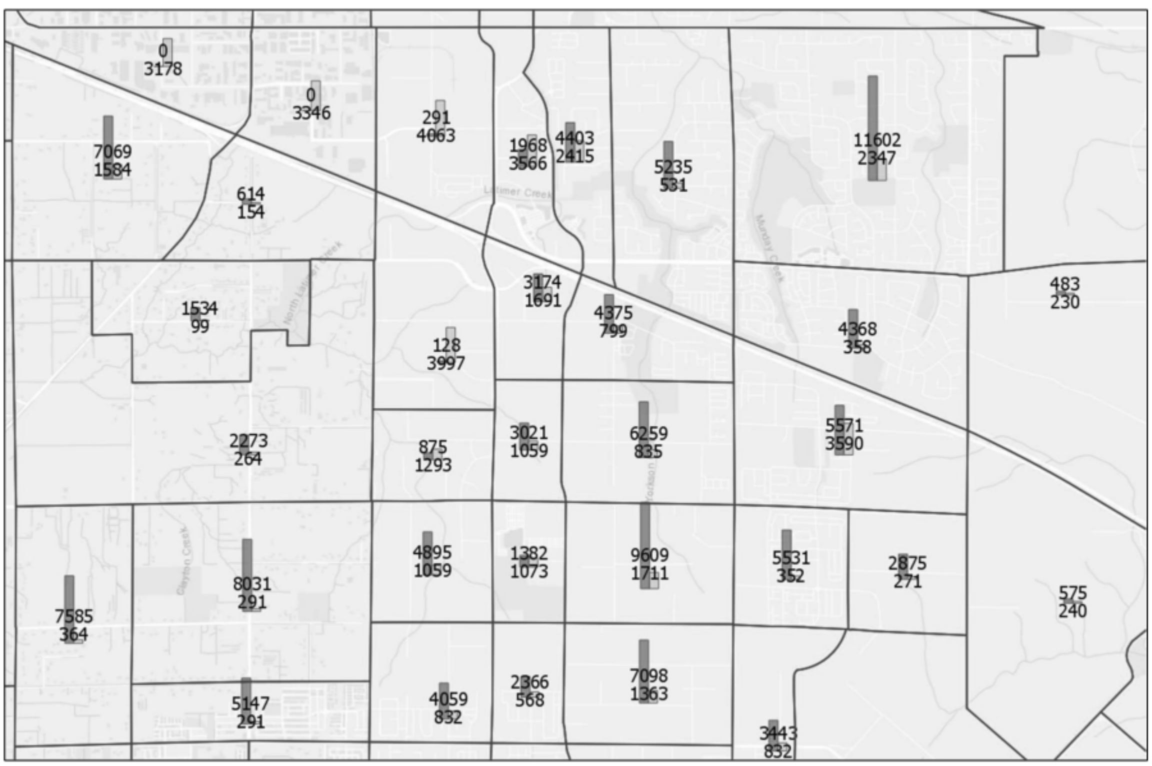


Figure 4.3: 2050 Population and Employment

4.2 Trip Generation

Trip generation derived travel demands were initially sourced from the RTM and are based on the land use assumptions discussed in the above section. The resultant daily person-trip generation for 26 traffic zones within North Langley are illustrated in *Figure 4.4* for each horizon year. The number of daily person trips generated is forecast to increase by 53% between 2016 and 2035. It is forecast to increase by another 37% between 2035 and 2050. Note that at the restricted covenants adjacent to the 200 Street interchange, it was assumed that the covenant trip generation would reach its maximum allowable limit by the 2035 horizon year. A summary of the maximum covenant trip generation is provided in *Figure 4.5* below.

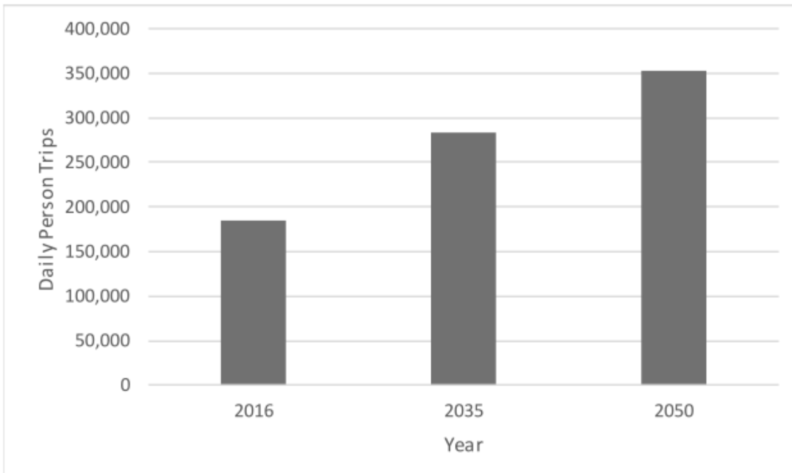


Figure 4.4: Trip Generation Summary

Figure 4.5: Covenant Two-Way Trip Generation Limit (Source: 2001 Bunt & Associates Report)

As part of the refinement process, it was noted that the RTM land-use does not explicitly account for the full build-out of the restricted covenants. Therefore, to reconcile these differences, several approaches were investigated with feedback from both Township of Langley and BC MoTI. The preferred approach involved estimating the employment for each restricted covenant as a percentage of the larger RTM traffic analysis zone (TAZ). Subsequently, employment quantities were back calculated using the marginal trip rate from the restricted covenant trip generation maximum allowable limits and were substituted back into the RTM. The process led to a net increase to employment for these zones as it was determined that the RTM under-estimated the trip generation for specific covenant parcels (at the maximum prescribed trip generation limit). This resulted in trip generation for the regional model that accounts for the maximum trip generation prescribed by the restricted covenant documents.

After these modifications were incorporated for the 26 traffic zones within North Langley, the number of daily person trips generated is forecast to increase by 57% between 2016 and 2035 as illustrated in *Figure 4.6*. It is forecast to increase by another 37% between 2035 and 2050.

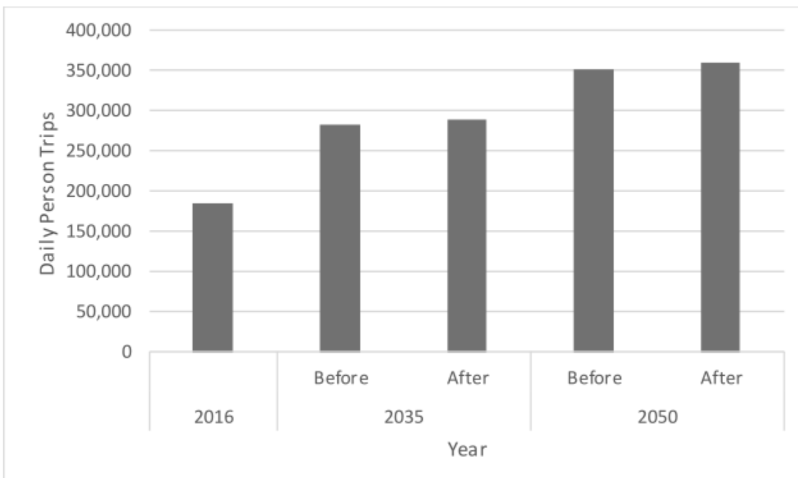


Figure 4.6: Trip Generation Summary

Travel demands generated at the macro-scopic level using the RTM were imported into the micro-simulation model (Aimsun) by coding in a more refined zone system (inbound and outbound connecters) representative of the more granular road network within the 200 Street interchange lands. For each restricted covenant parcel, a discrete zone was coded to directly control the number of vehicle trips to be generated. As such, the micro-simulation model is able to yield the exact number of vehicles permitted for a specific scenario which allows for detailed analysis of traffic operations at the intersection level.

4.3 Transportation Network Characteristics

Numerous improvements to the existing and future base transportation networks were incorporated after an extensive literature review of potential projects (as summarized in Section 2) and a workshop process with Township of Langley and BC MoTI.

The existing conditions (2016) base transportation network was updated to include the Highway 1 / 216 Street interchange project currently under construction and scheduled to open in late 2020. The main scope of the project is to construct a new full movement, four-lane interchange at 216 Street with left turn lanes that will provide access onto eastbound and westbound Highway 1. Although, the interchange is not physically built in 2016, it is important that the improvement is included in the 2016 existing conditions to facilitate direct comparisons of network performance of existing and future networks. *Figure 4.7* presents a sample of the difference in model traffic volumes during the PM peak hour with the interchange built.

Figure 4.7: Model PM Peak Hour Traffic Volume Difference – with and without 216 Street Interchange

Prior to assessing the performance of the future 2035 and 2050 base transportation networks, a list of road and transit network improvements was generated to outline the scope and approximate timeframe for implementation for each improvement. A workshop was held with both Township of Langley and BC MoTI to generate a list of potential improvements. Subsequently, an iterative procedure to refine the future improvements was undertaken with both the Township of Langley and BC MoTI providing feedback on the type and approximate year of implementation. The refined list of road and transit network improvements for each horizon year are provided in *Table 4.1* and *Table 4.2*, respectively. These potential improvements were incorporated into both the macro-scopic and micro-scopic models (where applicable within the analysis area) for their respective horizon years.

Table 4.1: Potential Road Network Improvements

ID	IMPROVEMENT DESCRIPTION	FROM	TO	ON	JURISDICTION	2035	2050
1	Highway 1 6-Lane Widening to 248 St, New 232 Street IC	216 St	248 St	Hwy 1	BC MOTI	X	X
2	Highway 1 6-Lane Widening to 248 Street to 264 St, New 264 Street IC (2+1)	248 St	264 St	Hwy 1	BC MOTI		X
3	Highway 1 6-Lane Widening 264 Street to Mt Lehman	264 St	Mt Lehman	Hwy 1	BC MOTI		X
4	Extend 196 Street to 88 Ave	72 Ave	88 Ave	196 St	TOL		X
5	Extend 198A Street to 88 Ave	86 Ave	88 Ave	198A St	TOL	X	X
6	Widen 80 Avenue to a 4-lane cross section	200 St	216 St	80 Ave	TOL	X	X
7	Widen 80 Avenue to a 4-lane cross section	196 St	200 St	80 Ave	TOL		X
8	Provide a 4-lane cross section on 202 St	72 Ave	86 Ave	202 St	TOL	X	X
9	Provide a 4-lane cross section on 202 Street	86 Ave	88 Ave	202 St	BC MOTI		
10	Provide a 2-lane cross section on 201 St	N/A	N/A	201 St	TOL	X	X
11	Widen 88 Avenue (west) to a 4-lane cross section	196 St	200 St	88 Ave	TOL	X	X
12	Extend 202 Street from 80 Avenue to 86 Ave	80 Ave	86 Ave	202 St	TOL	X	X
13	Extend and realign 212 Street from 208 Street to 80 Ave	208 St	80 Ave	212 St	TOL	X	X
14	Widen 200 Street to incorporate a median or side-running bus only lanes, 4 general purpose lanes, bicycle lanes, and multi-use greenways from 86 Avenue to Willowbrook Drive	86 Ave	Willowbrook Drive	200 St	TOL		X
15	Extend 206 Street south from 80 Avenue to 72 Ave	80 Ave	72 Ave	206 St	TOL		X
16	Extend 76 Avenue from 208 Street to 196 Ave	208 St	196 Ave	76 Ave	TOL	X	X
17	Realign / Widen 80 Avenue to 212 Street from 216 Street to along 212 Street (T-intersection)	216 St	212 St	80 Ave	TOL	X	X
18	Extend 214 Street from 81a Avenue to 76 Ave	81a Ave	76 Ave	214 St	TOL	X	X
19	Extend / Widen 78 Avenue from 216 Street to 212 St	216 St	212 St	78 Ave	TOL	X	X
20	Extend / realign 212 Street to 74b Ave	74b Ave	212 St	212 St	TOL	X	X
21	Expand 208 Street from 80 Avenue to 72 Ave	80 Ave	72 Ave	208 St	TOL	X	X
22	4L widening 208 St	84 Ave	64 Ave	208 St	TOL	X	X
23	Full movement I/C at 192 Street I/C	192 St	N/A	Hwy 1	BC MOTI		X
24	4L widening 216 Street at 74 Ave	76 Ave	88 Ave	216 St	TOL	X	X
25	4L widening 216 Street at Glover Rd	Glover Rd	96 Ave	216 St	TOL		X
26	Second WB lane on Glover Rd	216 St	64 Ave	Glover Rd	BC MOTI		X

Table 4.2: Potential Transit Network Improvements

ID	IMPROVEMENT DESCRIPTION	ROUTE NUMBER	FROM/TO	FROM/TO	VIA	2035	2050
1	Implement new B-Line from Langley to Pitt Meadows via 200 St, with connections to Coquitlam via Lougheed	TBD	Langley	Pitt Meadows	200 St	X	X
2	Implement new rapid transit system from Surrey City Centre to Fleetwood via Fraser Highway	TBD	Surrey City Centre	Langley City Centre	Fraser Hwy	X	X
3	Implement new rapid transit system from Fleetwood to Langley City Centre via Fraser Highway	TBD	Surrey City Centre	Langley City Centre	Fraser Hwy	X	X
4	Extend hours of service for the 595 bus line from Langley Centre to Maple Meadows Station	595	Langley Centre	Maple Meadows Centre	200 St	X	X
5	Extend hours of service/reduce wait times for the 342 bus line from Newton Exchange to Langley Centre	342	Newton Exchange	Langley Centre	Hwy 10	X	X
6	Extend hours of service/reduce wait times for the 364 bus line from Scottsdale Exchange to Langley Centre via 64 Ave	364	Scottsdale Exchange	Langley Centre	64 Ave	X	X
7	Extend hours of service for the 560/561 (C60) bus lines from Langley Centre to Langley Hospital	560/561 (C60)	Langley Centre	Langley Hospital	200 St, 48 Ave	X	X
8	Reduce wait times for the 501 bus line from Surrey Central Station to Langley Centre	501	Surrey Central Station	Langley Centre	200 St, 96 Ave	X	X
9	Extend hours of service for the 388 bus line from 22nd Street Station to Walnut Grove	388	22nd Street Station	Walnut Grove	96 Ave	X	X
10	Extend hours of service for the 531 bus line from White Rock to Willowbrook	531	White Rock	Willowbrook	200 St, 24 Ave	X	X
11	Reduce wait times/overcrowding for the 555 bus line from Lougheed Station to Carvolth Exchange via Highway 1	555	Lougheed Station	Carvolth Exchange	Hwy 1	X	X

5. Assessment Criteria

This section provides the framework that is used to evaluate the different land use and transportation network scenarios using the macro-scopic and micro-scopic models. A detailed discussion on metrics used as part of the evaluation process can be found in the document titled "*477242_01000 - Performance Metrics and Evaluation Framework*". The framework outlines the quantitative measures of performance selected based on the modelling tool used, the methodology used to obtain these performance metrics, and other evaluation criteria developed from key stakeholder objectives contained in relevant community plans and engineering documents.

To quantify the operating performance of the study area, two sets of performance metrics are established based on the level of detail capable by each evaluation software, one for macroscopic analysis using the refined Regional Traffic Model (RTM) and another for micro-simulation traffic operations analysis performed through Aimsun. The resultant key performance metrics and range of values adopted are summarized in *Table 5.1* below.

Table 5.1: Summary of Evaluation Framework

EVALUATION TOOL	PERFORMANCE METRICS	VALUE RANGE	MEASUREMENT METHODOLOGY
RTM (Emme)	Network Travel Distance (VKT / PKT)	N/A	Direct output from RTM
	Network Travel Time (VHT / PHT)	N/A	Direct output from RTM
	V/C Ratio	Good: >0 to <=0.85 Congested:>0.85 to <= 1.00 Over-capacity: >1.00	Direct output from RTM
	Roadway Usage	N/A	Direct output from RTM
Micro-simulation Model (Aimsun)	Network Travel Time (VHT) / Network Travel Distance (VKT)	N/A	Direct output from Aimsun
	Total Delay	N/A	Direct output from Aimsun
	Level of Service	Relative to Base Conditions however LOS exceeding "E" typically not desirable	Based on total delay and HCM 2010 guidelines
	Maximum Queue	N/A	Direct output from Aimsun
	Representative Route Travel Time	N/A	Direct output from Aimsun

Note: Additional metrics related to the micro-simulation modeling including processed volumes are summarized in Appendix B.

Table 5.2 below shows the Level of Service (LOS) ratings for both signalized and unsignalized intersections. While the same ratings, between "A" to "F", apply to both signalized and unsignalized intersections, the ratings have different delay thresholds depending on the intersection control type. Typically, LOS D or better indicates an acceptable level of operation, whereas LOS 'E" or "F" indicates unacceptable intersection operations although it is recognized that existing LOS for select existing intersections already exceeds these thresholds. For the purpose of this study in identifying the impacts of potential modifications to the restrictive covenant, LOS analysis will be applied to approach movements to each intersection of interest.

Table 5.2: Level of Service Ratings

LOS	TOTAL DELAY (SECONDS/VEHICLE)	
	SIGNALIZED INTERSECTION	UNSIGNALIZED INTERSECTION
A	≤10	≤10
B	>10 and ≤20	>10 and ≤15
C	>20 and ≤35	>15 and ≤25
D	>35 and <55	>25 and <35
E	>55 and <80	>35 and <50
F	>80	>50

6. Base Transportation Network Performance

This section summarizes the base transportation network performance for each horizon year at both the macro-scopic and micro-scopic analysis levels. The analysis focuses on the PM peak period as this is the period whereby the restricted covenant trip generation limits are in-effect. Outside of this period, there is no restriction to the trip generation at the covenant parcels in the 200 Street interchange lands. Quantitative metrics in-line with those identified in the evaluation framework are presented and qualitative observations are provided where applicable. Potential transportation networks improvements (as discussed in Section 4.3) are incorporated into each model for each applicable horizon year. The macro-level performance is presented first followed by micro-level performance for each of the three horizon years as detailed below:

1. 2016 Existing Base Conditions (Short Term);
2. 2035 Future Base Conditions (Medium Term); and
3. 2050 Future Base Conditions (Long Term).

6.1 2016 Existing Base (Short Term)

The following section summarizes the transportation network performance for the existing base case. The existing network includes all current road and transit improvements and assumes that the 216 interchange is completed. The travel demand at the 200 Street interchange restricted covenants are based on existing (2019) traffic count data.

Macro-Scopic Analysis

The macro-level analysis utilizes the refined RTM and focuses on the performance of the broader network bounded by 192 Street and 216 Street along Highway 1 and between 72 Avenue and 96 Avenue in the north-to-south direction.

Mode Share

The proportion of trips in the study area made by each of the following: single-occupancy vehicle (sov), high-occupancy vehicle (hov), bus, SkyTrain/Gondola (rail), West Coast Express (wce), walk, and bike, as modelled by the RTM, are reported for 2016. *Table 6.1* shows the proportion of trips that are produced by North Langley residents relative to the Township of Langley and the Regional totals. A comparison of mode share for each horizon year is provided in Appendix B for ease of comparison.

Table 6.1: 2016 Daily Mode Share from Origin

MODE	N LANGLEY	TOL	REGION
sov	48.2%	47.7%	41.3%
hov	38.7%	39.2%	34.3%
bus	2.0%	2.1%	5.2%
rail	0.3%	0.2%	5.6%
wce	0.1%	0.0%	0.2%
walk	9.8%	9.9%	11.7%
bike	1.0%	0.9%	1.7%
Total	100%	100%	100%

Observations

- The sustainable mode share in North Langley is in line with the Township of Langley.
- The sustainable mode share in North Langley is lower than regional average.

VKT & VHT

Network travel time and network travel distance is represented by Vehicle Hours Travelled (VHT) and Vehicle Kilometres Travelled (VKT). VHT and VKT are important metrics to measure the quality of service of a road network and is useful in comparing different model scenarios. Vehicle trips in the study area are further divided into the following vehicle classes: single-occupancy vehicle (SOV), high-occupancy vehicle (HOV), light goods vehicle (LGV), heavy goods vehicle (HGV), and transit vehicle (TRV), as modelled by the RTM, are reported for 2016 in *Table 6.2*. Future horizon year VKT and VHT will be compared to the 2016 base scenario.

Table 6.2: 2016 PM Network VKT and VHT

MEASURE	STUDY AREA	TOL	REGION
SOV KT	92,900	294,400	3,688,100
HOV KT	19,800	63,600	857,900
LGV KT	2,800	7,800	75,400
HGV KT	3,200	10,500	93,100
TRV KT	300	600	22,000
SOV HT	2,400	6,600	106,600
HOV HT	500	1,400	23,200
LGV HT	100	200	1,800
HGV HT	100	200	1,900
TRV HT	0	0	700

PKT & PHT

Passenger kilometres travelled (PKT) and passenger hours travelled (PHT) represent the distances and travel times that individual people travel. The total passenger kilometres travelled and hours travelled, as modelled by the RTM, are reported for 2016 in *Table 6.3*. Future horizon year PKT and PHT will be compared to the 2016 base scenario.

Table 6.3: 2016 PM Network PKT and PHT

MEASURE	STUDY AREA	TOL	REGION
PKT	2,000	4,600	939,800
PHT	100	200	34,700

Road Usage

The volume of traffic using each major road, as modelled by the RTM, are reported for 2016 with total Traffic Volume Plots presented in *Appendix C* for the PM peak hour.

Observations

- Peak direction on Highway 1 is eastbound in the PM peak hour.
- Highway 1 west of 200 Street has around 5,100 vph eastbound in the PM peak hour.
- Highway 1 east of 200 Street has around 4,100 vph eastbound in the PM peak hour.
- Other than Highway 1, 200 Street south of 88 Avenue W has the highest traffic volumes within the study area. This roadway has around 2,350 vph southbound in the PM peak hour.
- Among municipal roads, the peak direction is southbound and eastbound in the PM peak hour.

V/C Ratio

The volume-to-capacity (V/C) ratio for each major road during the PM peak hour, as modelled by the RTM, are reported for 2016. V/C Ratio Plots are presented in *Appendix D*. In addition, every major road within the study area with a V/C above 1.0 are reported in *Table 6.4* and *Table 6.5* below for highways and municipal roads, respectively. Please note that V/C ratios in the model are less reliable than other measures due to the relatively simplistic nature of the assumptions made to model road capacities.

Table 6.4: 2016 V/C Ratios – BC MoTI

ON		AT	V/C RATIO
			PM
Hwy 1	EB	200 St	1.16
Hwy 1	EB On-Ramp	200 St	1.14
200 St	SB	Hwy 1 SPUI	1.04

Table 6.5: 2016 V/C Ratios – Municipal

ON	DIR	APPROACHING	V/C RATIO
			PM
200 St	SB	72 Ave	1
202 St	SB	86 Ave	1.29
86 Ave	EB	202 St	1.04

Observations

- Six links were identified to have a V/C ratio exceeding 1.0 during the PM peak hour.
- As expected, V/C ratios are higher for the peak directions noted previously on Highway 1, as well as for municipal roads. The number of roadway links exhibiting a V/C over 1.0 are also higher for these directions.
- Highway 1 east of 200 Street has V/C ratios of around 1.1 eastbound in the PM peak hour.
- For municipal roads, in general, the north-south directions are more congested than the east-west directions.

Micro-Scopic Analysis

The micro-level traffic analysis utilizes the calibrated Aimsun model and focuses on the performance of the 200 Street interchange and adjacent roadways such as 202 Street including the access points to the restricted covenants. Note that there is inherent variability in the results presented below due to the stochastic nature of the model seeds used to produce each individual scenario.

Network Statistics (VHT / VKT)

Network travel time represents the total travel time travelled during the PM peak period and is represented by Vehicle Hours Travelled (VHT). Network travel time is an important metric to measure the quality of service of the road network and is useful in comparing different model scenarios. The network travel time (VHT) and network travel distance (VKT), as modelled by Aimsun, are reported for 2016 in *Figure 6.1* and *Figure 6.2* for the PM peak period. Future network VHT and VKT at the micro-simulation level will be compared against the 2016 base.

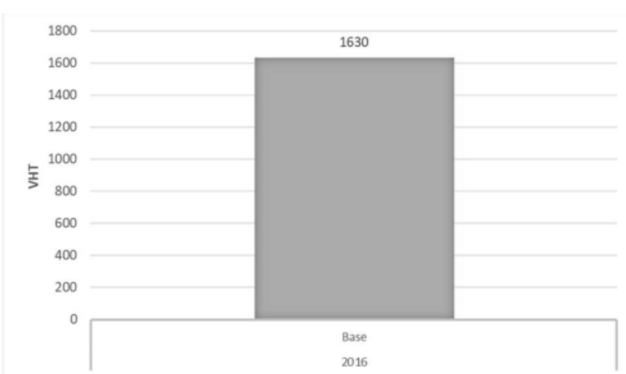


Figure 6.1: 2016 Network VHT

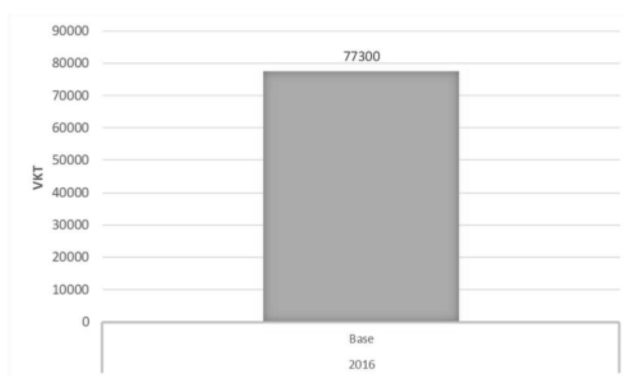


Figure 6.2: 2016 Network VKT

Intersection Performance (Delay / LOS)

The delay (seconds), Level of Services (LOS), and maximum queue (metres) for each lane group as modelled by Aimsun, are reported for the 2016 base scenario in *Table 6.6*. The delay experienced by a driver can be used to identify issues affecting the operating performance of a network. LOS represents the quality of service experienced by the driver, based on the delays experienced. Queues provide another measure of the relative congestion and can be induced by signal operations or when the traffic flow is higher than the roadway capacity. Future network intersection performance will be compared to the 2016 base.

Table 6.6: Intersection Approach Delay and Level of Service

INTERSECTION	DIRECTION	MOVEMENT	PM PEAK HOUR		
			DELAY (SEC)	LOS	MAX. QUEUE (M)
			PM		
200 Street and Hwy 1 Ramps	NB	T	61	E	261
	SB	T	15	B	104
	EB	L	96	F	157
	EB	R	12	B	185
	WB	L	53	D	81
	WB	R	97	F	105
200 Street and 88 Avenue E	NB	L	72	E	103
	NB	TR	15	B	147
	SB	L	61	E	47
	SB	TR	15	B	112
	EB	L	89	F	2
	EB	TR	93	F	31
	WB	LTR	51	D	85
200 Street and 88 Avenue W	NB	L	67	E	16
	NB	TR	33	C	176
	SB	L	58	E	134
	SB	TR	15	B	237
	EB	LTR	50	D	78
	WB	LTR	28	C	33
202nd Street and Route 1 HOV Ramps	NB	LTR	2	A	23
	SB	LTR	4	A	28
	EB	LTR	10	B	27
	WB	LTR	5	A	21
86 Avenue and 200 St	NB	LTR	23	C	146
	SB	LTR	23	C	160
	EB	LTR	42	D	70
	WB	LTR	34	C	97
86 Avenue and 201 St	NB	LTR	-	-	-
	SB	LTR	2	A	10

INTERSECTION	DIRECTION	MOVEMENT	PM PEAK HOUR		
			DELAY (SEC)	LOS	MAX. QUEUE (M)
			PM		
	EB	LTR	1	A	33
	WB	LTR	1	A	10
86 Avenue and 202 St	NB	LTR	-	-	-
	SB	LTR	21	C	65
	EB	LTR	18	C	75
	WB	LTR	8	A	46
88 Avenue E and 201 St	NB	LTR	-	-	-
	SB	LTR	35	C	65
	EB	LTR	2	A	34
	WB	LTR	3	A	41
88 Avenue E and 202 St	NB	LTR	40	D	46
	SB	LTR	36	D	126
	EB	LTR	37	D	88
	WB	LTR	15	A	14
88 Avenue E and NW Quadrant Access	NB	LR	5	A	29
	WB	TL	1	A	29
88 Avenue W and 201 St	NB	LTR	30	C	42
	SB	LTR	32	C	59
	EB	LTR	18	B	132

Observations

- As shown, the existing base case exhibits numerous turning movements with relatively poor levels of service and high delays, especially concentrated at the 200 Street interchange ramp terminals.
- 200 Street interchange EBL and the WBR off-ramp movements exhibits LOS F for the PM peak hour.
- Considerable delays and queues are noted for the NBT movement at the 200 Street interchange.
- 200 Street / 88 Avenue E EB approach exhibits LOS F; however, this is a low volume movement that only serves to provide access to the small development in the northwest quadrant of the 200 Street interchange.
- 200 Street / 88 Avenue W NBL and SBL movements operate at LOS E for the PM peak hour.
- The immediate access points adjoining the restricted covenants were shown to operate relatively well.

Route Travel Time

Travel time is a key metric in determining the level of congestion in a transportation network and is therefore another means of measuring traffic operations performance. Travel times were obtained for ten designated routes and are used to compare the effects of different travel demands on the road network. The route travel times as modelled by Aimsun, are reported for 2016 in *Figure 6.3*. Future network route travel times will be compared to the existing base.

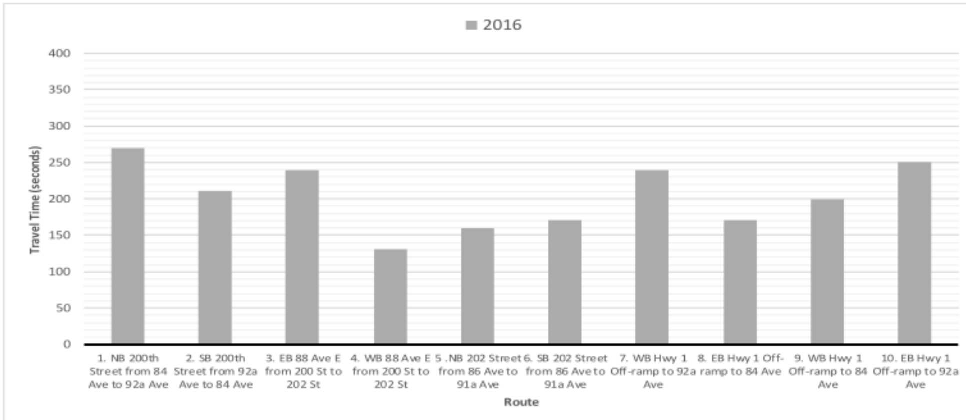


Figure 6.3: Existing Conditions Route Travel Times (seconds)

2016 Existing Base Key Findings

Based on the analysis conducted at the macro-scopic and microscopic levels, the following is a list of the key findings for the 2016 existing base scenario:

- The Single-Point-Urban-Interchange (SPUI) configuration of the 200 Street interchange exhibits significant congestion for the northbound direction and for the off-ramps adjoining Highway 1 during the PM peak period. In particular, the signalized intersections at the ramp terminals act as "bottlenecks" to the transportation system.
- It was observed in the model that a considerable amount of vehicles exiting Covenant Zone 1 (south west corner of the intersection at 88 Avenue E / 202 Street) wishing to travel northbound on 202 Street were forced to use the right-turn to southbound 202 Street and subsequently use the roundabout to turn-around and travel northbound. The single-lane roundabout configuration may lead to issues in the future with increased utilization of 202 Street.
- The intersection at 88 Street E / 200 Street was shown to have several movements operating at the LOS E and LOS F range including the NBL and SBL turning movements. In addition, egress from Covenant Zone 6 in the north-west quadrant uses the eastbound approach at the intersection of 88 Street E / 200 Street. It was noted that signalized green time given to this approach was low and often leads to only two or three vehicles able to proceed during an entire signal cycle.
- The eastbound off-ramp operations at the 200 Street interchange are poor in the PM peak hour. Queues were observed to extend for a significant length along the off-ramps.
- At the restricted covenant access points, minimal traffic operations issues were noted. This may due in part to the travel demands not being at the maximum restricted covenant trip generation limit.
- It was noted that demand from/to Covenant Zone 6 in the northwest quadrant of the 200 Street interchange is close to the maximum allowable two-way trip generation limit as prescribed by the restricted covenant trip generation limits. As a result, the traffic operations impact caused by this covenant is not expected to worsen in the future horizon years.

6.2 2035 Future Base (Medium Term)

The following section summarizes the transportation network performance for the 2035 horizon year future base case scenario. The future 2035 network includes the existing road and transit network with a completed 216 Street interchange and several key improvements including:

1. Highway 1 6-lane widening to 248 Street and a new 232 Street interchange;
2. Extension of 202 Street to a 4-lane cross section between 86 Avenue and 72 Avenue with a new signalized intersection connecting the existing 202 Street north of 86 Avenue with the widened roadway to the south;
3. Implementation of a new B-Line from Langley to Pitt Meadows via 200 Street, with connections to Coquitlam via Lougheed;
4. Implementation of a new rapid transit system from Surrey City Centre to Fleetwood via Fraser Highway; and
5. Implementation of a new rapid transit system from Fleetwood to Langley City Centre via Fraser Highway.

A full list of road and transit network improvements for the 2035 horizon year can be found in the above Section 4.3. Travel demand in the 2035 horizon year is substantially greater than 2016 and is spurred by an increase to population within the study area of approximately 74% from 2016 to 2035. In addition, the restricted covenants have reached their maximum trip generation limits thereby leading to additional travel demands within the 200 Street interchange lands.

Macro-Scopic Analysis

The macro-level analysis utilizes the refined RTM and focuses on the performance of the broader network bound by 192 Street and 216 Street along Highway 1 and between 72 Avenue and 96 Avenue in the north-to-south direction.

Mode Share

The proportion of trips in the study area made by each of: single-occupancy vehicle (sov), high-occupancy vehicle (hov), bus, SkyTrain/Gondola (rail), West Coast Express (wce), walk, and bike, as modelled by the RTM, are reported for 2035. *Table 6.7* shows trips that are produced by residents in North Langley. For North Langley, a consolidated set of model results across all three horizon years to facilitate comparison is included in *Appendix B*.

Table 6.7: 2035 Daily Mode Share from Origin

MODE	N LANGLEY	TOL	REGION
sov	45.6%	45.0%	38.8%
hov	38.9%	39.2%	33.6%
bus	2.4%	2.3%	5.6%
rail	1.6%	2.1%	7.5%
wce	0.1%	0.0%	0.2%
walk	10.1%	10.2%	12.4%
bike	1.3%	1.2%	1.9%
Total	100%	100%	100%

Observations

- In 2035, the sustainable mode share in North Langley is in line with the Township of Langley.
- In 2035, the sustainable mode share in North Langley is lower than the regional average.
- Increases in transit mode share in 2035 are likely related to the proposed Surrey Langley SkyTrain.
- Relative to 2016, the 2035 SOV mode share is lower by approximately 3% with transit and active modes increasing correspondingly.

VKT & VHT

The total vehicle kilometres travelled and hours travelled, as modelled by the RTM, are reported in 2035 in *Table 6.8*. For the study area, a consolidated set of model results across all three horizon years to facilitate comparison is included in *Appendix B*.

Table 6.8: 2035 Network VKT and VHT

MEASURE	STUDY AREA	TOL	REGION
SOV KT	124,900	380,500	4,454,800
HOV KT	29,900	87,200	1,085,900
LGV KT	3,300	9,300	89,800
HGV KT	4,200	14,000	131,600
TRV KT	400	900	29,400
SOV HT	4,200	10,300	140,600
HOV HT	800	2,200	32,100
LGV HT	100	200	2,400
HGV HT	100	300	2,900
TRV HT	0	0	1,100

Observations

- VKT within the study area increase by 37% (PM) from 2016 to 2035.
- VHT within the study area increase by 75% (PM) from 2016 to 2035.
- Higher VHT than VKT growth is spurred by increased trip making and suggests an increase in congestion levels from 2016 to 2035.

PKT & PHT

The total passenger kilometres travelled and hours travelled, as modelled by the RTM, are reported for 2035 in *Table 6.9*.

Table 6.9: 2035 Network PKT and PHT

MEASURE	STUDY AREA	TOL	REGION
PKT	5,600	15,100	1,586,000
PHT	300	700	57,000

Observations

- PKT within the study area increases by 176% (PM) from 2016 to 2035.
- PHT within the study area increases by 226% (PM) from 2016 to 2035.
- Higher PKT growth than combined population and employment growth suggests uptake in transit ridership.

Road Usage

The volume of traffic using each major road, as modelled by the RTM, are reported for each scenario with Total Traffic Volumes Plots presented in *Appendix C* for the PM peak hour.

Observations

- In 2016, Highway 1 west of 200 Street has around 5,100 vph eastbound in the PM peak hour. In 2035, these increase by 13.7% to 5,800 vph.
- In 2016, Highway 1 east of 200 Street has around 4,100 vph eastbound in the PM peak hour. In 2035, these increase by 6.1% to 4,350 vph.
- In 2016, 200 Street south of 88 Avenue W has around 2,350 vph southbound in the PM peak hour. In 2035, these increase by 14.9% to 2,700 vph.
- 202 Street and 201 Street extension south of 86 Avenue are both well utilized, and these north-south routes may draw traffic from 200 Street.

V/C Ratio

The volume-to-capacity (V/C) ratio for each major road during the PM peak hour, as modelled by the RTM, are reported for 2035. V/C Ratio Plots are presented in *Appendix D.* In addition, every major road within the study area with V/C above 1.0 are reported in *Table 6.10* and *Table 6.11*. Please note that V/C ratios in the model are less reliable than other measures due to the relatively simplistic nature of the assumptions made to model road capacities. A consolidated set of model results across all three horizon years to facilitate comparison is included in *Appendix B*.

Table 6.10: 2035 V/C Ratios – BC MOTI

ON	DIR	AT	V/C RATIO
Hwy 1	WB On-Ramp	192 St	1.05
Hwy 1	WB On-Ramp	200 St	1.05
Hwy 1	WB	216 St	1.17
Hwy 1	EB	200 St	1.23
Hwy 1	EB On-Ramp	200 St	1.00
Hwy 1	EB	216 St	1.24
192 St	SB	Hwy 1 EB Ramps	1.27
192 St	SB	Hwy 1 EB Ramps	1.27
192 St	SB	Hwy 1 EB Ramps	1.27
200 St	NB	Hwy 1 SPUI	1.03
202 St	SB	Hwy 1	1.14
202 St	NB	Hwy 1	1.39

Table 6.11: 2035 V/C Ratios – Municipal

ON	DIR	APPROACHING	V/C RATIO
192 St	SB	72 Ave	1.03
192 St	NB	94 Ave	1.08
194 St	NB	94 Ave	1.07
200 St	SB	72 Ave	1.01
202 St	SB	86 Ave	1.45
96 Ave	EB	200 St	1.01
96 Ave	EB	208 St	1.05
88 Ave	WB	192 St	1.15
88 Ave	EB	204 St	1.01
80 Ave	WB	192 St	1.06
72 Ave	WB	208 St	1.01

Observations

- 22 links were identified to have a V/C ratio exceeding 1.0.
- Highway 1 east of 200 Street has V/C ratios of 1.1 eastbound in the PM peak hour. In 2035, these V/C ratios increase to 1.2.
- Highway eastbound off-ramp has a V/C of 1.4 for the PM peak hour.
- 200 Street northbound at Highway 1 deteriorates and shows V/C ratios of in excess of 1.0.
- 202 Street between 86 Avenue and 88 Avenue E (north of the 202 Street extension) exhibits V/C ratios in excess of 1.0. The two-lane segment of 202 Street at Highway 1 operates poorly with high V/C ratios.

- For municipal roads, in general, the north-south directions are more congested than the east-west directions.

Micro-Scopic Analysis

The micro-level traffic analysis utilizes the calibrated Aimsun model and focuses on the performance of the 200 Street interchange and adjacent roadways such as 202 Street including the access points to the restricted covenants. Intersection signal timings within the network have been optimized for future travel demands where feasible.

Network Statistics - VHT / VKT

Network travel time represents the total travel time travelled during the peak hour and is represented by Vehicle Hours Travelled (VHT). Network travel time is an important metric to measure the quality of service of a road network and is useful in comparing different model scenarios. The network travel time (VHT) and network travel distance (VKT), as modelled by Aimsun, are reported for the PM peak period in *Figure 6.4 and Figure 6.5* for 2035 with comparison to 2016.

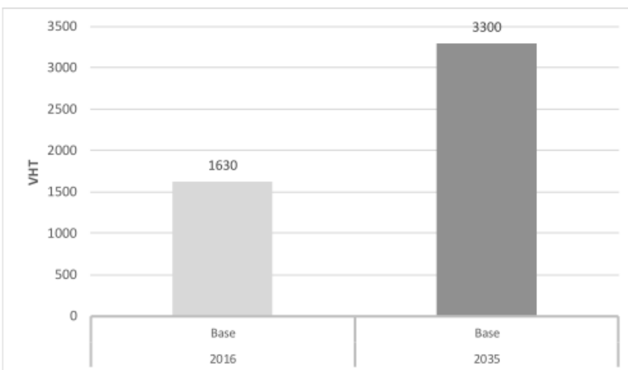


Figure 6.4: 2035 Network VHT

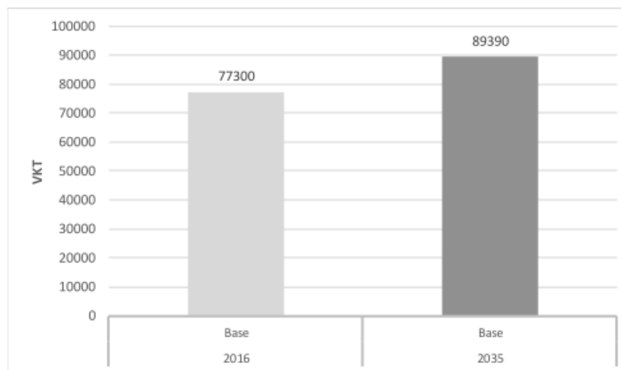


Figure 6.5: 2035 Network VKT

Observations

- A significant increase in VHT was observed for the 2035 scenario compared to the 2016 existing base representing a 200% increase.
- A moderate increase in VKT of approximately 15% was observed for the 2035 scenario compared to the 2016 existing base.

Intersection Performance (Delay / LOS / Queues)

The delay (seconds), Level of Services (LOS), and maximum queue (metres) for each lane group as modelled by Aimsun, are reported for the future base model for the 2035 horizon year with comparison to the 2016 base scenario in *Table 6.12*. The delay experienced by a driver can be used to identify issues affecting the operating performance of a network. LOS represents the quality of service experienced by the driver, based on the delays experienced. Queues provide another measure of the relative congestion and can be induced by signal operations or when the traffic flow is higher than the roadway capacity.

Table 6.12: Intersection Performance

INTERSECTION	DIRECTION	MOVEMENT	PM PEAK HOUR					
			DELAY (SEC)		LOS		MAX. QUEUE (M)	
			2016	2035	2016	2035	2016	2035
200 Street and Hwy 1 Ramps	NB	T	61	>100	E	F	261	330
	SB	T	15	25	B	C	104	131
	EB	L	96	>100	F	F	157	>500
	EB	R	12	>100	B	F	185	>500
	WB	L	53	68	D	E	81	138
	WB	R	97	>100	F	F	105	131
200 Street and 88 Avenue E	NB	L	72	80	E	F	103	110
	NB	TR	15	21	B	C	147	148
	SB	L	61	>100	E	F	47	61
	SB	TR	15	74	B	E	112	297
	EB	L	89	68	F	E	2	14
	EB	TR	93	>100	F	F	31	41
	WB	LTR	51	45	D	D	85	112
200 Street and 88 Avenue W	NB	L	67	55	E	E	16	58
	NB	TR	33	>100	C	F	176	233
	SB	L	58	58	E	E	134	111
	SB	TR	15	37	B	D	237	282
	EB	LTR	50	78	D	E	78	155
	WB	LTR	28	25	C	C	33	43
202nd Street and Route 1 HOV Ramps	NB	LTR	2	24	A	C	23	110
	SB	LTR	4	11	A	B	28	58
	EB	LTR	10	>100	B	F	27	220
	WB	LTR	5	33	A	C	21	47
86 Avenue and 200 St	NB	LTR	23	>100	C	F	146	376
	SB	LTR	23	30	C	C	160	193
	EB	LTR	42	>100	D	F	70	218
	WB	LTR	34	31	C	C	97	92
86 Avenue and 201 St	NB	LTR	-	30	-	D	0	13
	SB	LTR	2	99	A	F	0	109
	EB	LTR	1	21	A	C	33	137
	WB	LTR	1	18	A	C	0	139
86 Avenue and 202 St	NB	LTR	-	55	-	E	0	207
	SB	LTR	21	46	C	D	65	72
	EB	LTR	18	42	C	D	75	169
	WB	LTR	8	24	A	C	46	79
88 Avenue E and 201 St	NB	LTR	-	43	-	D	0	41

INTERSECTION	DIRECTION	MOVEMENT	PM PEAK HOUR					
			DELAY (SEC)		LOS		MAX. QUEUE (M)	
			2016	2035	2016	2035	2016	2035
	SB	LTR	35	68	C	E	65	75
	EB	LTR	2	19	A	B	34	74
	WB	LTR	3	14	A	B	41	96
88 Avenue E and 202 St	NB	LTR	40	46	D	D	46	46
	SB	LTR	36	61	D	E	126	152
	EB	LTR	37	>100	D	F	88	289
	WB	LTR	15	93	A	F	14	152
88 Avenue E and NW Quadrant Access	NB	LR	5	5	A	A	29	29
	WB	TL	1	1	A	A	29	34
88 Avenue W and 201 St	NB	LTR	30	42	C	D	42	58
	SB	LTR	32	95	C	F	59	94
	EB	LTR	18	28	B	C	132	131

Observations

- Traffic operations are poor for the 200 Street interchange with the EBL and WBR off-ramps exhibiting LOS F for the PM peak hour. Increases to demand cause the northbound approach to exhibit LOS F with queues extending through 88 Avenue W.
- 200 Street / 88 Avenue E EBL exhibits LOS E in the PM peak hour. The SBL and EBT/R also exhibit LOS F. The NBL operates at LOS F in the PM peak hour with queues extending out of the dedicated turn bay.
- Traffic congestion worsens significantly at 202 Street / 86 Avenue with the northbound approach exhibiting LOS F and metering traffic onto 202 Street. In addition, to the west at 201 Street / 86 Avenue, the additional traffic generated by the restricted covenants results in an increase to the southbound demand at this intersection with LOS F.
- 200 Street / 88 Avenue W northbound approach experiences LOS F while several other movements experience marked increases in delay.
- The eastbound approach to the 202 Street roundabout experiences LOS F in the PM peak hour.

Route Travel Time

Travel time is a key metric in determining the level of congestion in a transportation network and is therefore another means of measuring operations performance. Travel times were obtained for ten designated routes and are used to compare the effects of different travel demands on the road network. The route travel times as modelled by Aimsun, are reported for 2035 in *Figure 6.6* with a comparison to the 2016 existing base travel times.

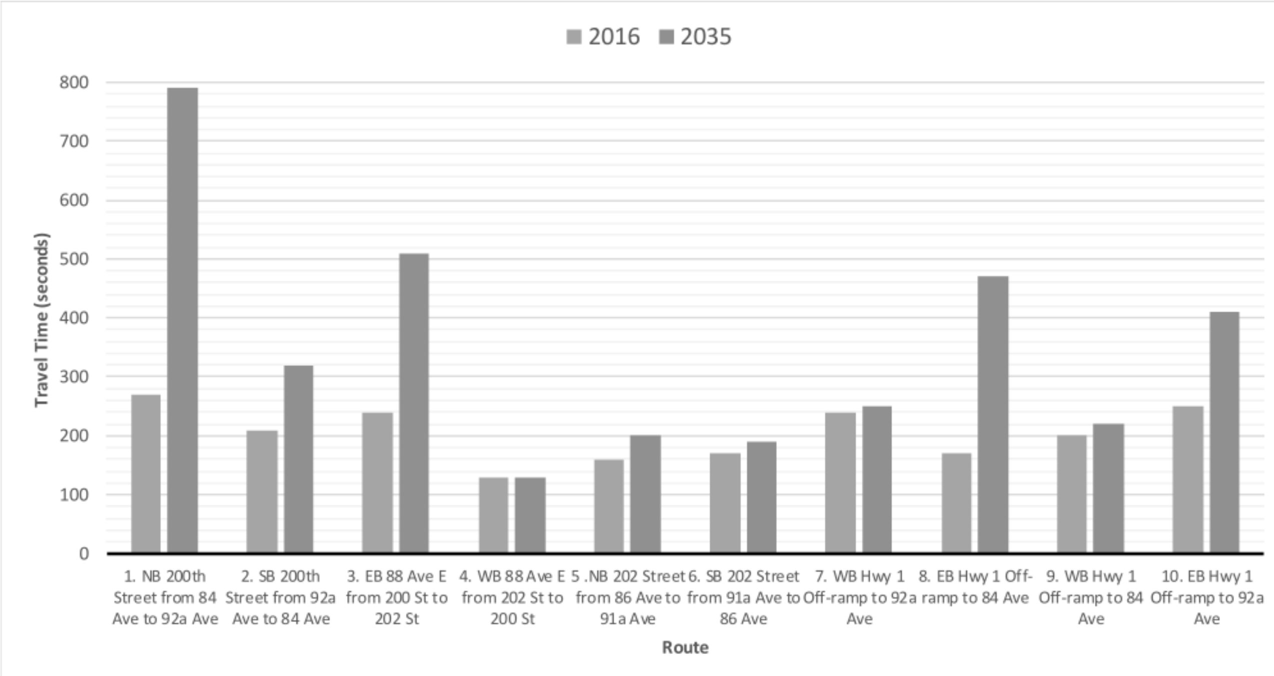


Figure 6.6: 2035 Route Travel Times (seconds)

Observations

- Significant increases to northbound travel times along 200 Street were observed. Sporadic gridlock of 200 Street leads to cascading congestion on feeder routes.
- Routes using the eastbound Highway 1 off-ramp also increase substantially compared to the existing base.

2035 Future Base (Medium Term) Key Findings

Based on the analysis conducted at the macro-scopic and microscopic levels, the following is a list of the key findings for the 2035 future base scenario:

- Population and employment growth in the intervening years between 2016 and 2035 leads to an increase in trip making (+57%) within the study area. As a result, total network travel time and travel distance are considerably higher than the existing base case.
- Auto (SOV) mode share is lower by approximately 3% relative to 2016 levels with transit and active mode share increasing correspondingly.
- 202 Street and 201 Street extension south of 86 Avenue are both well utilized. These new north-south routes may draw traffic from 200 Street but also add additional pressure on turning movements that access these roadways.
- Maximum covenant trip generation is assumed to have been achieved for the 2035 horizon year. As such, key access points to the covenant zones experience increases in delay including along 201 Street, 88 Avenue W, and 86 Avenue.

- At the north end of the 202 Street four lane extension between 86 Avenue to 72 Avenue, the roadway connects to the existing two-lane section of 202 Street running under Highway 1 and through a single lane roundabout. It was observed that the interface intersection at 202 Street / 86 Avenue experienced a significant increase to travel demand and acts as a “bottleneck” to through traffic.
- Similar to the existing base scenario, it was observed that a considerable amount of vehicles exiting Covenant Zone 1 (south west corner of the intersection at 88 Avenue E / 202 Street) wishing to travel northbound on 202 Street were forced to use the eastbound right-turn to turn southbound on 202 Street and subsequently use the roundabout to turn around and travel northbound. These turnaround trips interact with the additional traffic going to / coming from the 202 Street extension, south of 86 Avenue, causing additional congestion.
- The eastbound and westbound Highway 1 off-ramps at 200 Street were observed to operate worse than existing conditions. The growth in travel demands and buildout of the covenant zones lead to an increase in vehicles using the ramps. As such, queues were shown to extend along the length of the ramps with substantially higher delays and travel times. Blockage of the left-turn movements at the ramp terminals was observed.
- Full buildout of Covenant 4 in the south-east quadrant of the 200 Street interchange results in over 1,000 two-way vehicle trips during the PM peak period. This is a significant increase from existing travel demand and therefore 201 Street, south of 88 Avenue W was shown to operate poorly.
- Additional demand on 200 Street (especially northbound) and on 86 Avenue between 200 Street and 202 Street was observed to cause significant increases to delay.
- The eastbound approach to 88 Avenue W / 200 Street experiences a significant increase to delay partly caused by the buildout of the southwest quadrant of the 200 Street interchange restricted covenant.

6.3 2050 Future Base (Long Term)

The following section summarizes the transportation network performance for the 2050 horizon year future base case scenario. The future 2050 network includes the improvements identified in the previous 2035 horizon year as well as several key changes including:

1. Construction of a full-movement interchange at 192 Street at Highway 1;
2. Highway 1 6-Lane Widening from 248 Street to 264 Street, New 264 Street Interchange (2+1);
3. Highway 1 6-Lane Widening from 264 Street to Mt Lehman; and
4. Widening of 200 Street to incorporate median or side-running bus only lanes, 4 general purpose lanes, bicycle lanes, and multi-use greenways from 86 Avenue to Willowbrook Drive.

A full list of road and transit network improvements for the 2050 horizon year can be found in the above Section 4.3. Travel demand in the 2050 horizon year is substantially greater than 2016 and moderately higher than 2035 due to increases to population and employment within the study area. At the restricted covenants, the travel demand is similar to the 2035 horizon year and is assumed to have already reached its maximum trip generation limit.

Macro-Scopic Analysis

The macro-level analysis utilizes the refined RTM and focuses on the performance of the broader network bounded by 192 Street and 216 Street along Highway 1 and between 72 Avenue and 96 Avenue in the north-to-south direction.

Mode Share

The proportion of trips in the study area made by each of: single-occupancy vehicle (sov), high-occupancy vehicle (hov), bus, SkyTrain/Gondola (rail), West Coast Express (wce), walk, and bike are reported for 2050, as modelled by the RTM. *Table 6.13* shows trips that are produced by residents in North Langley. For North Langley, a consolidated set of model results across all three horizon years to facilitate comparison is included in *Appendix B*.

Table 6.13: 2050 Daily Mode Share from Origin

MODE	N LANGLEY	TOL	REGION
sov	44.9%	44.3%	38.3%
hov	38.8%	39.1%	33.4%
bus	2.5%	2.4%	5.5%
rail	1.7%	2.2%	7.7%
wce	0.1%	0.0%	0.2%
walk	10.4%	10.5%	12.8%
bike	1.7%	1.5%	2.0%
Total	100%	100%	100%

Observations

- In 2050, the sustainable mode share in North Langley is in line with the Township of Langley.
- In 2050, the sustainable mode share in North Langley is lower than regional average.
- Auto (SOV) mode share was shown to decrease marginally relative to 2035 with transit and active modes increasing in lieu.

VKT & VHT

The total vehicle kilometres travelled and hours travelled, as modelled by the RTM, are reported for 2050 in *Table 6.14*. For the study area, a consolidated set of model results across all three horizon years to facilitate comparison is included in *Appendix B*.

Table 6.14: 2050 Network VKT and VHT

MEASURE	STUDY AREA	TOL	REGION
SOV KT	145,600	416,500	4,839,700
HOV KT	41,500	103,800	1,200,400
LGV KT	3,700	10,200	98,200
HGV KT	4,800	16,000	149,000
TRV KT	400	900	30,700
SOV HT	5,500	12,200	164,900
HOV HT	1,200	2,500	37,800
LGV HT	100	300	2,800
HGV HT	200	400	3,600
TRV HT	0	0	1,200

Observations

- VKT within the study area increases by 37% (PM) from 2016 to 2035.
- VKT within the study area further increases by 28% (PM) from 2035 to 2050.
- VHT within the study area increase by 75% (PM) from 2016 to 2035.
- VHT within the study area further increases by 59% (PM) from 2035 to 2050.
- Higher VHT than VKT growth suggests increased congestion levels from 2016 to 2050.

PKT & PHT

The total passenger kilometres travelled and hours travelled, as modelled by the RTM, are reported for 2050 in *Table 6.15*. For the study area, a consolidated set of model results across all three horizon years to facilitate comparison is included in *Appendix B*.

Table 6.15: 2050 Network PKT and PHT

MEASURE	STUDY AREA	TOL	REGION
PKT	7,600	16,900	1,785,200
PHT	400	700	65,000

Observations

- PKT within the study area increases by 176% (PM) from 2016 to 2035.
- PKT within the study area further increases by 99% (PM) from 2035 to 2050.
- Higher PKT growth than combined population and employment growth suggests uptake in transit ridership from 2016 to 2050.
- PHT within the study area increases by 226% (PM) from 2016 to 2035.
- PHT within the study area further increases by 84% (PM) from 2035 to 2050.

Road Usage

The volume of traffic using each major road, as modelled by the RTM, are reported for 2050. Total traffic volume plots are presented in *Appendix C*.

Observations

- Highway 1 west of 200 Street has around 5,100 vph eastbound in the PM peak hour. In 2035, this increases to 5800 vph and in 2050, increases to 6,350 vph.
- Highway 1 east of 200 Street has around 4,100 vph eastbound in the PM peak hour. In 2035, this increases 4350 vph and in 2050, increases to 4,750 vph.
- 200 Street south of 88 Avenue W has around 2,350 vph southbound in the PM peak hour. In 2035, this increases to 2,700 vph and in 2050, decreases to 2,500 vph.
- 192 Street full-movement interchange is well utilized and potentially draws traffic away from the 200 Street interchange.

V/C Ratio

The volume-to-capacity (V/C) ratio for each major road during the PM peak hour, as modelled by the RTM, are reported for 2050. V/C Ratio Plots are presented in *Appendix D*. In addition, every major road within the study area with V/C above 1.0 are reported in *Table 6.16* and *Table 6.17* below. Please note that V/C ratios in the model are less reliable than other measures due to the relatively simplistic nature of the assumptions made to model road capacities. A consolidated set of model results across all three horizon years to facilitate comparison is included in *Appendix B*.

Table 6.16: 2050 V/C Ratios – BC MoTI

ON	DIR	AT	V/C RATIO
Hwy 1	WB	192 St	1.02
Hwy 1	WB On-Ramp	192 St	1.10
Hwy 1	WB On-Ramp	200 St	1.13
Hwy 1	WB	216 St	1.25
Hwy 1	EB	192 St	1.14
Hwy 1	EB	200 St	1.30
Hwy 1	EB On-Ramp	200 St	1.05
Hwy 1	EB	216 St	1.32
Hwy 1	EB Off-Ramp	192 St	1.34
Hwy 1	EB Off-Ramp	200 St	1.32
192 St	SB	Hwy 1 WB Ramps	1.27
192 St	SB	Hwy 1 EB Ramps	1.00
200 St	SB	Hwy 1 SPUI	1.24
200 St	NB	Hwy 1 SPUI	1.06

202 St	SB	Hwy 1	1.22
202 St	NB	Hwy 1	1.42

Table 6.17: 2050 V/C Ratios – Municipal

ON	DIR	APPROACHING	V/C RATIO
192 St	SB	88 Ave	1.05
192 St	SB	80 Ave	1.40
192 St	SB	72 Ave	1.07
192 St	NB	88 Ave	1.01
192 St	NB	80 Ave	1.05
196 St	SB	80 Ave	1.17
200 St	SB	80 Ave	1.12
202 St	SB	86 Ave	1.53
208 St	SB	87 Ave	1.07
96 Ave	EB	208 St	1.11
88 Ave	EB	204 St	1.10
84 Ave	EB	201 St	1.05
80 Ave	WB	192 St	1.17
72 Ave	WB	208 St	1.20

Observations

- 30 links were identified to have a V/C ratio exceeding 1.0.
- Highway 1 east of 200 Street has V/C ratios of around 1.1 eastbound in the PM peak hour. In 2035, these V/C ratios increase to 1.2 and in 2050, these V/C ratios increase to 1.3.
- Highway 1 eastbound off-ramp has a V/C of 1.3 in the PM peak hours.
- 200 Street northbound at Highway 1 deteriorates and shows V/C ratios of 1.1 in the PM peak hours.
- 202 Street between 86 Avenue and 88 Avenue E (north of the 202 Street extension) exhibits V/C ratios in excess of 1.0. The two-lane segment of 202 Street at Highway 1 operates poorly with high V/C ratios.
- For municipal roads, in general, the north-south directions are more congested than the east-west directions.

Micro-Scopic Analysis

The micro-level traffic analysis utilizes the calibrated Aimsun model and focuses on the performance of the 200 Street interchange and adjacent roadways such as 202 Street including the access points to the restricted covenants.

Network Statistics (VHT / VKT)

Network travel time represents the total travel time travelled during the peak hour and is represented by Vehicle Hours Travelled (VHT). Network travel time is an important metric to measure the quality of service of a road network and is useful in comparing different model scenarios. The network travel time (VHT) and network travel distance (VKT), as modelled by Aimsun, are reported for 2050 in *Figure 6.7* and *Figure 6.8* for the PM peak period.

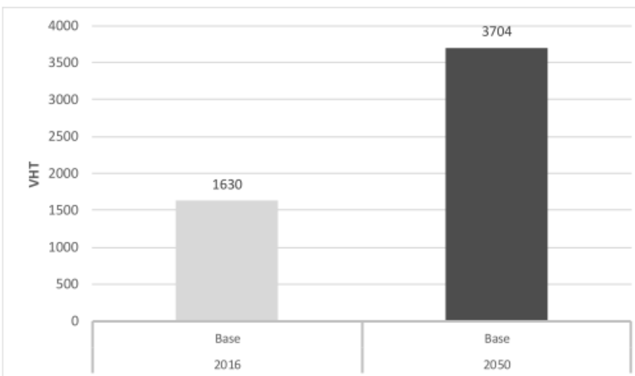


Figure 6.7: 2050 Network VHT

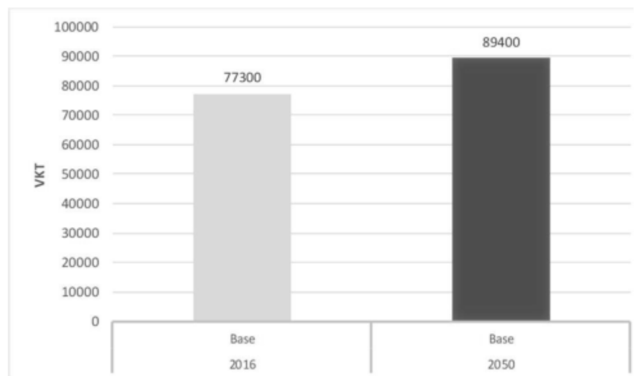


Figure 6.8: 2050 Network VKT

Observations

- Similar to the 2035 horizon year, a significant increase in the VHT and VKT was observed for the 2050 scenario compared to the 2016 existing base. This is driven in part by the additional vehicles within the network as well as the resulting increase to congestion and queueing.

Intersection Performance (Delay / LOS)

The delay (seconds), Level of Services (LOS), and maximum queue (metres) for each lane group as modelled by Aimsun, are reported for the future base model for the 2050 horizon year with comparison to the 2016 base scenario in *Table 6.18*. The delay experienced by a driver can be used to identify issues affecting the operating performance of a network. LOS represents the quality of service experienced by the driver, based on the delays experienced. Queues provide another measure of the relative congestion and can be induced by signal operations or when the traffic flow is higher than the roadway capacity.

Table 6.18: Intersection Approach Delay and Level of Service

INTERSECTION	DIRECTION	MOVEMENT	PM PEAK HOUR					
			DELAY (SEC)		LOS		MAX. QUEUE (M)	
			2016	2050	2016	2050	2016	2050
200 Street and Hwy 1 Ramps	NB	T	61	89	E	F	261	299
	SB	T	15	31	B	C	104	151
	EB	L	96	>100	F	F	157	>500
	EB	R	12	>100	B	F	185	>500
	WB	L	53	>100	D	F	81	155
	WB	R	97	>100	F	F	105	149
200 Street and 88 Avenue E	NB	L	72	95	E	F	103	116
	NB	TR	15	22	B	C	147	151
	SB	L	61	>100	E	F	47	68
	SB	TR	15	71	B	E	112	288
	EB	L	89	69	F	E	2	11
	EB	TR	93	>100	F	F	31	40
	WB	LTR	51	64	D	E	85	152
200 Street and 88 Avenue W	NB	L	67	51	E	D	16	60
	NB	TR	33	40	C	D	176	211
	SB	L	58	60	E	E	134	101
	SB	TR	15	78	B	E	237	335
	EB	LTR	50	94	D	F	78	175
	WB	LTR	28	25	C	C	33	42
202nd Street and Route 1 HOV Ramps	NB	LTR	2	52	A	D	23	144
	SB	LTR	4	14	A	B	28	60
	EB	LTR	10	>100	B	F	27	441
	WB	LTR	5	25	A	C	21	48
86 Avenue and 200 St	NB	LTR	23	45	C	D	146	221
	SB	LTR	23	38	C	D	160	201
	EB	LTR	42	46	D	D	70	110
	WB	LTR	34	29	C	C	97	92
86 Avenue and 201 St	NB	LTR	-	27	-	D	0	69
	SB	LTR	2	>100	A	F	0	110
	EB	LTR	1	23	A	C	33	145
	WB	LTR	0	25	A	C	0	141
86 Avenue and 202 St	NB	LTR	-	65	-	E	0	209
	SB	LTR	21	49	C	E	65	69
	EB	LTR	18	47	C	E	75	171
	WB	LTR	8	48	A	E	46	129

INTERSECTION	DIRECTION	MOVEMENT	PM PEAK HOUR					
			DELAY (SEC)		LOS		MAX. QUEUE (M)	
			2016	2050	2016	2050	2016	2050
88 Avenue E and 201 St	NB	LTR	-	37	-	D	0	41
	SB	LTR	35	26	C	C	65	74
	EB	LTR	2	11	A	B	34	61
	WB	LTR	3	17	A	B	41	107
88 Avenue E and 202 St	NB	LTR	40	49	D	D	46	43
	SB	LTR	36	>100	D	F	126	172
	EB	LTR	37	>100	D	F	88	194
	WB	LTR	15	93	A	F	14	158
88 Avenue E and NW Quadrant Access	NB	LR	5	6	A	A	29	29
	WB	TL	1	1	A	A	29	34
88 Avenue W and 201 St	NB	LTR	30	51	C	D	42	59
	SB	LTR	32	>100	C	F	59	96
	EB	LTR	18	31	B	C	132	133

Observations

- 200 Street interchange WBL and WBR off-ramps exhibit LOS F as do the EBL and EBR off-ramps.
- 200 Street interchange northbound movement exhibits LOS F in PM peak hour with queues extending to 88 Avenue W.
- 200 Street / 88 Avenue E left-turn movements operate poorly at LOS F and the eastbound approach exhibits LOS F as well albeit for a low volume movement.
- The eastbound approach to the 202 Street roundabout experiences LOS F in the PM peak hour.
- Along 86 Avenue, the NB and SB movements experience high delays with LOS E or F at both 202 Street and 201 Street. In addition, 86 Avenue is more congested with LOS E in both the EB and WB directions.

Route Travel Time

Travel time is a key metric in determining the level of congestion in a transportation network and is therefore another means of measuring operations performance. Travel times were obtained for ten designated routes and are used to compare the effects of different travel demands on the road network. The route travel times as modelled by Aimsun, are reported for 2050 in *Figure 6.9* with a comparison to the 2016 existing base travel times.

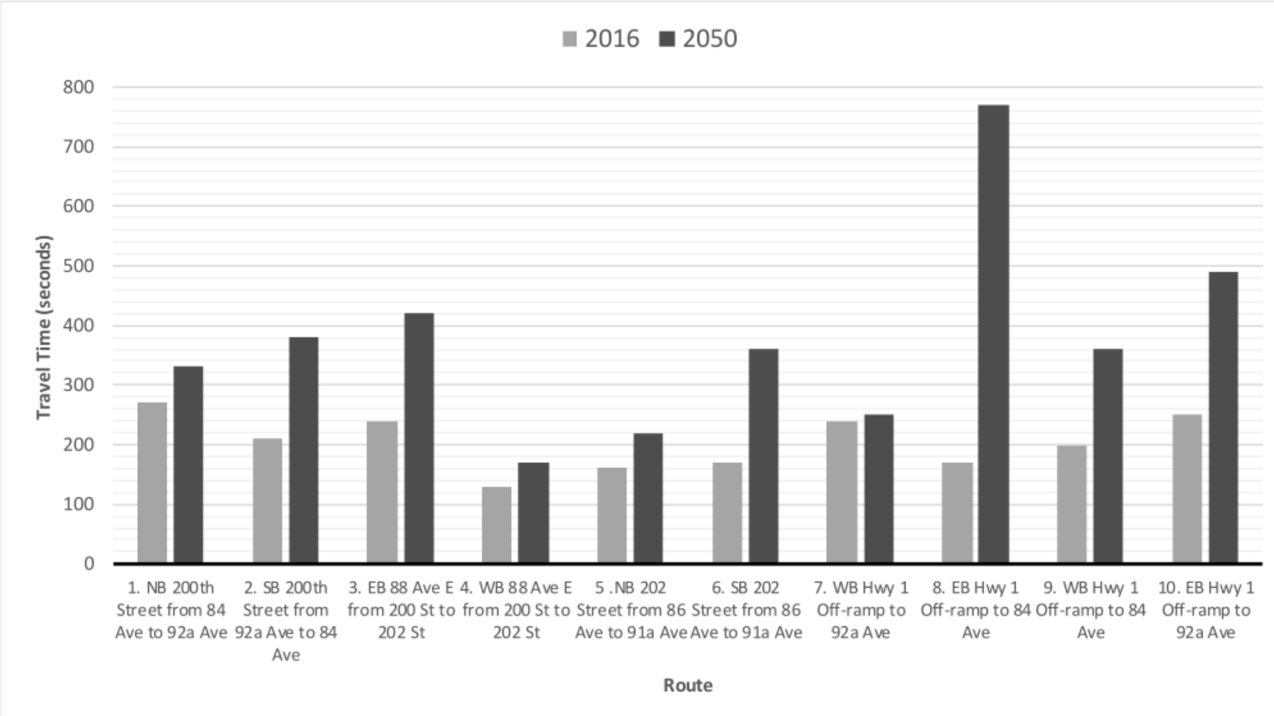


Figure 6.9: 2050 Route Travel Times (seconds)

Observations

- Increases to northbound travel times along 200 Street were observed; however, relative to 2035, there is a marked improvement.
- Route travel times using the eastbound Highway 1 off-ramp increase substantially compared to the 2016 existing base.

2050 Future Base (Long Term) Key Findings

Based on the analysis conducted at the macro-scopic and microscopic levels, the following is a list of the key findings for the 2050 future base scenario:

- Additional population and employment growth between 2035 and 2050 are forecast to lead to an increase in trip making within the study area. The number of daily person trips generated is forecast to increase by 37% between 2035 and 2050.
- Auto (SOV) mode share was shown to decrease marginally relative to 2035 with transit and active modes increasing in lieu.
- Deficiencies identified for the existing 2016 and 2035 base networks permeate to the 2050 scenario; especially at the 200 Street interchange off-ramps as the ramp terminals continue to act as constraints to the transportation network.
- Intersections at restricted covenant access points including 201 Street / 86 Avenue, 201 Street / 86 Avenue, and at 200 Street / 88 Avenue W operate poorly. The single lane configuration of 86 Avenue and 202 Street north of 86 Avenue were observed to act as “bottlenecks” for traffic.

- Build-out of the 192 Street interchange by the 2050 horizon year results in a reduction to net travel demand at the 200 Street interchange ramps and 200 Street.
- The eastbound off-ramp at 200 Street interchange experiences significant congestion. A desire-line for vehicles exiting the highway wishing to travel to the bolstered 202 Street or 201 Street extension south of 86 Avenue results in high southbound left-turning demand at both 88 Avenue W / 200 Street and 88 Avenue E / 200 Street. This demand was observed to exceed the capacity of the left-turns and result in congestion and queueing propagating upstream.
- Additional demand on 86 Avenue between 200 Street and 202 Street was observed to continue to cause significant increases to delay on the two-lane section of roadway.
- The roundabout on 202 Street adjoining the Highway 1 HOV on/off-ramps was observed to operate poorly with the increased travel demands. In particular, the southbound queues at 202 Street / 86 Avenue were observed to negatively affect traffic operations at the roundabout, leading to delays for the Highway 1 HOV off-ramp.
- Similar to 2035, full buildout of Covenant Zone 4 in the south-east quadrant of the 200 Street interchange results in over 1,000 two-way vehicle trips during the PM peak hour. This is a significant increase from existing travel demand and therefore 201 Street south of 88 Avenue W was shown to operate poorly.

6.4 Summary of Base Transportation Network Performance

The results of the analysis for the 2016 existing base scenario and future base 2035 and 2050 scenarios indicate that the transportation system is expected to experience a significant increase to congestion, travel time, and delay. The full build-out of the restricted covenants combined with the substantial growth to background trips results in increased travel demand for the study area. Based on the analysis, the following is a list of key findings for the base transportation scenarios:

- Between 2016 and 2035, there is expected to be a 57% increase to total trips, while between 2035 and 2050 there is expected to be a further increase of 37% to total trips.
- Full build-out of the restricted covenants is anticipated by the 2035 horizon year. The seven restricted covenants are forecast to generate over 3,145 two-way vehicle trips per hour, localized around the 200 Street interchange.
- Relative to the traffic operations performance of the 2016 existing base scenario, there is expected to be a significant increase to delay and travel time within 200 Street interchange lands for the future base 2035 and 2050 scenarios. As the single-point design of the 200 Street interchange is relatively constrained already, the growth of background traffic compounded by the build-out of the restricted covenants leads to worsening levels of service despite potential improvements to the adjacent transportation network.
- The large increases to route travel times, delays, and queueing in 2035 and 2050 for key movements including along 200 Street and 202 Street are in excess of existing traffic operations levels.
- At the 200 Street interchange, 2035 traffic operations are considerably worse than existing while 2050 traffic operations are similar to 2035. Importantly, some turning movements exhibit reductions to delay in 2050 compared to when potential long-range network improvements are applied (i.e. 192 Street Interchange).

- Planned municipal roads are well utilized for both the 2035 and 2050 horizon years. In particular, the extension of 202 Street and 201 Street south of 86 Avenue as well as the buildout of the 192 Street interchange show high utilization.
- Transit mode share doubles in 2035 compared to 2016 which is likely related to the proposed Surrey-Langley SkyTrain. Higher passenger kilometres travelled (PKT) growth compared to the combined population and employment growth suggests an uptake in transit ridership from 2016 to 2050.
- Auto (SOV) mode share was shown to decrease for each future horizon year with uptake in transit and active mode share to compensate.
- In general, the north-south directions are more congested than the east-west directions.

7. Sensitivity Analysis

The following section examines the impact to the transportation network of relaxing the restricted covenant trip generation limits (henceforth referred to as the modified covenant) for the 2035 and 2050 horizon years. This sensitivity test examines the robustness of the network to accommodate increasing travel demands destined to and originating from the restricted covenants over the prescribed maximums. Analysis is conducted within the microsimulation environment with comparison to the future base transportation network performance with the restricted covenant trip generation limits in place.

7.1 Modified Covenant Trip Generation

A global increase to the modified covenant trip generation of 30% over the prescribed maximum was analyzed. The locations of the existing restricted covenant parcels as well as the existing PM peak hour maximum two-way vehicle trip generation and modified covenant trip generation limits (in red) are shown in *Figure 7.1* below. The resultant increase to trip generation for the sensitivity scenario is detailed in *Table 7.1*. As shown, the existing two-way maximum vehicle trip generation from the seven restricted covenant parcels is approximately 3,145 vehicles per hour while the sensitivity scenario increases the trip generation limit by 30% to 4,088 vehicles per hour, equating to an increase of 945 vehicles per hour. These additional vehicle trips are assigned to the future network proportionally for each modified covenant.

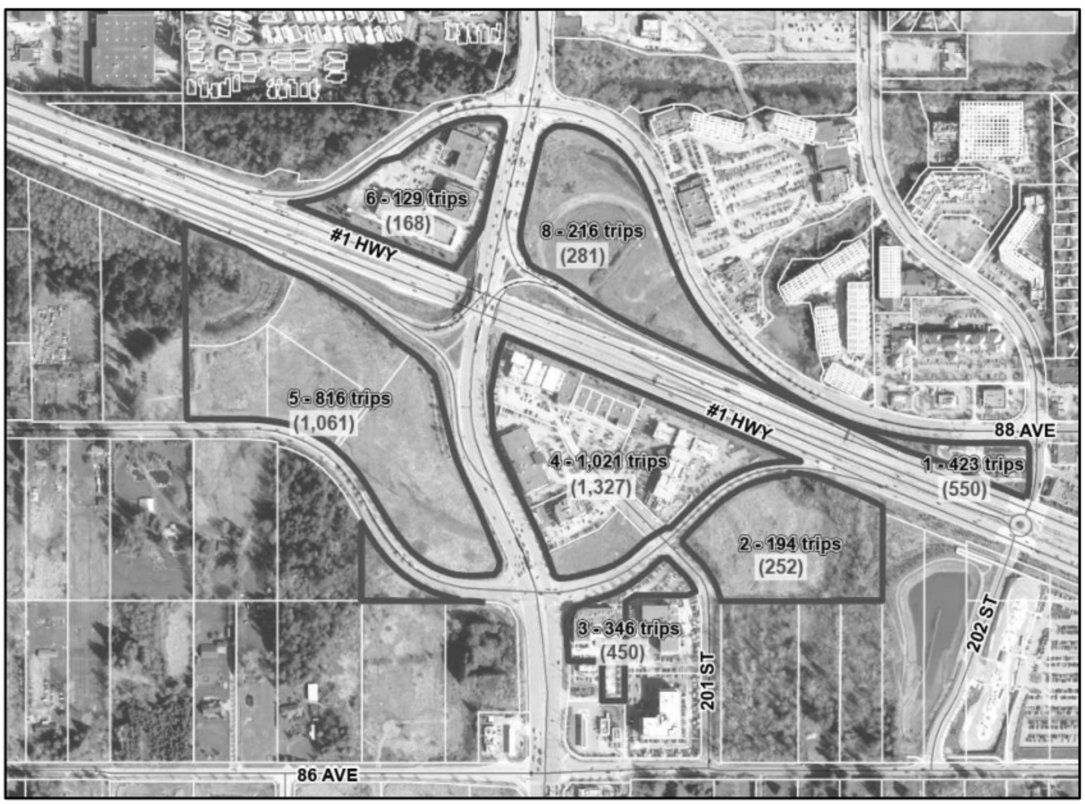


Figure 7.1: Existing Restricted Covenant Two-Way Trip Generation Limits (vph)

Table 7.1: Covenant Two-Way Vehicle Trip Generation (vph)

COVENANT AREA ID	EXISTING RESTRICTED COVENANT (VPH)	MODIFIED COVENANT +30% (VPH)	DELTA (VPH)
1	129	168	+39
2	216	281	+65
3	423	550	+127
4	194	252	+58
5	1021	1327	+306
6	346	450	+104
7	816	1061	+245
Total	3145	4088	+944

7.2 Transportation Network Performance

The following section summarizes the transportation network performance for the modified covenant scenario for the 2035 and 2050 horizon years using the micro-simulation traffic operations model (Aimsun). Comparison to the future base model operations is provided for each measure of effectiveness.

Network Statistics (VHT / VKT)

A comparison of the future base scenario and sensitivity scenario network travel time (VHT) and network travel distance (VKT), as modelled by Aimsun, are reported for 2035 and 2050 in *Figure 7.2* and *Figure 7.3* for PM peak period. Network travel time represents the total travel time travelled during the peak period and is represented by Vehicle Hours Travelled (VHT). Network travel time is an important metric to measure the quality of service of a road network and is useful in comparing different model scenarios.

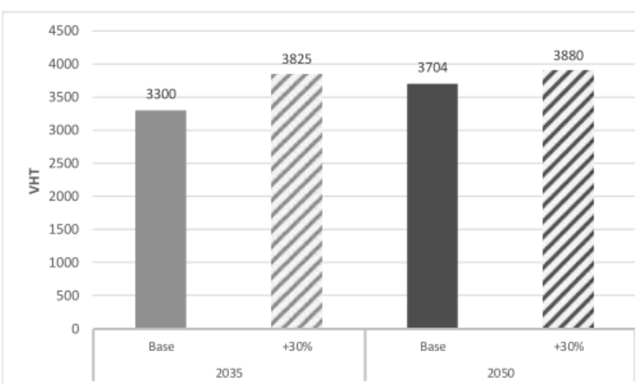


Figure 7.2: Network VHT

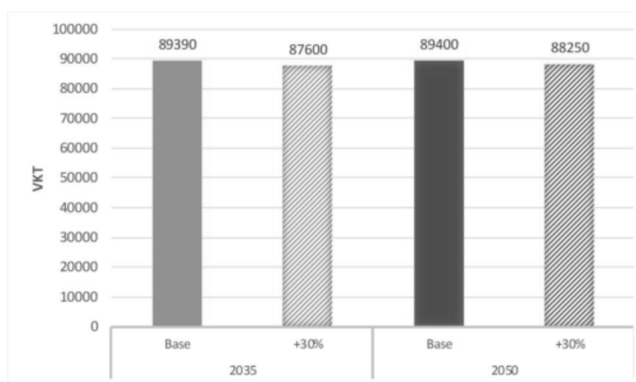


Figure 7.3: Network VKT

Observations

- A 15% increase in VHT was observed for the 2035 future base scenario compared to the 2035 modified covenant scenario while a 5% increase was observed for the 2050 horizon year.
- VKT decreases slightly for both 2035 and 2050 modified covenant scenarios as a result of congestion and queues blocking vehicles from entering the network during the peak hour.

Intersection Performance

The delay (seconds), LOS, and maximum queues modelled by Aimsun, are reported for the 2035 and 2050 sensitivity scenarios (+30%) with comparison to the future base scenarios in *Table 7.2*.

Table 7.2: Intersection Performance

INTERSECTION	DIR	MVT	PM PEAK HOUR											
			DELAY (SEC)				LOS				MAX. QUEUE (M)			
			2035		2050		2035		2050		2016		2035	
			BASE ABS.	+30% Δ	BASE ABS.	+30% Δ	BASE	+30%	BASE	+30%	BASE ABS.	+30% Δ	BASE ABS.	+30% Δ
200 Street and Hwy 1 Ramps	NB	T	>100	+45	89	+37	F	F	F	F	330	+3	299	-43
	SB	T	25	+1	31	+43	C	C	C	E	131	-1	151	+29
	EB	L	>100	+15	>100	+16	F	F	F	F	>500	+55	>500	+43
	EB	R	>100	+30	>100	+24	F	F	F	F	>500	+96	>500	+81
	WB	L	>100	+52	>100	+32	F	F	F	F	138	+138	155	+130
	WB	R	>100	+6	>100	+10	F	F	F	F	131	+141	149	+130
200 Street and 88 Avenue E	NB	L	80	+5	95	+1	F	F	F	F	110	+2	116	-20
	NB	TR	21	0	22	+64	C	C	C	F	148	+2	151	+5
	SB	L	>100	+12	>100	+16	F	F	F	F	61	+3	68	-1
	SB	TR	74	+16	71	+10	E	F	E	F	297	0	288	+5
	EB	L	68	+28	69	+27	E	F	E	F	14	+1	11	0
	EB	TR	>100	+45	>100	+39	F	F	F	F	41	+65	40	+49
	WB	LTR	45	+3	64	+34	D	D	E	F	112	+12	152	+25
200 Street and 88 Avenue W	NB	L	55	-1	51	+6	E	D	D	E	58	+2	60	-10
	NB	TR	>100	+25	40	+7	F	F	D	D	233	-2	211	-11
	SB	L	58	-1	60	+11	E	E	E	E	111	+6	101	0
	SB	TR	37	+4	78	+34	D	D	E	F	282	-17	335	-2
	EB	LTR	78	+44	94	+27	E	F	F	F	155	+91	175	+16
	WB	LTR	25	+4	25	+2	C	C	C	C	43	+5	42	-10
202nd Street and Route 1 HOV Ramps	NB	LTR	24	+12	52	-33	C	D	D	B	110	+21	144	-18
	SB	LTR	11	+3	14	+2	B	B	B	B	58	+1	60	-3
	EB	LTR	>100	+16	>100	+16	F	F	F	F	220	+219	441	-24
	WB	LTR	33	+9	25	+20	C	D	C	B	47	+11	48	+58
86 Avenue and 200 St	NB	LTR	>100	+22	45	+61	F	F	D	F	376	+28	221	+70
	SB	LTR	30	+2	38	+13	C	C	D	D	193	-1	201	-10
	EB	LTR	>100	+10	46	+10	F	F	D	E	218	0	110	+29

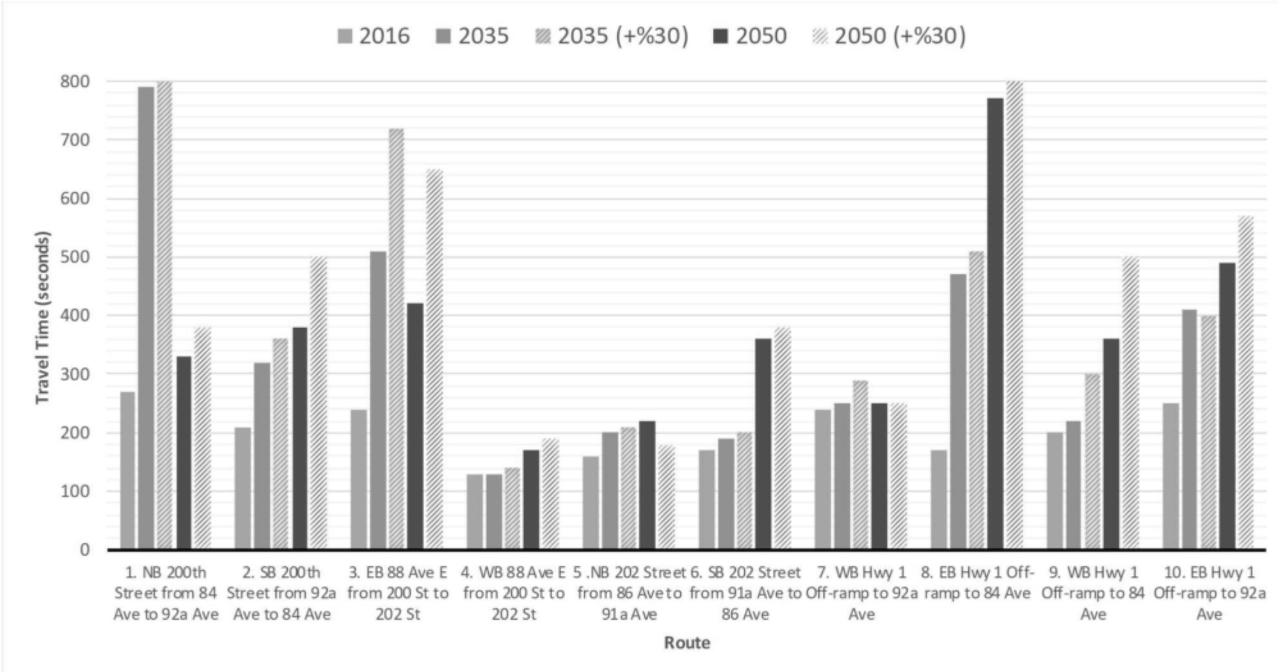
INTERSECTION	DIR	MVT	PM PEAK HOUR											
			DELAY (SEC)				LOS				MAX. QUEUE (M)			
			2035		2050		2035		2050		2016		2035	
			BASE ABS.	+30% Δ	BASE ABS.	+30% Δ	BASE	+30%	BASE	+30%	BASE ABS.	+30% Δ	BASE ABS.	+30% Δ
	WB	LTR	31	-3	29	-4	C	C	C	C	92	+2	92	-13
86 Avenue and 201 St	NB	LTR	30	-4	27	+5	C	C	C	C	13	-1	69	+30
	SB	LTR	99	0	>100	+5	F	F	F	F	109	+1	110	-2
	EB	LTR	21	+1	23	+13	C	C	C	D	137	+1	145	-1
	WB	LTR	18	+6	25	+8	B	C	C	C	139	+4	141	+4
86 Avenue and 202 St	NB	LTR	55	+65	65	+41	E	F	E	F	207	+5	209	+3
	SB	LTR	46	-1	49	+8	D	D	D	E	72	-2	69	-17
	EB	LTR	42	0	47	+12	D	D	D	E	169	-1	171	-1
	WB	LTR	24	+2	48	+26	C	C	D	E	79	+5	129	+25
88 Avenue E and 201 St	NB	LTR	43	+3	37	+11	D	D	D	D	41	+2	41	+1
	SB	LTR	68	-22	26	+19	E	D	C	D	75	+1	74	+3
	EB	LTR	19	+17	11	+41	B	D	B	D	74	+31	61	+59
	WB	LTR	14	0	17	-1	B	B	B	B	96	-19	107	-3
88 Avenue E and 202 St	NB	LTR	46	+2	49	-2	D	D	D	D	46	-1	43	-11
	SB	LTR	61	-2	>100	+1	E	E	F	F	152	+9	172	-4
	EB	LTR	>100	+33	>100	+24	F	F	F	F	289	+87	194	+84
	WB	LTR	93	+10	93	-22	F	F	F	E	152	+6	158	-1
88 Avenue E and NW Quadrant Access	NB	LR	5	+49	6	+47	A	D	A	D	29	+1	29	+1
	WB	TL	1	0	1	0	A	A	A	A	34	-4	34	-5
88 Avenue W and 201 St	NB	LTR	42	+17	51	+14	D	E	D	E	58	+2	59	-10
	SB	LTR	95	+11	>100	+6	F	F	F	F	94	+5	96	0
	EB	LTR	28	+1	31	+9	C	C	C	D	131	+4	133	0

Observations

- Existing deficiencies in the future base networks are compounded by the increased travel demands caused by the modified covenants.
- Traffic performance at the 200 Street interchange continues to be poor for the 2035 and 2050 horizon years with most movements continuing to exhibit LOS F while the southbound and westbound approaches worsen.

Route Travel Times

Travel time is a key metric in determining the level of congestion in a transportation network and is therefore another means of measuring operations performance. Travel times were obtained for ten designated routes and are used to compare the effects of different travel demands on the road network. The route travel times as modelled by Aimsun, are reported for the mitigation scenarios in *Figure 7.4* with a comparison to the base travel times.



Note: Y-axis capped at 800 seconds to maintain visibility

Figure 7.4: Route Travel Times (seconds)

Observations

- Increases to travel time relative to the future base scenarios were observed for almost every route.
- The largest increases to travel time were observed for routes along 88 Avenue E and along 200 Street in both the north and south directions.

7.3 Summary of Sensitivity Analysis Results

The results of the modified covenant scenario reveal that traffic operations within the study area operate poorly for both the 2035 and 2050 sensitivity analysis scenarios. Relative to the future base scenarios, traffic operations are worse as deficiencies in the transportation network are compounded by the 30% growth to the modified covenant trip generation. Comparing the transportation network performance of the 2035 and 2050 modified covenant scenarios to the 2016 base case, it is evident that the traffic operations are also significantly worse.

Several intersections and approach movements were shown to reach a critical state with instances of gridlock occurring due to the excessive travel demands. This has a cascading impact to traffic operations as queues can begin blocking upstream intersections leading to further congestion. Correspondingly, route travel times also increase precipitously.

At the access points directly adjacent to the modified covenants, particularly at 200 Street / 88 Avenue W and 86 Avenue / 201 Street, the additional vehicle demands are focused through these constraining intersections and become “bottlenecks” for the overall transportation network.

8. Mitigation Measures

This section discusses proposed mitigation measures to address key traffic operations deficiencies observed for the future 2035 and 2050 base transportation networks with an emphasis on the 200 Street interchange lands and adjacent restricted covenant access points. A workshop was held with the Township of Langley and BC MoTI to discuss initial mitigation measures to improve the roadway network in the study area. Mitigation measures were generated by evaluating the performance of the future base transportation networks, identifying critical locations, as well as the determining the mechanism responsible for each deficiency. Subsequently, a screening process was conducted to retain or exclude specific mitigation measures based on identified constraints. The proposed mitigation measures attempt to minimize impacts to adjacent properties and roadways. Note that a preliminary right-of-way evaluation has been conducted at this stage.

The effectiveness of the mitigation measures is evaluated quantitatively using the micro-simulation traffic operations model (Aimsun). An evaluation of potential mitigation measures outside the 200 Street interchange lands (i.e. at 192 Street Interchange) is assessed qualitatively.

8.1 Proposed Mitigation Measures

Based on the traffic operations performance of the future base transportation networks, locations where traffic operations deficiencies were observed is shown graphically in *Figure 8.1* with each location mapped to a list describing each deficiency using a numerical identifier (i.e. ①). A traffic operations severity scale is also provided to indicate the relative importance of each deficiency in *Figure 8.2*. Both 2035 and 2050 future base horizon years were observed to have similar constraints and therefore have been grouped together.

The mitigation measures range from simple signal phasing alterations to widening of the roadway to increase the vehicular capacity. As shown, the majority of mitigation measures focus on improvements south of Highway 1 as this is where the bulk of congestion in the future base models were observed and is also where the most intense proposed development is forecast to occur.

Each location is described in the list below in terms of the network constraint, the proposed mitigation measure, and whether the mitigation measure was retained for further evaluation. It should be noted that the single-point design of the 200 Street interchange does not provide much flexibility in terms of optimizations aside from signal timing / signal phasing modifications. Therefore, the "toolbox" of potential mitigation measures to address congestion at the interchange itself is fairly limited without exploring significant infrastructure improvements / structural upgrades.

Figure 8.1: Location of Traffic Operations Constraints

Figure 8.2: Traffic Operations Severity Scale

A detailed list of the primary traffic operations constraint, potential mitigation measure, and commentary on whether the mitigation measure was retained for evaluation are provided below:

① <u>88 Avenue E / 200 Street</u>

- Constraint: Eastbound egress from the northwest quadrant was shown to experience considerable delays due to the traffic signal allocating only minimal green time to serve eastbound vehicles. It is acknowledged that the travel demand for this movement is relatively low and is ultimately constrained by the restricted covenant in place.
- Mitigation Measure: Increase eastbound signalized green time to better accommodate eastbound vehicles egress from the restricted covenant.
- Screening: This mitigation measure was not retained as it was determined that the overall benefit to the eastbound approach would not outweigh the increased delay and coordination drawbacks for the higher volume northbound / southbound directions.

② Westbound Highway 1 Off-Ramp at 200 Street

- Constraint: Westbound vehicles exiting Highway 1 at 200 Street are constrained by the signal at the ramp terminal. Queues for the westbound right-turn were observed to propagate along the off-ramp causing blockage of the westbound left-turn lane. This leads to starvation of the westbound left-turn approach.
- Mitigation Measure: Reallocate the lanes such that the left-turn lane receives its own dedicated lane while the second right-turn lane develops from the curbside right-turn lane. This better accommodates westbound left-turning vehicles by allowing them to bypass queued vehicles waiting to turn right.
- Screening: This mitigation measure was retained as it may potentially reduce queue spillback from the off-ramp and increase the efficiency of the ramp terminal signal.

③ 202 Street Between 86 Avenue and 88 Avenue E

- Constraint: Potential improvements to the expansion and extension of 202 Street south of 86 Avenue was shown to drive additional travel demand through 202 Street north of 86 Avenue. As a result, the four-lane section of 202 Street currently becomes bottlenecked at the two-lane section of 202 Street north of 86 Avenue and through the roundabout adjoining the Highway 1 HOV on/off-ramps.
- Mitigation Measure: Expand 202 Street to a four-lane cross-section to match the cross-section of the extension south of 86 Avenue. This will improve continuity of roadway facilities and mitigate the bottleneck caused by the four-lane to two-lane constriction.
- Screening: This mitigation measure was retained to provide increased capacity along 202 Street. It is noted that there are retaining walls to the east of the roadway and a retention pond to the west which may complicate constructability.

④ 202 Street Roundabout at Highway 1 HOV Ramps;

- Constraint: Increased demand for 202 Street was shown to cause capacity issues at the roundabout which is constrained with single lanes in each direction. Expansion of 202 Street north of 86 Avenue to a four-lane cross-section as proposed in Mitigation Measure 3 would benefit by allowing for the four-lane cross-section to continue through to 88 Avenue E. Currently, the right-of-way constraints are likely to prohibit conversion of the single-lane roundabout to a two-lane roundabout.
- Mitigation Measure: Normalize the intersection by converting the roundabout to a signalized intersection. This would allow for the four-lane extension of 202 Street south of 86 Avenue to connect with 88 Avenue E.
- Screening: This mitigation measure was retained, and a preliminary review of the available right-of-way indicates that a four-lane cross-section with left-turn bays can be accommodated.

⑤ 86 Avenue / 202 Street

- Constraint: Extension of 202 Street south of 86 Avenue and development of adjacent lands causes additional demand at this intersection which is currently stop controlled. Extensive delays and queues are observed at this intersection.
- Mitigation Measure: Signalize the intersection and provide left-turn bays for all approaches.
- Screening: This mitigation measure was retained to provide continuity through the bolstered section of 202 Street, south of 86 Avenue and is planned to be implemented as part of future development.

⑥ 86 Avenue between 200 Street and 202 Street;

- Constraint: Development of adjacent properties and extension of 201 Street and 202 Street south of 86 Avenue leads to significant increases to travel demand along this two-lane road. Insufficient capacity was observed during the peak hours.
- Mitigation Measure: Provide a four-lane cross-section along 86 Avenue from 200 Street to 202 Street to accommodate the increase in travel demands. Potential right-in/right-out operations only at the mid-block access point between 200 Street and 201 Street to minimize queue spill-backs from the left-turns.
- Screening: This mitigation measure was retained to provide increased vehicular capacity and is planned to be implemented as part of future development.

⑦ 201 Street between 88 Avenue W and 86 Avenue

- Constraint: Build-out of the restricted covenants generates a significant number of additional trips along 201 Street as three restricted covenant parcels are adjacent to this section of roadway. As a result, 201 Street was shown to have insufficient capacity to accommodate the increased travel demands.
- Mitigation Measure: Expand 201 Street to a four-lane cross-section and signalize the access point to the property on the east side of 201 Street.
- Screening: This mitigation measure was retained to provide increased vehicular capacity; especially due to its proximity to the restricted covenant parcels and is planned to be implemented as part of future development.

⑧ 86 Avenue / 201 Street

- Constraint: Considerable increase to travel demands emanating from the restricted covenants in the south east quadrant of the 200 Street interchange and the extension of 201 Street south of 86 Avenue leads to insufficient capacity for this intersection.
- Mitigation Measure: Signalize the intersection and provide storage bays for left-turning vehicles. Connect the intersection approaches to the bolstered 86 Avenue and 201 Street.

- Screening: This mitigation measure was retained as it provides the intersection control to accommodate the bolstered 201 Street and 86 Avenue traffic and is planned to be implemented as part of future development.

⑨ 86 Avenue / 200 Street

- Constraint: Significant development south of 86 Avenue along 201 Street and 202 Street leads to a desire line for vehicles travelling along 200 Street to access these properties. As a result, the vehicles waiting to make a southbound left-turn were observed to spill back into the southbound through lanes on 200 Street.
- Mitigation Measure: Lengthen the southbound left-turn bay and provide additional southbound left-turn signalized green time to more efficiently clear the increased travel demand.
- Screening: This mitigation measure was retained as there is available right-of-way.

⑩ 88 Avenue W / 201 Street

- Constraint: The build-out of the restricted covenant in the southeastern quadrant of the 200 Street interchange as well as development of undeveloped lands along 201 Street south of 88 Avenue W was shown to lead to a significant increase to travel demands through this intersection, particularly in the northbound and southbound directions.
- Mitigation Measure: Improve the southbound and northbound approaches to 88 Avenue W by providing separate left-turn bays, and advanced signal phases to improve ingress and egress of the developments. Connect the northbound approach to the four-lane section of 201 Street.
- Screening: This mitigation measure was retained to provide improved ingress and egress to the restricted covenant parcels.

⑪ Eastbound Highway 1 Off-Ramp to Southbound 200 Street

- Constraint: An increase to travel demands southbound on 200 Street as well for the eastbound Highway 1 off-ramp was shown to exceed the capacity of the existing off-ramp. As a result, queues were prone to extending along the off-ramp.
- Mitigation Measure: Provide a two-lane eastbound to southbound off-ramp configuration that extends through the signal to 88 Avenue W.
- Screening: This mitigation measure was not retained due to insufficient right-of-way and conflicts with adjacent properties. In addition, there are grade differences that would make the construction of this improvement difficult and costly.

⑫ 88 Avenue W / 200 Street

- Constraint: An increase to travel demands southbound on 200 Street as well for the eastbound Highway 1 off-ramp was shown to exceed the capacity of the southbound approach.

- Mitigation Measure: Provide an additional southbound lane through the intersection that is continued from the two-lane eastbound off-ramp from Highway 1 proposed in mitigation measure 11.
- Screening: This due to mitigation measure was not retained insufficient right-of-way and conflicts with adjacent properties. In addition, there are grade differences that would make this improvement difficult and costly to construct.

8.2 Mitigation Measure Evaluation

The proposed mitigation measures that were retained as part of the screening process were implemented into the micro-simulation models for the future 2035 and 2050 horizon years for the PM peak period. The micro-simulation traffic operations model was utilized to analyze the effectiveness of the proposed mitigation measures. Quantitative measures of effectiveness were extracted including delay, level of service, and travel times amongst others. Comparison to the future base model traffic operations are provided for each measure of effectiveness.

Network Statistics (VHT / VKT)

A comparison of the future base scenario and mitigation measures scenario network travel time (VHT) and network travel distance (VKT), as modelled by Aimsun, are reported for 2035 and 2050 in *Figure 8.3* and *Figure 8.4* for the PM peak period. Network travel time represents the total travel time travelled during the peak period and is represented by Vehicle Hours Travelled (VHT). Network travel time is an important metric to measure the quality of service of a road network and is useful in comparing different model scenarios.

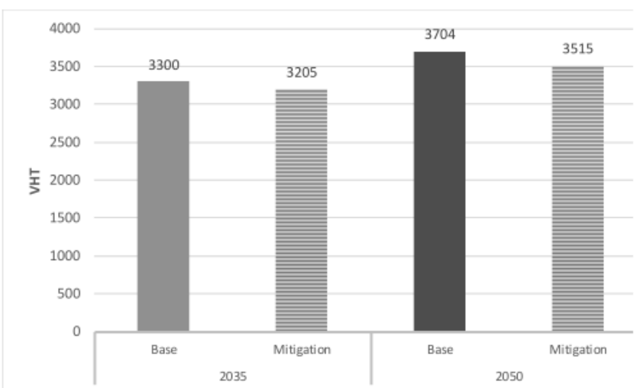


Figure 8.3: Network VHT

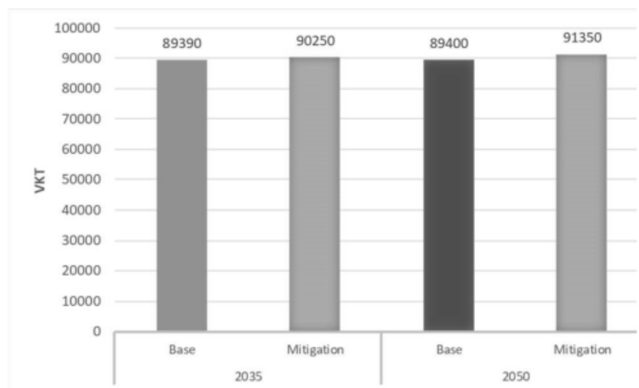


Figure 8.4: Network VKT

Observations

- A 3% decrease to VHT was observed for the 2035 mitigation measures scenario compared to the 2035 future base scenario while 5% decrease was observed for the 2050 horizon year.
- VKT increases slightly for both 2035 and 2050 mitigation scenario as a result of additional vehicles able to enter the focus area due to slightly reduced congestion.

Intersection Performance

The delay (seconds), LOS, and maximum queues modelled by Aimsun, are reported for 2035 and 2050 mitigation measure scenarios with comparison to the future base scenarios in *Table 8.1*.

Table 8.1: Intersection Performance

INTERSECTION	DIR	MVT	PM PEAK HOUR											
			DELAY (SEC)				LOS				MAX. QUEUE (M)			
			2035		2050		2035		2050		2035		2050	
			BASE ABS	MIT. Δ	BASE ABS	MIT. Δ	BASE	MIT.	BASE	MIT.	BASE ABS	MIT. Δ	BASE ABS	MIT. Δ
200 Street and Hwy 1 Ramps	NB	T	>100	-12	89	-5	F	F	F	F	330	+2	299	-3
	SB	T	25	+1	31	-8	C	C	C	C	131	+5	151	-12
	EB	L	>100	-11	>100	-8	F	F	F	F	>500	-86	>500	-77
	EB	R	>100	-23	>100	-14	F	F	F	F	>500	-90	>500	-45
	WB	L	>100	-44	>100	-26	F	E	F	F	138	+19	155	-7
	WB	R	>100	-35	>100	-19	F	E	F	F	131	+8	149	+18
200 Street and 88 Avenue E	NB	L	80	-2	95	+5	F	E	F	F	110	-2	116	+5
	NB	TR	21	0	22	+2	C	C	C	C	148	-1	151	+1
	SB	L	>100	-6	>100	-23	F	F	F	F	61	+4	68	-7
	SB	TR	74	-29	71	-29	E	D	E	D	297	-7	288	-56
	EB	L	68	-11	69	+9	E	E	E	E	14	-3	11	+3
	EB	TR	>100	-6	>100	-19	F	E	F	F	41	-13	40	-6
	WB	LTR	45	+12	64	-15	D	E	E	D	112	-6	152	-16
200 Street and 88 Avenue W	NB	L	55	-6	51	+8	E	D	D	E	58	+6	60	+2
	NB	TR	>100	-12	40	-3	F	F	D	D	233	-1	211	+3
	SB	L	58	-2	60	+9	E	E	E	E	111	+1	101	+8
	SB	TR	37	0	78	-21	D	D	E	E	282	-31	335	-55
	EB	LTR	78	0	94	-6	E	E	F	F	155	+3	175	+10
	WB	LTR	25	+5	25	+1	C	C	C	C	43	+29	42	+9
202nd Street and Route 1 HOV Ramps	NB	LTR	24	-6	52	-7	C	B	D	D	110	-9	144	-3
	SB	LTR	11	+9	14	+17	B	B	B	C	58	-1	60	-3
	EB	LTR	>100	-98	>100	-94	F	B	F	B	220	-186	441	-406
	WB	LTR	33	-19	25	-6	C	B	C	B	47	-9	48	-15
86 Avenue and 200 St	NB	LTR	>100	-22	45	+12	F	F	D	E	376	+13	221	+15
	SB	LTR	30	-2	38	-4	C	C	D	C	193	-7	201	-7
	EB	LTR	>100	-18	46	-2	F	F	D	D	218	+12	110	-2
	WB	LTR	31	-3	29	+5	C	C	C	C	92	+5	92	+21
	NB	LTR	30	+2	27	-4	C	C	C	C	13	+1	69	+88

INTERSECTION	DIR	MVT	PM PEAK HOUR											
			DELAY (SEC)				LOS				MAX. QUEUE (M)			
			2035		2050		2035		2050		2035		2050	
			BASE ABS	MIT. Δ	BASE ABS	MIT. Δ	BASE	MIT.	BASE	MIT.	BASE ABS	MIT. Δ	BASE ABS	MIT. Δ
86 Avenue and 201 St	SB	LTR	99	-21	>100	-31	F	E	F	E	109	0	110	+1
	EB	LTR	21	-4	23	-8	C	B	C	B	137	-32	145	-37
	WB	LTR	18	-5	25	-12	B	B	C	B	139	-59	141	-58
86 Avenue and 202 St	NB	LTR	55	-14	65	-28	E	D	E	D	207	-3	209	-5
	SB	LTR	46	-20	49	-19	D	C	D	C	72	0	69	+3
	EB	LTR	42	-4	47	-8	D	D	D	D	169	-1	171	-1
	WB	LTR	24	+7	48	-10	C	C	D	D	79	-9	129	-61
88 Avenue E and 201 St	NB	LTR	43	-9	37	-4	D	C	D	C	41	+1	41	-2
	SB	LTR	68	-46	26	+3	E	C	C	C	75	-3	74	+1
	EB	LTR	19	-9	11	-2	B	A	B	A	74	+7	61	+2
	WB	LTR	14	-2	17	-5	B	B	B	B	96	-23	107	-25
88 Avenue E and 202 St	NB	LTR	46	0	49	-1	D	D	D	D	46	-1	43	+3
	SB	LTR	61	-6	>100	-22	E	E	F	E	152	+16	172	0
	EB	LTR	>100	-14	>100	-19	F	F	F	F	289	-126	194	-46
	WB	LTR	93	-78	93	-84	F	B	F	A	152	-75	158	-104
88 Avenue E and NW Quadrant Access	NB	LR	5	0	6	+1	A	A	A	A	29	-1	29	0
	WB	TL	1	0	1	0	A	A	A	A	34	-4	34	-4
88 Avenue W and 201 St	NB	LTR	42	-6	51	-13	D	D	D	D	58	-5	59	-3
	SB	LTR	95	-59	>100	-61	F	D	F	D	94	-2	96	-6
	EB	LTR	28	+1	31	-6	C	C	C	C	131	0	133	0

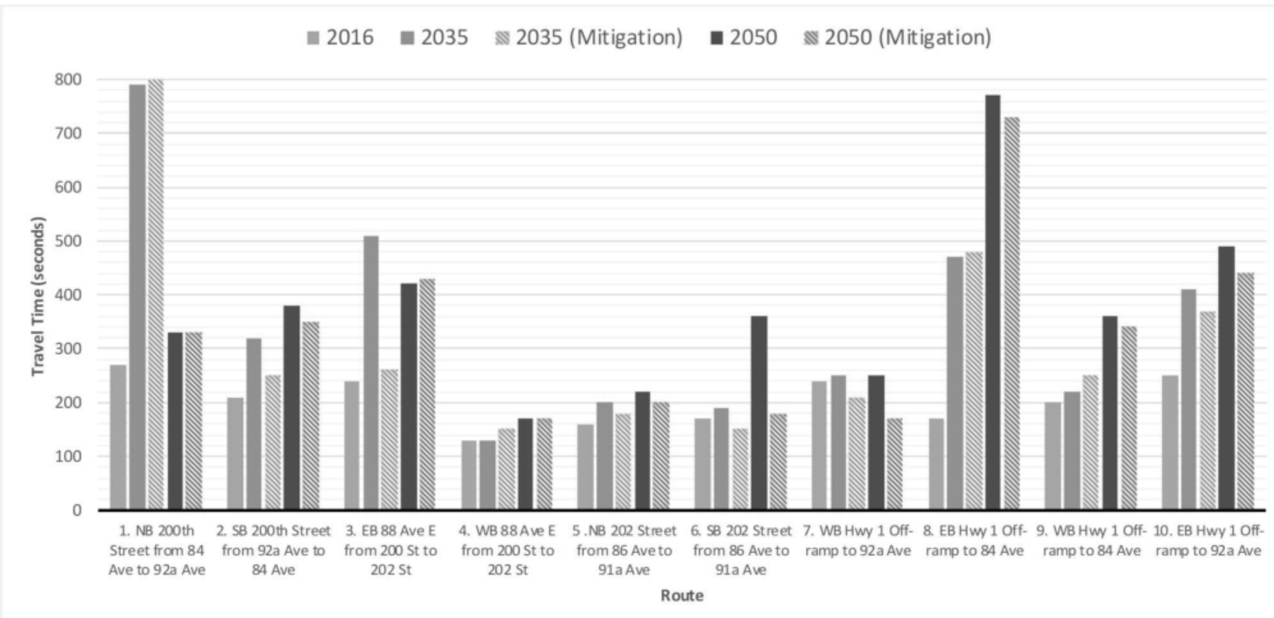
Observations

- Overall, the mitigation measures were shown to improve the traffic operations within the study area.
- Upgrades to restricted covenant access points and adjacent intersections was shown to result in higher throughput and reduced delays. This was especially evident for the intersections adjacent to the southeast quadrant of the 200 Street interchange fronting 88 Avenue W.
- Significant improvements were observed along 202 Street including at 86 Avenue, 88 Avenue E, and the Highway 1 HOV ramps.
- Reductions to delay at the Highway 1 westbound off-ramp were observed although delays remain relatively high due to the demands at the ramp terminal.
- Moderate improvements were observed along the bolstered 201 Street south of 88 Avenue W.

- Due to the constrained configuration of the 200 Street interchange, delays and level of service at the interchange itself remain poor and continue to be worse than the 2016 existing traffic operations performance by a wide margin.

Route Travel Times

Travel time is a key metric in determining the level of congestion in a transportation network and is therefore another means of measuring traffic operations performance. Travel times were obtained for ten designated routes and are used to compare the effects of different travel demands on the road network. The route travel times as modelled by Aimsun, are reported for the mitigation scenarios in *Figure 8.5* with a comparison to the base travel times.



Note: Y-axis capped at 800 seconds to maintain visibility

Figure 8.5: Route Travel Times (seconds)

Observations

- Improvements to travel times were observed for the majority of routes.
- The largest reductions to route travel time were shown for routes traversing 202 Street.
- The northbound routes along 200 Street continue to exhibit high travel times. Constraints at the 200 Street interchange were shown to continue metering traffic crossing Highway 1.

8.3 Mitigation Measures Summary

A summary of the effectiveness of each retained mitigation measure is provided below in *Table 8.2*. A description of the observed transportation network benefits is also provided. Overall, the retained mitigation measures provide marked improvements to traffic operations and result in reductions to both delay and queueing while allowing for increased throughput. However, relative to the 2016 existing base case traffic operations, the overall network still exhibits significant congestion.

Table 8.2: Summary of Mitigation Measure Effectiveness

ID	LOCATION	MITIGATION MEASURE	EFFECTIVENESS
②	Westbound Highway 1 Off-Ramp at 200 Street	Reallocate the lanes such that the left-turn lane receives its own dedicated lane while the second right-turn lane develops from curbside right-turn lane. This better accommodates westbound left-turning vehicles by allowing them to bypass queued vehicles waiting to turn right.	*Somewhat Better* Reduction to starvation of the westbound left-turn lane were noted leading to improved efficiencies and marginally reduced delays. There is a reduction to westbound right-turn lane queue storage.
③	202 Street Between 86 Avenue and 88 Avenue E	Expand 202 Street to a four-lane cross-section to match the cross-section of the extension south of 86 Avenue. This will improve continuity of roadway facilities and mitigate the bottleneck caused by the four-lane to two-lane constriction.	*Significantly Better* Improved capacity results in reduced delays and queues. Large increases to travel demand along 202 Street due to new developments is better served with the increased roadway capacity.
④	202 Street Roundabout at Highway 1 HOV Ramps;	Normalize the intersection by converting the roundabout to a signalized intersection. This would allow for the four-lane extension of 202 Street south of 86 Avenue to connect with 88 Avenue E.	*Significantly Better* Higher throughput afforded by the roadway expansion and removal of the roundabout "bottleneck" leads to improved traffic operations. Note that general vehicle traffic exiting the gas station on the southwest corner of 202 Street / 88 Avenue E may have increased difficulty travelling northbound due to the removal of the roundabout.
⑤	86 Avenue / 202 Street	Signalize the intersection and provide left-turn bays for all approaches.	*Somewhat Better* Overall improved traffic operations especially with dedicated turning facilities and continuity of expanded four-lane cross-section along 202 Street.
⑥	86 Avenue between 200 Street and 202 Street	Provide a four-lane cross-section along 86 Avenue from 200 Street to 202 Street to accommodate the increase in travel demands	*Somewhat Better* Increased vehicle capacity better accommodates the higher travel demands through this roadway especially due to increased development south of Highway 1.
⑦	201 Street between 88 Avenue W and 86 Avenue	Expand 201 Street to a four-lane cross-section and signalize the access point to the property on the east side of 201 Street.	*Significantly Better* Significant benefits due to higher travel demands through this section of roadway with the build-out of the restricted covenants.

ID	LOCATION	MITIGATION MEASURE	EFFECTIVENESS
⑧	86 Avenue / 201 Street	Signalize the intersection and provide storage bays for left-turning vehicles. Connect the intersection approaches to the bolstered 86 Avenue and 201 Street.	*Somewhat Better* This Intersection serves a large portion of restricted covenant traffic. Bolstering of the left-turn capacity as well as full signalization results in improved throughput and reduced delays.
⑨	86 Avenue / 200 Street	Lengthen southbound left-turn bay and provide additional southbound left-turn signalized green time to more efficiently clear the increased travel demand	*Somewhat Better* High demand and desire line for vehicles on 200 Street to turn left and access 202 Street. Lengthening of the turn-bay reduces the potential of queue spill-back.
⑩	88 Avenue W / 201 Street	Improve the southbound and northbound approaches to 88 Avenue W by providing separate left-turn bays, and advanced signal phases to improve ingress and egress of the developments. Connect the northbound approach to the four-lane section of 201 Street.	*Somewhat Better* Ingress and egress from the restricted covenant on the south-east quadrant is improved and results in higher throughput and reduced delays.

While the retained mitigation measures were shown to be relatively effective in improving localized traffic operations, there remain deficiencies within the transportation network that cause delays and travel times in excess of existing 2016 conditions. To resolve these deficiencies, it is likely that improvements to the transportation network outside of the study area may be required. Based on discussions with Township of Langley and BC MoTI staff, a list of potential supplemental mitigation measures was generated. These improvements focus more so on macro-level changes that may result in reduced travel demand to the 200 Street interchange. The list of supplemental mitigation measures is as follows:

1. Upgrade the eastbound Highway 1 off-ramp at 192 Street interchange by allowing for eastbound right-turns to be made. It is noted that there are concerns with community groups opposed (Port Kells) and in favour of this change (Clayton). This modification is proposed to occur prior to the construction of the 192 Street west-facing ramps and would be a near-term improvement that is envisioned to be implemented before the full-build out of the 192 Street interchange.
    - Potential benefits include reducing the travel demands for the eastbound off-ramp at 200 Street which was shown to operate over-capacity in the future horizon years. In particular, by allowing for eastbound right-turns to be made, heavy vehicle traffic at 200 Street would likely experience a marked decline.
    - This improvement is also relatively cost effective to implement but would require consultation with relevant community groups.

2. Provide a westbound off-ramp at 192 Street in the intervening period prior to the full build-out of the 192 Street interchange.
    - Potential benefits include the reduction of traffic using 200 Street; however, the magnitude of change to vehicle demand and the impact to traffic operations is not known at this point in time.

- This project would likely increase vehicle demands on the municipal network in the vicinity of the 192 Street interchange. The increased demand may necessitate the need for further road network upgrades to accommodate the increased traffic.
- The cost of implementing the proposed off-ramp could be high due to the relatively constrained right-of-way available and due to property impacts to the north-eastern corner of the interchange.
- There may also be community groups opposed to this project due to the likely increase in traffic volumes through the area.

3. Extend 204 Street as an overpass / underpass across Highway 1. This parallel route would provide a new north-south connection, potentially leading to a reduction to through traffic at 200 Street. As part of the Yorkson Community Plan, there is already an extension of 204 Street from 80 Avenue to 86 Avenue.
    - Potential benefits include increased transportation network resiliency and improved connectivity for the Carvolth and Willoughby neighbourhoods.
    - There remain constructability concerns as there is only an existing 10 metre road right of way which currently contains municipal utilities such as water and large sanitary mains. This would make constructing an underpass or piles for an overpass difficult or may require relocation of utilities. In addition, as part of the 202 Street underpass, Highway 1 was raised which may complicate grades for a new approach along 204 Street.

4. Extend 204 Street as an active transportation-only overpass across Highway 1. In an effort to continue supporting sustainable modes of transportation this connection would provide increased permeability for active users.
    - There is a future commuter route on 88 Avenue and therefore 204 Street provides a north-south interface with the proposed bike network.
    - If right-of-way constraints on 200 street required the relocation of the multi-use-path to facilitate a signal at the existing roundabout at 202 Street / Highway 1 HOV ramps, then 204 Street would provide a replacement connection in close proximity. Note that given the preliminary right-of-way assessment conducted as part of this study, the multi-use path along 202 Street likely does not need to be relocated.
    - On the south side of Highway 1, there are limited plans to provide cycling facilities on 204 Street. However, proposed upgrades to 86 Avenue would provide the closest connection for active facility. Therefore, extension of 204 Street active facilities to 86 Avenue would be necessary.
    - Highway 1 is elevated slightly to provide clearance for the 202 Street underpass. As a result, providing an active transportation overpass at 204 street may incur additional costs to raise the structure. An alternative underpass is typically not recommended for active transportation uses due to the perceived reduction to the quality of the facility (user comfort and safety).
    - Many active trips would be destined or originate from the Carvolth Transit Exchange. Providing direct and easy access from the proposed 204 Street active facility to Carvolth Transit Exchange is critical. Currently, a commercial property (Marcaret's Patchwork Ltd) east of the transit exchange acts as a barrier.

9. Key Findings

This study assessed the existing (2016) and future (2035 and 2050) base transportation networks, conducted a sensitivity test to evaluate the robustness of the transportation network to accommodate increased travel demands, and proposed and tested several mitigation measures. The transportation network performance assessments identified key traffic operations deficiencies. The analysis involved identifying link level and intersection level capacity and level of service, evaluating global network performance, and comparing select route travel times within the study area.

In general, traffic operations in the 2035 and 2050 future base scenarios are considerably worse than existing. There are a number of factors which are responsible including the substantial population and employment growth for the adjacent neighbourhoods as well as the full build-out of the restricted covenants. These factors are illustrated below in *Figure 9.1* which lead to a large increase to trip making in the future horizon years. The number of additional trips for each horizon year compared to the existing base is significant and the resulting increase to travel demands adds additional pressure to the already constrained study area transportation network, particularly at the 200 Street interchange.

Figure 9.1: Components of Total Study Area Trip Generation

The following overall findings identified from this study are provided below:

- Substantial growth to population and employment is forecast for the study area and adjacent communities. The combined growth is 74% from 2016 to 2035, and 48% from 2035 to 2050.
- Between 2016 and 2035, the growth to population and employment translates to a 57% increase to the number of total trips, while between 2035 and 2050 there is expected to be a further increase of 37% to total trips.
- The 200 Street interchange was shown to operate close to its peak capacity in the 2016 existing base scenario. Forecast population and employment growth for the future 2035 and 2050 horizon years and resulting increase to trip making has detrimental impacts to the transportation network. Existing constraints such as the at the 200 Street interchange off-ramp terminals and "bottlenecked" intersections were shown to worsen significantly in terms of traffic operations performance.
- The restricted covenant trip generation limits were originally designed for the 2020 horizon year based on the 2001 Bunt & Associates study. Substantial growth to population and employment totals in the intervening years results in the system operating over capacity by the 2035 horizon year.
- 2035 and 2050 future base traffic operations are poor with severe congestion; even relative to existing conditions. Several locations were identified as bottlenecks, particularly the 200 Street interchange ramp terminals and 202 Street between 86 Avenue and 88 Avenue E. Increased congestion and delays are

primarily focused on areas south of Highway 1 as this coincides with the areas where the most intense development is occurring.

- Future potential road and transit improvements were shown to be relatively well utilized including the extension of 202 Street and 201 Street south of 86 Avenue and the long-term 192 Street interchange upgrade.
- Maximum build-out of the restricted covenants results in over 3,200 vehicle trips per hour within the 200 Street interchange lands during the PM peak period. These trips are localized around the constrained 200 Street interchange and cause traffic operations breakdowns at adjacent intersections and restricted covenant access points.
- The sensitivity analysis to examine the robustness of the network to accommodate increasing travel demands destined to and originating from the restricted covenants over the prescribed maximums revealed that existing deficiencies to the transportation network were further compounded by the increase to covenant trip generation. The sensitivity scenario induced a 30% increase to all restricted covenant trips during the PM peak period. This translates to approximately 950 additional vehicles per hour and resulted in a 15% increase to vehicle hours travelled in 2035 and a 5% increase in 2050, relative to the future base scenarios. The majority of turning movements at the 200 Street interchange were shown to operate at level of service ‘F’ for the 2035 and 2050 horizon years with sporadic gridlock of several key turning movements.
- Based on the traffic operations deficiencies observed in the future base scenarios, a list of potential mitigation measures was generated. A screening process was then adopted to remove mitigation measures with constraints around property availability and constructability. The resulting mitigation measures were evaluated based on the prescribed evaluation framework. The results indicated that the vast majority of mitigation measures improved traffic operations performance. In particular, conversion of 202 Street to a four-lane cross-section and signalization of key intersections was shown to provide marked benefits to the transportation network. Despite the improvements, there still remain deficiencies to the transportation network such that several turning movements and route travel times still exceed existing levels by a significant margin.
- There remains potential for supplemental mitigation measures to alleviate traffic operations issues within the 200 Street interchange lands. These include upgrading the eastbound off-ramp at 192 Street interchange by allowing for eastbound right-turns to be made, construction of a new westbound off-ramp at 192 Street, and/or providing another parallel north-south vehicle or active transportation-only connection across Highway 1 at 204 Street. As discussed in earlier sections of this document, these mitigation measures may provide benefits to the 200 Street interchange lands but may encounter constructability issues and/or resistance from community groups. Further investigation of potential mitigations measures may be warranted.

10. Conclusions

The Gateway area in the vicinity of the 200 Street interchange is still under development with the aim to create a sense of arrival to the Carvolth and Willoughby communities and to encourage development of landmark buildings at this high-profile location. With the increased development interest in these areas in the vicinity of the 200 Street interchange, there is a need to understand the performance of the transportation network for medium and long term horizon years as well as to determine the impact caused by potential modifications to the restrictive covenant which currently limits the trip generation in the area.

This document provided an assessment of the existing (2016) and future (2035 and 2050) transportation networks by providing quantitative and qualitative measures of performance. The study analyzed the potential traffic operations impacts caused by changes to the restrictive covenant, evaluated the effectiveness of several traffic operations mitigation measures, and provided qualitative commentary on potential broader (more extensive) supplemental mitigation measures.

In general, continued growth of population and employment within the study area as well as build-out of the restricted covenants to their maximum allowable limit was shown to cause a deterioration to the level of service to the transportation network with increases to delay and travel time. The additional covenant travel demand was observed to cause negative impacts to adjacent intersections. Road and transit improvements in the future horizon years are anticipated to be well utilized; however, there remain opportunities for improvements to address key network constraints in the vicinity of the 200 Street interchange.

Based on the results and key findings as presented in this report, the following is a list of potential options:

- As evidenced by the traffic analysis results for the future 2035 and 2050 transportation networks, it is not recommended that the restricted covenants on the parcels within the 200 Street interchange lands be modified to allow an increase to the trip generation.
- Localized mitigation measures resulted in marked improvement for select intersections. Township of Langley and BC MoTI are encouraged to further investigate and/or adopt mitigation measures, including but not limited to:
    - Upgrade 202 Street between 86 Avenue and 88 Avenue E to a four-lane cross-section.
    - Upgrade and signalize the intersection at 202 Street / 86 Avenue to accommodate the increased right-of-way and construct left-turn bays for each approach.
    - Normalize the single-lane roundabout at 202 Street / Highway 1 HOV ramps to a signalized intersection with expanded right-of-way.
    - Upgrade 86 Avenue between 200 Street and 202 Street to provide additional east-west capacity.
    - Upgrade 201 Street between 86 Avenue and 88 Avenue W to allow for a four-lane cross-section.
    - Upgrade and signalize the intersection at 201 Street / 86 Avenue.
    - Upgrade the intersection at 201 Street / 88 Avenue W by providing dedicated northbound and southbound left-turn bays, thereby increasing the ingress / egress capacity for the adjacent restricted covenants.

- Given the existing SPUI configuration of the 200 Street interchange and limited flexibility for modifications, exploration of other travel demand management (TDM) measures to reduce future vehicle demand at the 200 Street interchange is recommended. This includes the following potential supplemental measures:
    - Allowing eastbound right-turns at the 192 Street interchange;
    - Providing a westbound off-ramp at 192 Street in the interim (prior to build-out of the full interchange);
    - Alternative vehicle or active transportation only north-south connections across Highway 1 (such as at 204 Street), and;
    - Continued support of alternative non-auto mode share through enhanced transit and active transportation infrastructure and services.

In conclusion, the substantial forecast increase to travel demand for the 2035 and 2050 horizon years was shown to cause a corresponding increase to delay, worsening levels of service for key movements, and considerable increases to travel time relative to the existing base network. The result is a dramatic increase to network congestion. Therefore, the restricted covenants should not be modified to allow increased trip generation for the future horizon years.

Appendix A

Supplemental Site 8 Traffic Analysis

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Withheld pursuant to/removed as

s.21

Appendix B

Consolidated Data

Consolidated data tables for selected measures of effectiveness for the macro-scopic and micro-scopic analysis are provided below.

Table B.1: Mode Share Comparison (RTM)

MODE	2016	2035	2050
	DAILY	DAILY	DAILY
sov	48.2%	45.6%	44.9%
hov	38.7%	38.9%	38.8%
bus	2.0%	2.4%	2.5%
rail	0.3%	1.6%	1.7%
wce	0.1%	0.1%	0.1%
walk	9.8%	10.1%	10.4%
bike	1.0%	1.3%	1.7%
Total	100.0%	100.0%	100.0%

Table B.2: Network VHT and VKT Comparison (RTM)

MEASURE	PM 2016	PM 2035	PM 2050
SOVKT	92,900	124,900	145,600
HOVKT	19,800	29,900	41,500
LGVKT	2,800	3,300	3,700
HGVKT	3,200	4,200	4,800
TRVKT	300	400	400
SOVHT	2,400	4,200	5,500
HOVHT	500	800	1,200
LGVHT	100	100	100
HGVHT	100	100	200
TRVHT	0	0	0

Table B.3: Network PHT and PKT Comparison (RTM)

MEASURE	PM 2016	PM 2035	PM 2050
PKT	2,000	5,600	7,600
PHT	100	300	400

Table B.4: Processed Vehicle Volume (Aimsun)

INTERSECTION	APPROACH DIRECTION	PM		
		VOLUME (VPH)		
		2016	2035	2050
200 St and Hwy 1 Ramps	NB	1,740	1,900	2,140
	SB	1,940	2,250	2,250
	EB	1,880	1,790	1,330
	WB	730	720	610
200 St and 88 Ave E	NB	2,760	2,920	3,000
	SB	2,260	2,590	2,650
	EB	80	90	80
	WB	430	670	900
200 St and 88 Ave W	NB	1,790	1,960	2,340
	SB	2,840	3,260	2,960
	EB	520	1,010	1,070
	WB	190	350	350
202nd St and Route 1 HOV Ramps	NB	420	670	680
	SB	590	970	940
	EB	190	370	260
	WB	60	150	90
86 Ave and 200 St	NB	1,620	1,570	1,710
	SB	2,770	3,280	2,920
	EB	210	350	470
	WB	580	650	860
86 Ave and 201 St	NB	-	100	80
	SB	130	540	500
	EB	360	680	830
	WB	560	970	1,160
86 Ave and 202 St	NB	-	650	880
	SB	650	1,060	900
	EB	320	840	880
	WB	480	530	600
88 Ave E and 201 St	NB	-	90	90
	SB	140	180	210
	EB	700	940	840
	WB	380	580	790
88 Ave E and 202 St	NB	510	770	710
	SB	530	920	1,000
	EB	590	760	630
	WB	570	860	960
88 Ave E and NW Quadrant Access	NB	80	90	90
	WB	1,190	1,410	1,710
88 Ave W and 201 St	NB	210	470	520
	SB	130	590	540
	EB	1,160	1,090	1,120

Appendix C

Volume Plots (RTM)

2016 Total Volumes [Sc21000] - 2016 Carvolth 216IC AM

2016_03_Carvolth_216IC (Q:/SW/1309 (477242) MoT As & When Planning & Design #32/WBS 01000 Calvolth Traffic Study/Emme/2011 TransLink Regional Model/RTM_Ph32/2016_03_Carvolth_216IC/emmebank)
Scenario 21000: 2016 Carvolth 216IC AM
2019-11-20 11:06 (p005210b@BTLF9N2)

PARSONS

2035 Total Volumes [Sc21000] - 2035 Carvolth 216IC Committed AM

2035_10_Carvolth_Committed_RCEmp (Q:/SW/1309 (477242) MoT As & When Planning & Design #32/WBS 01000 Calvolth Traffic Study/Emme/2011 TransLink Regional Model/RTM_Ph32/2035_10_Carvolth_Committed_RCEmp/emmebank)
Scenario 21000: 2035 Carvolth 216IC Committed AM
2020-02-18 11:08 (p005210b@BTLF9N2)

PARSONS

2050 Total Volumes [Sc21000] - 2050 Carvolth 216IC Committed AM

2050_10_Carvolth_Committed_RCEmp (Q:/SW/1309 (477242) MoT As & When Planning & Design #32/WBS 01000 Calvolth Traffic Study/Emme/2011 TransLink Regional Model/RTM_Ph32/2050_10_Carvolth_Committed_RCEmp/emmebank)
Scenario 21000: 2050 Carvolth 216IC Committed AM
2020-02-18 11:06 (p005210b@BTLF9N2)

PARSONS

2016 Total Volumes [Sc23000] - 2016 Carvolth 216IC PM

2016_03_Carvolth_216IC (Q:/SW/1309 (477242) MoT As & When Planning & Design #32/WBS 01000 Calvolth Traffic Study/Emme/2011 TransLink Regional Model/RTM_Ph32/2016_03_Carvolth_216IC/emmebank)
Scenario 23000: 2016 Carvolth 216IC PM
2019-11-20 11:07 (p005210b@BTLF9N2)

PARSONS

2035 Total Volumes [Sc23000] - 2035 Carvolth 216IC Committed PM

2035_10_Carvolth_Committed_RCEmp (Q:/SW/1309 (477242) MoT As & When Planning & Design #32/WBS 01000 Calvolth Traffic Study/Emme/2011 TransLink Regional Model/RTM_Ph32/2035_10_Carvolth_Committed_RCEmp/emmebank)
Scenario 23000: 2035 Carvolth 216IC Committed PM
2020-02-18 11:09 (p005210b@BTLF9N2)

PARSONS

2050 Total Volumes [Sc23000] - 2050 Carvolth 216IC Committed PM

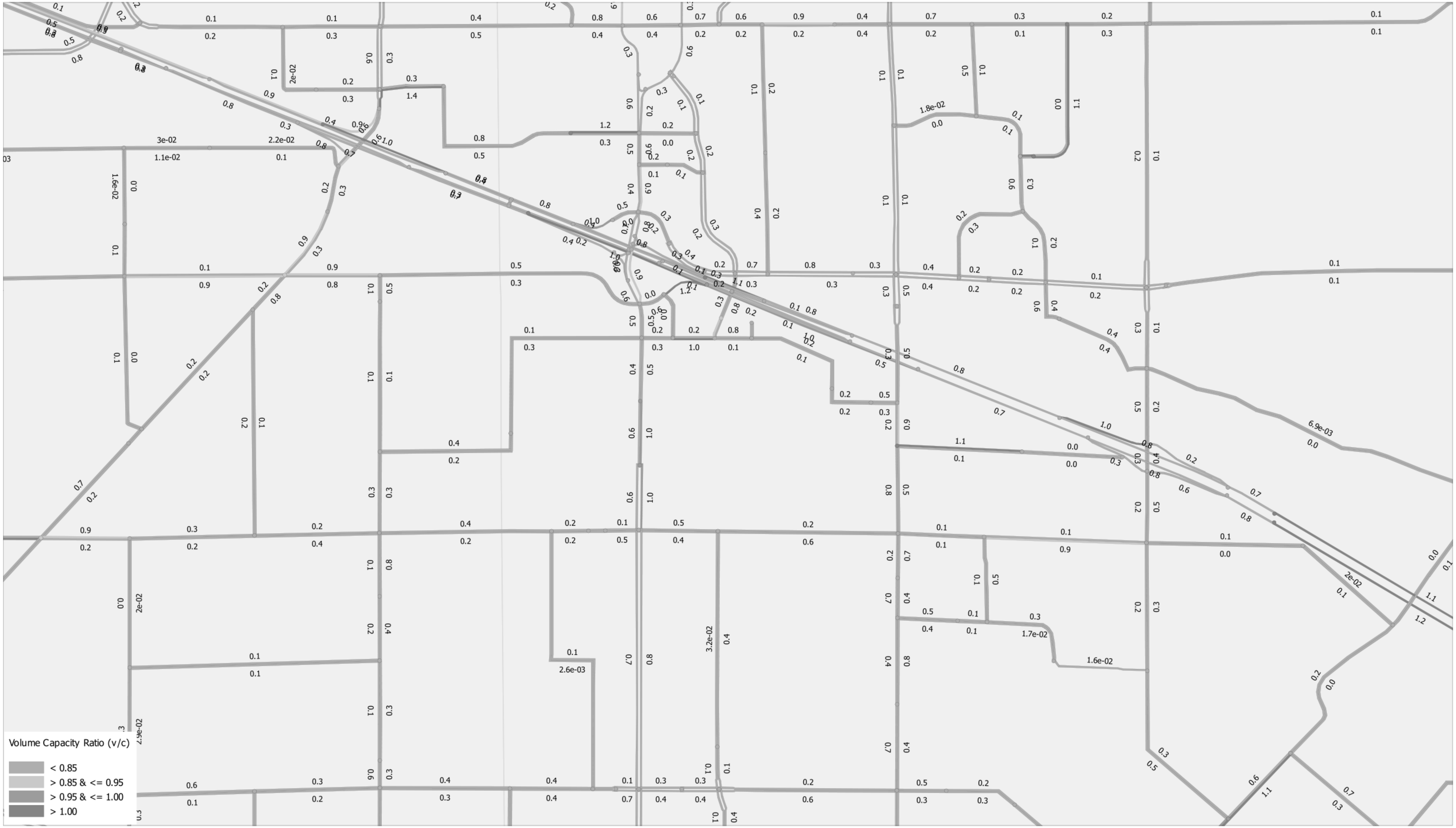
2050_10_Carvolth_Committed_RCEmp (Q:/SW/1309 (477242) MoT As & When Planning & Design #32/WBS 01000 Calvolth Traffic Study/Emme/2011 TransLink Regional Model/RTM_Ph32/2050_10_Carvolth_Committed_RCEmp/emmebank)
Scenario 23000: 2050 Carvolth 216IC Committed PM
2020-02-18 11:07 (p005210b@BTLF9N2)

PARSONS

Appendix D

V/C Plots (RTM)

2016 Volume Capacity Ratio [Sc21000] - 2016 Carvolth 216IC AM



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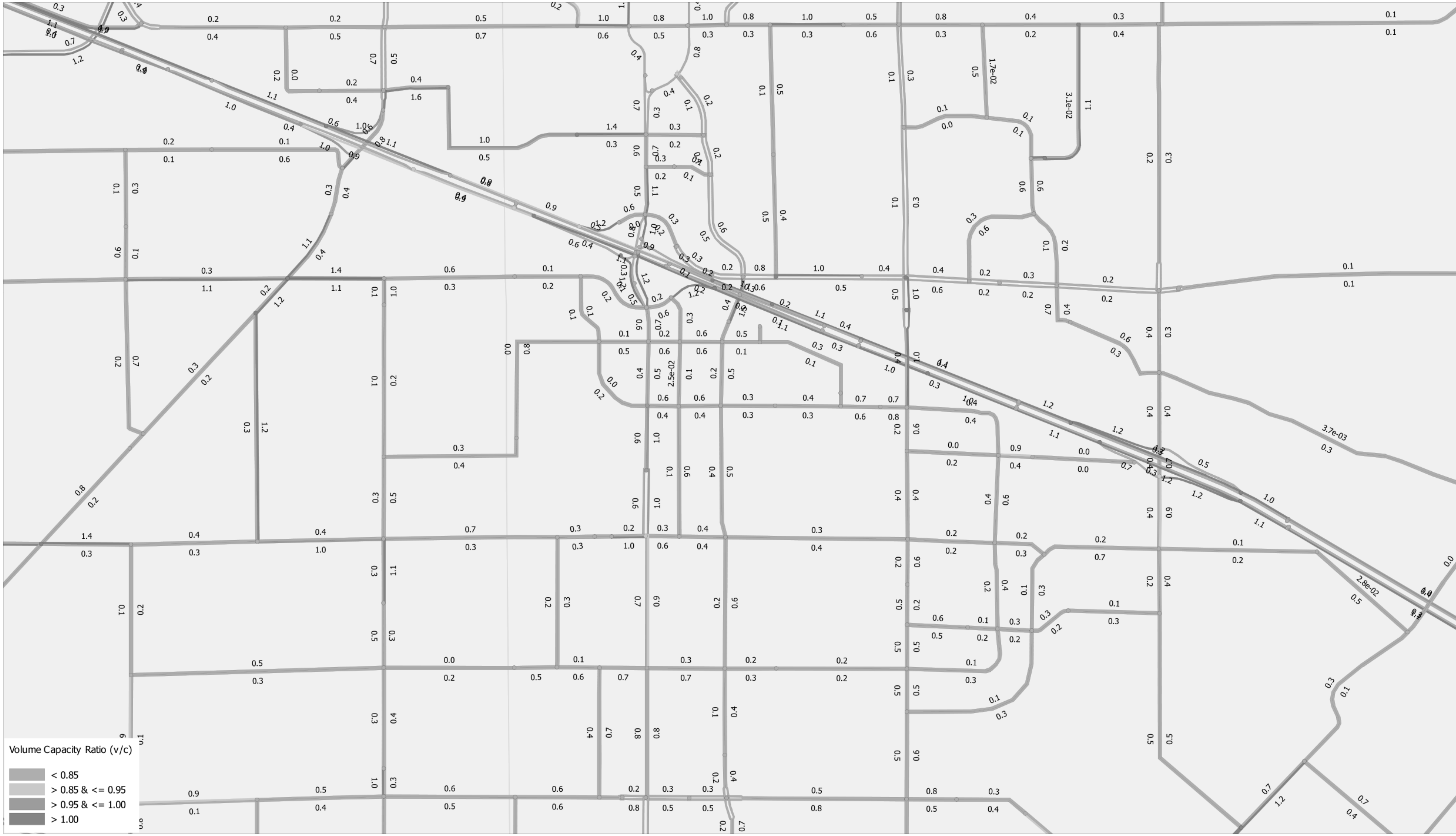
Scenario 21000: 2016 Carvolth 216IC AM
2019-11-20 11:06 (p005210b@BTLF9N2)

PARSONS

2035 Volume Capacity Ratio [Sc21000] - 2035 Carvolth 216IC Committed AM



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Scenario 21000: 2035 Carvolth 216IC Committed AM
2020-02-18 11:08 (p005210b@BTLF9N2)

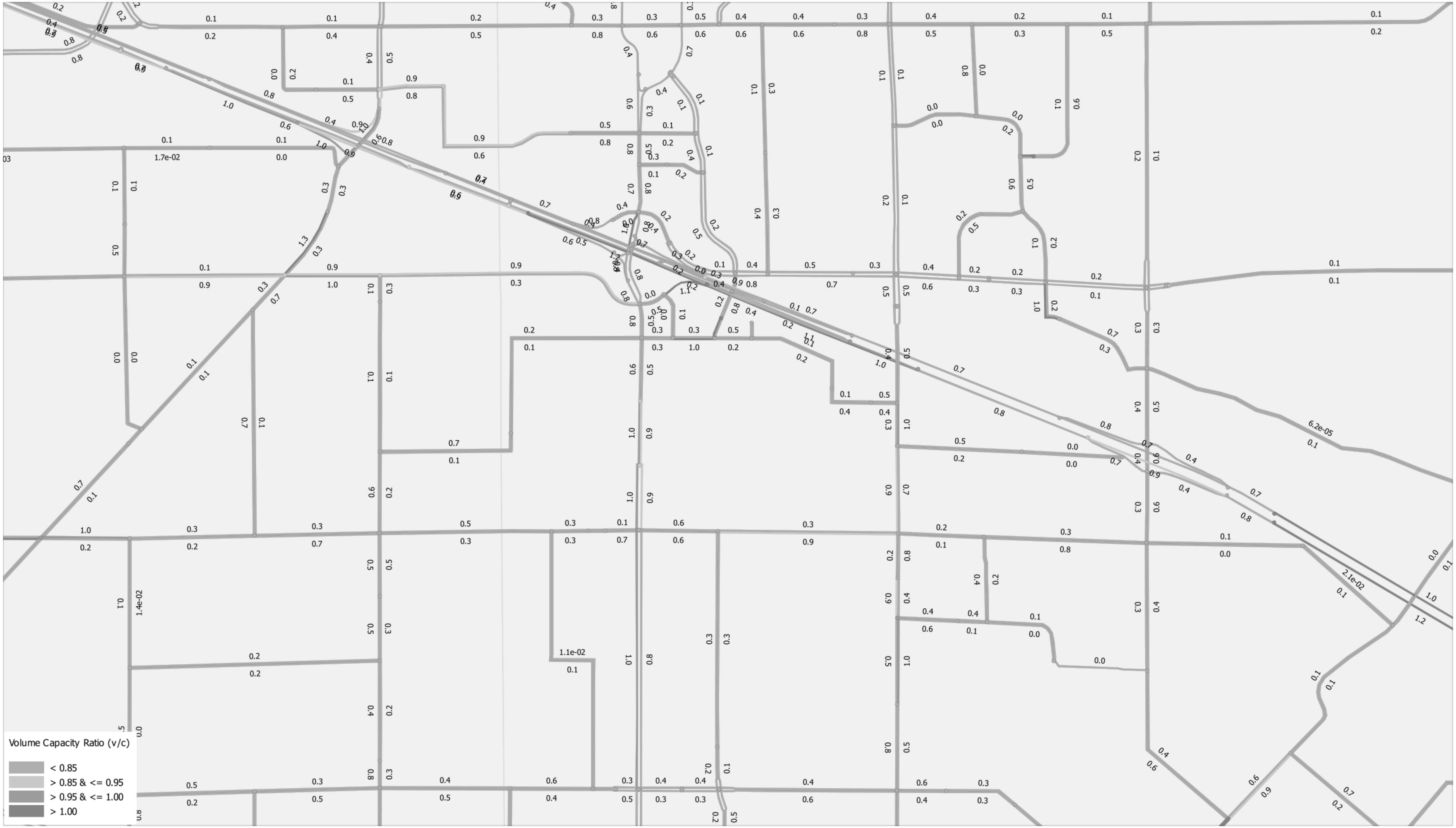
PARSONS

2050 Volume Capacity Ratio [Sc21000] - 2050 Carvolth 216IC Committed AM

2050_10_Carvolth_Committed_RCEmp (Q:/SW/1309 (477242) MoT As & When Planning & Design #32/WBS 01000 Calvolth Traffic Study/Emme/2011 TransLink Regional Model/RTM_Ph32/2050_10_Carvolth_Committed_RCEmp/emmebank)
Scenario 21000: 2050 Carvolth 216IC Committed AM
2020-02-18 11:07 (p005210b@BTLF9N2)

PARSONS

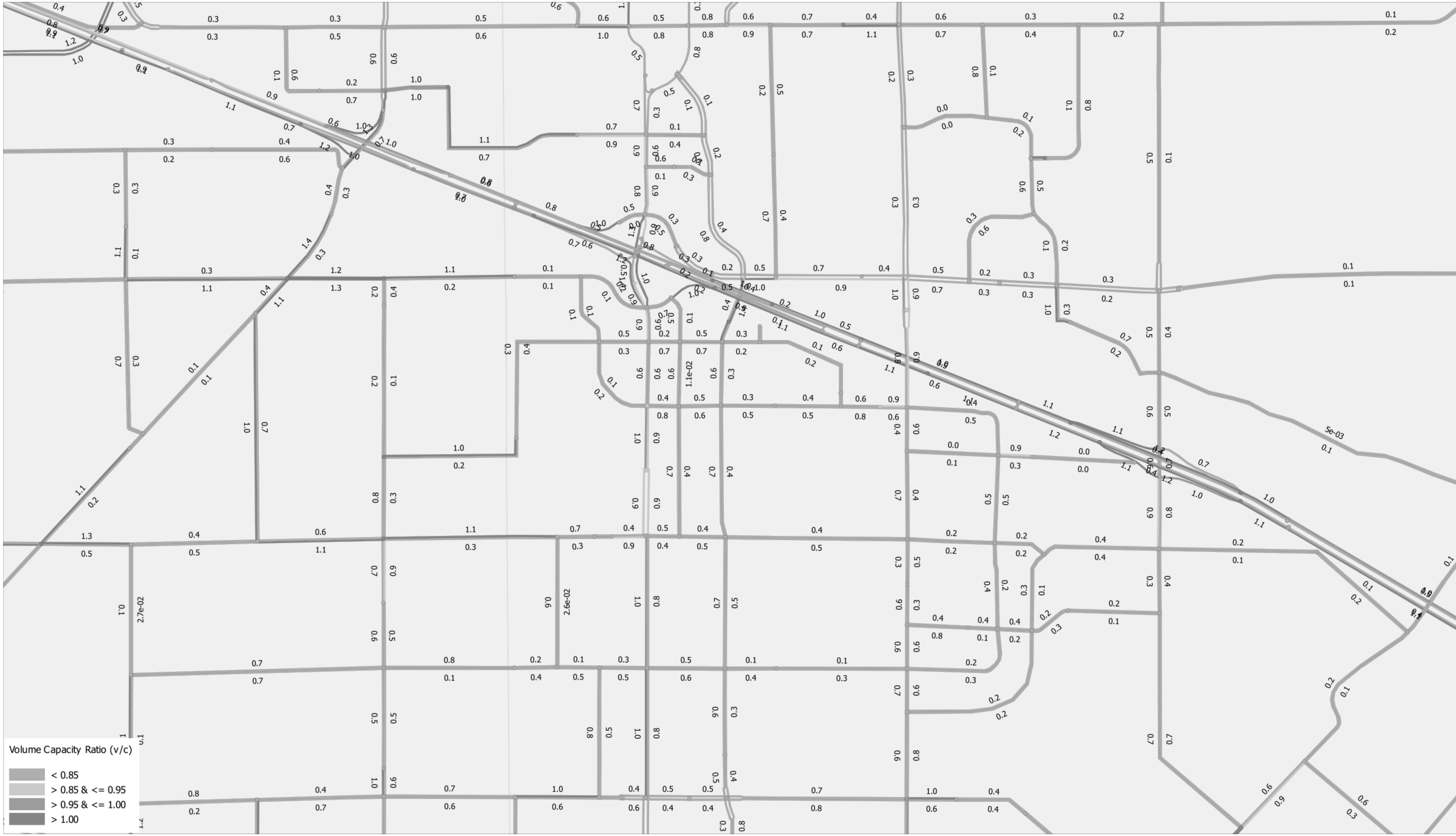
2016 Volume Capacity Ratio [Sc23000] - 2016 Carvolth 216IC PM



2016_03_Carvolth_216IC (Q:/SW/1309 (477242) MoT As & When Planning & Design #32/WBS 01000 Calvolth Traffic Study/Emme/2011 TransLink Regional Model/RTM_Ph32/2016_03_Carvolth_216IC/emmebank)
Scenario 23000: 2016 Carvolth 216IC PM
2019-11-20 11:07 (p005210b@BTLF9N2)

PARSONS

2035 Volume Capacity Ratio [Sc23000] - 2035 Carvolth 216IC Committed PM



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Scenario 23000: 2035 Carvolth 216IC Committed PM
2020-02-18 11:09 (p005210b@BTLF9N2)

PARSONS

2050 Volume Capacity Ratio [Sc23000] - 2050 Carvolth 216IC Committed PM

2050_10_Carvolth_Committed_RCEmp (Q:/SW/1309 (477242) MoT As & When Planning & Design #32/WBS 01000 Calvolth Traffic Study/Emme/2011 TransLink Regional Model/RTM_Ph32/2050_10_Carvolth_Committed_RCEmp/emmebank)
Scenario 23000: 2050 Carvolth 216IC Committed PM
2020-02-18 11:07 (p005210b@BTLF9N2)

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Appendix E

Summary of Background Documentation

Summaries for the relevant background documents were generated and are provided in Appendix E. The following is a list of the pertinent background documents:

- Carvolth Neighbourhood Plan (No. 4995);
- Willoughby Community Plan (No. 3800);
- Township of Langley Official Community Plan (No. 1842);
- Walnut Grove Community Plan (No.1836);
- Latimer Neighbourhood Plan (No.5101);
- Yorkson Neighbourhood Plan (No. 4030);
- Williams Neighbourhood Plan (No. 5335); and
- Smith Neighbourhood Plan (No. 5265).

It is important to note that the review of the documents focused on automobile and transit aspects of the network. In addition, it was noted that there was some overlap between the coverage area of select neighbourhood plans. Where land use is regulated under two or more plans, the most recent plan to be adopted should take precedence.

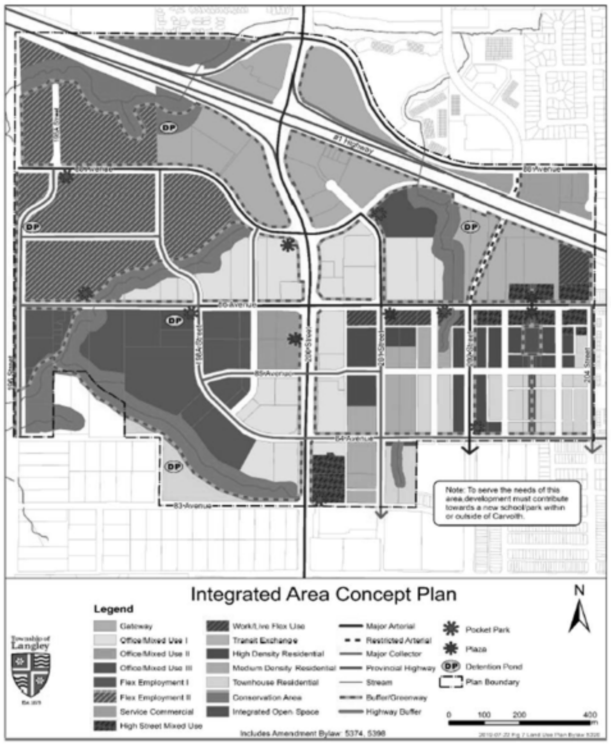
<table>
<tr><td>Title</td><td>Carvolth Neighbourhood Plan (No. 4995)</td></tr>
<tr><td>Author</td><td>Township of Langley</td></tr>
<tr><td>Client</td><td>N/A</td></tr>
<tr><td>Date</td><td>May 27, 2013 (amended on July 22, 2019)</td></tr>
<tr><td>Location</td><td>Carvolth</td></tr>
<tr><td>Horizon Year</td><td>2041</td></tr>
<tr><td colspan="2">Land Use and Transportation Goals</td></tr>
<tr><td colspan="2">Carvolth is envisioned to be a mixed-use gateway to the Township of Langley. It will also be a transit hub and a major employment node. The neighbourhood is planned to be pedestrian and transit-oriented while still being able to accommodate for vehicle traffic and goods movement. Diverse housing types will be available in Carvolth to support a range of ages and income levels.</td></tr>
<tr><td colspan="2">Existing Land Use</td></tr>
<tr><td colspan="2">Carvolth is currently designated as Business Park and Business Centre Mixed Use in the Willoughby Community Plan, permitting a mix of office, light industrial, retail, and service commercial uses.
There are four character areas in Carvolth: Gateway Node, Gateway Corridor, Transit Village, and Flex Employment.
Gateway Node involves properties adjacent to the 200 Street Interchange and is a strategic access point to the Township of Langley.
Gateway Corridor stretches between 83 Avenue and 88 Avenue on 200 Street and is intended to be a major transit-oriented, high density, and mixed-use corridor due to 200 Street being a part of TransLink's Frequent Transit Network (FTN).</td></tr>
</table>

- Transit Village is made up of a compact, fine-grained mix of housing, shops and services, and parks and plazas. An interconnected transportation network provides connections to the Carvolth Transit Exchange, shops and services, and employment nodes along 200 Street.
  - Flex Employment is an area with capacity for future employment uses. It has low intensity land use which generates low traffic and therefore light industrial development is preferred in this area. There is potential for an Outlet Distribution Centre in this area, subject to various regulations and guidelines.
- The area consists of some mixed-use office and retail development, strip commercial uses along 200 Street, some warehousing, distribution and office uses west of 200 Street, and primarily rural residential uses on large lots East of 200 Street.
- Notable developments in the area include the headquarters of the BC Government Employees Union (BCGEU), the world headquarters of Pharmasave, a distribution centre for Fraser Health, a Sandman Hotel, and the Carvolth Transit Exchange.
- Carvolth is also projected to have approximately 5,000 residents and 12,800 jobs by full build-out in 2041.

Future Land Use

- The following policies regarding land use are to be implemented within the Carvolth neighbourhood:
  - Transit-supportive uses are to be located within 400 metres of transit infrastructure along 200 Street, 202 Street, and Carvolth Transit Exchange to reinforce Carvolth's role as a transit hub.
  - Offices will be concentrated along 200 Street and within areas designated for Gateway Mixed Use to create a transit-oriented employment district.
  - A mix of new residential and commercial uses and services will be provided to support transit use and walking especially with the presence of Carvolth Transit Exchange.
  - A retail high street is to be created within the Transit Village area along 86 Avenue.
  - Developments in the Gateway designation may not exceed the traffic generation limits specified on any restrictive covenant registered on the property.
  - Emphasize land uses and development that reduces automobile use and enhances the street network to accommodate vehicle and commercial goods traffic and prioritize transit use, cycling and walking.
  - Preserve industrial areas for light industry uses that support Township businesses.
  - Accommodate ground-oriented work / live uses in Work/Live Flex Use.
  - Future expansion of High Street Mixed Use within lands designated Transit Exchange may be considered.
- A map of intended land uses in Carvolth is shown below:

Figure 7. Integrated Area Concept Plan



Existing Transportation Network
• Key routes within the neighbourhood include 200 Street and 202 Street in the north-south direction and West 88 Avenue, East 88 Avenue, and 86 Avenue in the east-west direction. Highway 1 also runs across the northern part of the neighbourhood. • The Carvolth Transit Exchange is a major destination on the Regional Transit Network and is an eastern hub for a Rapid Bus service connecting the Township to the SkyTrain system.

Future Transportation Network
• Active transportation and transit are to be prioritized. Vehicle and commercial goods traffic as well as access to businesses and residences still need to be accommodated. • More route options will be created for vehicle traffic, particularly for north-south traffic. • Increasing the capacity of the street network primarily for multi-modal mobility, rather than focusing solely on vehicle travel. • A grid street or lane network that enhances connectivity will be created. A more interconnected grid network is to be provided in the Transit Village area to provide access to the mix of uses in this area and emphasize the pedestrian and transit orientation of the area. • A safe, viable, and attractive public transit option for getting around Carvolth and reaching other parts of the township is to be ensured. • A boulevard treatment on priority streets in the Transit Village and Gateway Corridor Character Areas will be implemented.

- A new major arterial along 202 Street will be created to connect Carvolth Transit Exchange through the Latimer neighbourhood and beyond to the south and under Highway 1 to Walnut Grove to the north.
- Multiple new lanes are proposed in the Transit Village area to create a more pedestrian and transit-oriented area and provide more access to the various destinations within the area.
- West of 200 Street, the street network is made up of large blocks with limited connectivity to surrounding areas due to various geographical constraints and new streets proposed in this area will maintain this characteristic.
- Community-wide transit routes that facilitate access to Carvolth businesses and residential areas will be prioritized to allow safe and convenient connections with other public and private transit systems including regional bus, cycling, and both private and public shuttles.
- Mobility demand is to be managed by encouraging private and public developments to support non-automobile travel.
- According to a preliminary transportation impact assessment conducted as part of the Carvolth planning process, the full build out (including the Outlet Distribution Centre) would generate the following traffic in 2041:

Table 1. Trip Generation.

Description	Period	Vehicle Trips In	Vehicle Trips Out
All Trips	AM	4,753	2,412
	PM	6,238	8,108
Less Internal Trips	AM	350	161
	PM	249	420
Less Pass-By Retail Trips	AM	0	0
	PM	834	868
Total Trips	AM	4,403	2,251
	PM	5,156	6,819

- The road capacity required to accommodate development traffic in each direction of travel, assuming a lane capacity of 1000 vehicles per lane is:

Table 2. Trip Assignment.

Description	Period	Vehicle Trips In	Vehicle Trips Out
North	AM	0.6	0.3
	PM	0.7	0.9
East	AM	0.8	0.4
	PM	0.9	1.2
South	AM	1.4	0.7
	PM	1.6	2.1
West	AM	1.2	0.6
	PM	1.4	1.8

- The following road network is required to meet additional road capacity from proposed developments:
  - One arterial lane in the north direction.
  - Two arterial lanes in the east direction.
  - Two arterial lanes in the west direction.
  - Three arterial lanes in the south direction.
- The following road improvements are also recommended to achieve additional road capacity in various directions of travel:

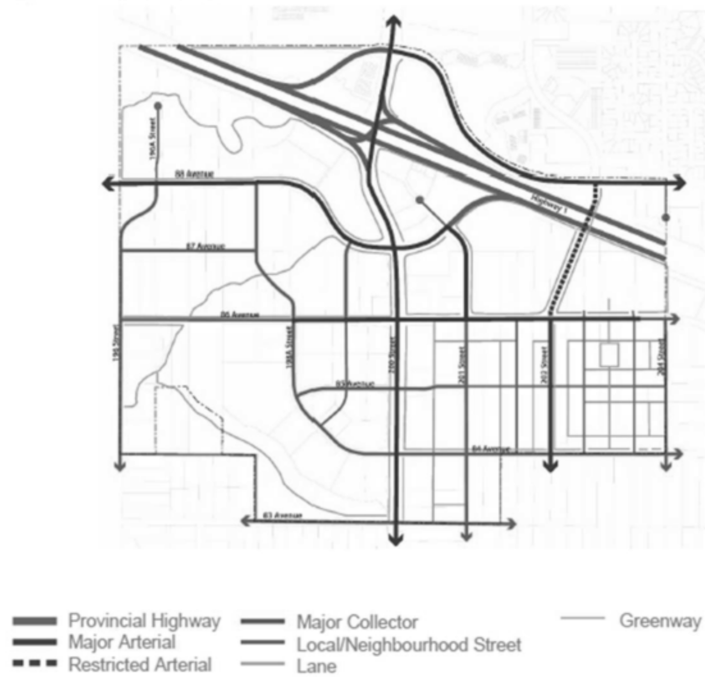
Table 3. Road Improvements.

Direction	Road Link	Transportation Improvements
Internal	196 Street	Extend to 88 Avenue
	198 A Street	Extend to 88 Avenue
	87 Avenue	Connect 196 Street and 198A Street
North	208 Street	Widen to 4-lane cross-section, including the Highway 1 overpass
East	Highway 1	Provide 216 Street Interchange
	80 Avenue	Widen to 4-lane cross-section
South	202 Street	Provide 4-lane cross-section
	201 Street	Provide 2-lane cross-section
West	88 Avenue	Widen to 4-lane cross section
		Remove heavy vehicle restriction
	80 Avenue	Widen to 4-lane cross section

Note that the 208 Street Overpass has been completed and the 216 Street Interchange is currently being constructed.

- A map of mobility network is shown below:

Figure 17. Mobility Network Map.

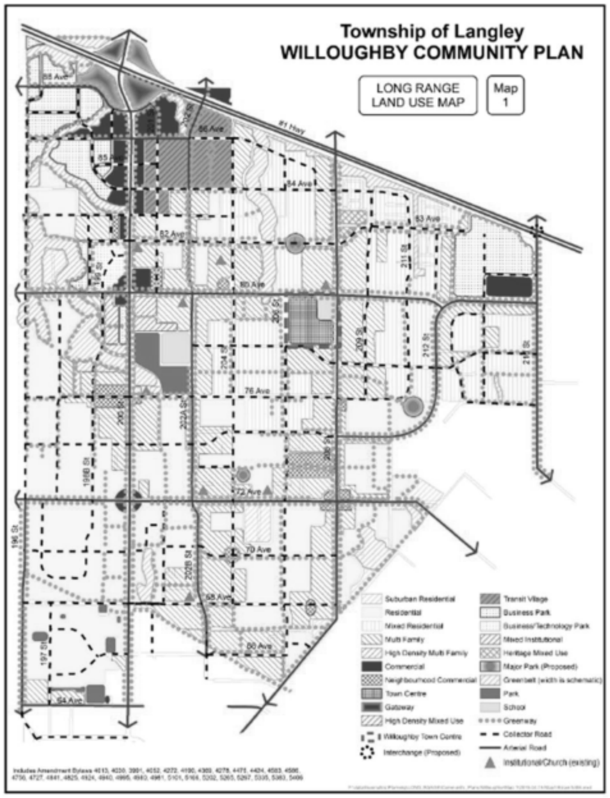


- A map of existing and proposed new street network is shown below:

Figure 20. Existing and Proposed New Street Network.

Title	Willoughby Community Plan (No. 3800)
Author	Township of Langley
Client	N/A
Date	May 4, 1998 (amended on April 19, 2019)
Location	Willoughby
Horizon Year	Not Specified
Land Use and Transportation Goals	
The Willoughby area is one of the few parts of the Township of Langley designated for and capable of accommodating major urban development. The area is envisioned to consist of a series of distinct but interrelated neighbourhoods, defined primarily by current or proposed key grid roads. Each neighbourhood is meant to support key land use elements, including an elementary school, a park, shops, higher density housing, and employment opportunities. A town centre that is to be supported by nearby employment opportunities is also envisioned in the area. A total population of approximately 65,000 people is anticipated. In terms, of transportation in the area, additional road and intersection capacity is to be provided at specific locations, where required to meet projected traffic increases. Another objective is to expand transit services to reach more parts of the community and increase its frequency.	
Existing Land Use	
• The Willoughby area is currently characterized by rural residential development, including estate homes, larger lot hobby farms, several institutional uses and extensive areas of woodlots and pastures. Non-residential uses in the area include a youth resource centre, schools, a market, a hall, and several large churches. A few parks also exist in the community. • An Agricultural Land Reserve (ALR) remains in a small part of the area. The main ALR is located southwest of the 200 Street / Highway 1 intersection, north of 84 Avenue.	

- The Willoughby land use map is shown below:



Future Land Use

- Two business areas intended for light industrial development and service commercial uses are identified with proximity to 200 Street. Principal access to buildings in these areas shall be from secondary routes to avoid interference with 200 Street's role as a major arterial.
  - The Business Park area on 88 Avenue west of 200 Street is intended to reflect a new alignment of the 86 - 88 Avenue connection to 200 Street to accommodate changes at the 200 Street and Highway 1 intersection.
  - The Business Park area at 80 Avenue near 216 Street is predicated on the Highway #1 interchange at 216 Street.
- It is intended that major commercial uses as well as higher density housing have convenient access to 208 Street and to 80 Avenue.
- The main commercial centres in Willoughby will be in the Gateway and Town Centre areas which will be mixed-use areas. The Gateway area will include retail commercial, offices, institutional uses and amenity space while ensuring the safety of the road network. The Town Centre area will include retail commercial, high density residential use, institutional use and public amenity space. All commercial centres will offer opportunities for creation of transit hubs.
- Several other neighbourhood commercial areas are located throughout the community. These commercial centres are either centered on 200 Street to serve automobile traffic or along secondary major roads for convenient access to nearby neighbourhoods. Secondary centres are planned at 208 Street and 72 Avenue and 212 Street and 83 Avenue.

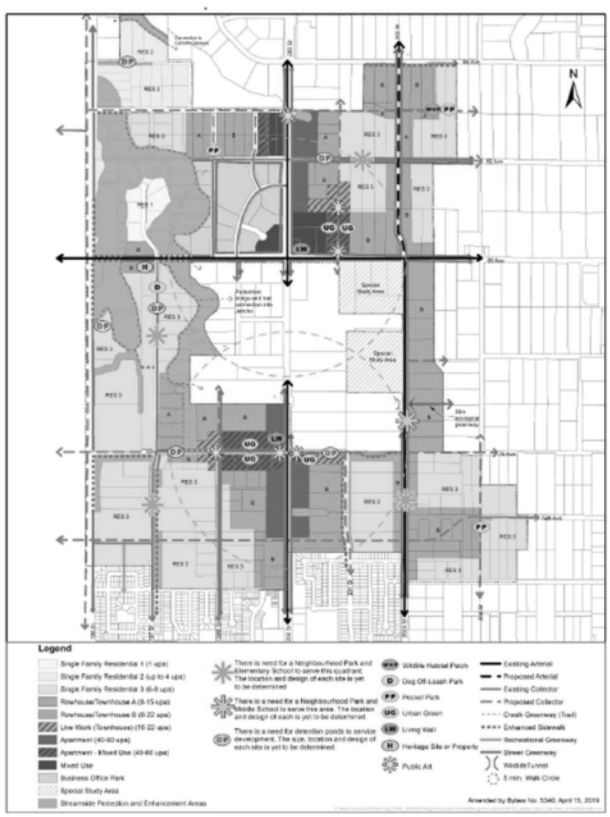
Existing Transportation Network
• Major arterial roads in Willoughby include 200 and 208 Street, carrying north-south traffic, and 80 Avenue, 72 Avenue, and 64 Avenue, carrying east-west traffic. • Currently, the only access to Highway 1 from the Willoughby community is the 200 Street Interchange. • An overpass of 208 Street across Highway 1, connecting Willoughby to the Walnut Grove community, has been completed. • The primary route into, out of, and though Willoughby is 200 Street. A few streets, including 72 Avenue and 80 Avenue, provide good access into the community. These roads have ample capacity to accommodate existing needs as well as future growth. • The transit network in Willoughby is less developed than the road network. Route 501 links the Langley City centre to Surrey Central SkyTrain Station and runs through the community on 202 Street, but service is infrequent. A similar route via 200 Street provides additional service during the peak periods. Service levels are typical of those for rural areas. Other parts of Willoughby are not served by transit. Provision should be made for connections to a potential Interurban Railway Station at Milner.
Future Transportation Network

• An interchange at 216 Street is currently being constructed to serve both Willoughby and Walnut Grove.
• The following policies are adopted for the development of Willoughby's transportation network:
    o Additional road and intersection capacity are to be provided at specific locations, where required to meet projected traffic increases.
    o It is proposed that, as demand arises, the penetration of transit services into Willoughby and the frequency of service be improved.

<table>
<tr><td>Title</td><td>Latimer Neighbourhood Plan (No. 5101)</td></tr>
<tr><td>Author</td><td>Township of Langley</td></tr>
<tr><td>Client</td><td>N/A</td></tr>
<tr><td>Date</td><td>September 28, 2015 (amended on October 1, 2018)</td></tr>
<tr><td>Location</td><td>Latimer</td></tr>
<tr><td>Horizon Year</td><td>2036</td></tr>
<tr><td colspan="2">Land Use and Transportation Goals</td></tr>
<tr><td colspan="2">Latimer is visioned to be a complete, livable, mixed density, walkable neighbourhood that is well-served by high frequency transit and framed by its natural features. In addition, a transportation objective is to support mobility for all modes of travel, including general purpose and commercial vehicle traffic, transit, walking, and cycling.</td></tr>
<tr><td colspan="2">Existing Land Use</td></tr>
<tr><td colspan="2">

- The predominant existing land use is rural residential, with most land parcels being larger than 0.8 hectares in area.
- At 200 Street and 82 Avenue, there is a business park development.
- There are institutional uses, including churches and a secondary school, within the neighbourhood.
- Note that the Langley Events Centre is located within the Jericho Neighbourhood, at the centre of the surrounding Latimer areas.
- A map of Latimer's land use is shown below:

Map 1 – Latimer Land Use Plan



</td></tr>
</table>

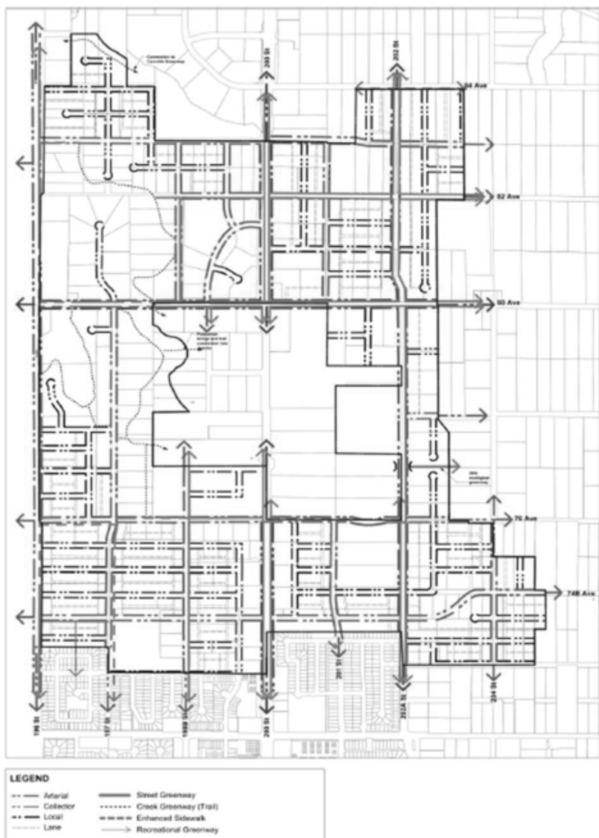
Future Land Use
• Along 200 Street, land use is to be intensified with a mix of transit supportive uses and densities. • Neighbourhood nodes along 200 Street at 80 Avenue and 76 Avenue are to be established. • Diverse housing opportunities, ranging from single detached homes to multi-family townhouse and apartment units, for people of all ages, income levels and abilities are to be created. • A residential build-out population of approximately 18,700 people in 7,900 dwelling units is to be accommodated. • Mixed-use and small-scale commercial uses in strategic locations of the neighbourhood are to be provided, to allow residents, employees, visitors and transit users to access everyday services within a convenient walking distance. • An elementary school and a middle school would likely be required in Latimer as the neighbourhood grows.
Existing Transportation Network

• Two major north-south corridors, 200 Street and 202 Street, exist in the Latimer neighbourhood. 200 Street provides important connections between Langley City Centre, Willoughby, Highway 1, and the Golden Ears Bridge. At the time of publication, 200 Street can accommodate 30,000 vehicles per day.
• An important east-west corridor is 80 Avenue which connects Latimer to the Willoughby area and the City of Surrey.
• The remaining road network in the neighbourhood is characterized by a disconnected grid street network with large blocks.
• Transit routes that provide regional connections from Langley Centre and Langley South through Latimer include:
  o Routes 501, 509, and 590, which are destined to the Surrey Central SkyTrain Station.
  o Route 595 destined to the Maple Meadows West Coast Express Station.
  o Route 388 destined to Braid SkyTrain Station in New Westminster via Surrey.
• Most transit services listed above run through 200 Street and operate every 30 minutes throughout the day. Some routes increase their service frequency to 15 minutes during the morning and afternoon peak hours. Route 388 only operates in the morning and afternoon peak hours.
• Since the Carvolth Transit Exchange's opening in September 2013, routes along 200 Street that travel through the Latimer Neighbourhood to the north are now directed east along 86 Avenue to the new Carvolth Transit Exchange.

Future Transportation Network
• 200 Street is envisioned to accommodate all modes of transportation, with median or side-running bus only lanes, four general purpose lanes, bicycle lanes, and multi-use greenways along the corridor. This cross section is to be implemented from 86 Avenue to Willowbrook Drive. Note that 200 Street is part of TransLink's Major Road Network (MRN). • 200 Street is also identified as a Frequent Transit Network (FTN) route in the short term (2011) and medium term (2021) of TransLink's South of Fraser Area Transit Plan, which provides a long-term vision for transit in 2031. Over the long term, 200 Street is envisioned to be part of the Rapid Transit Network with potential to accommodate bus or light rail rapid transit service within a dedicated median.

- A fine grained, interconnected network of streets is to be established. Traffic calming methods to allow easy local access to neighbourhood streets and direct through-traffic to arterials located at appropriate intervals will be used on the streets.
- A local road network based on a modified grid with an east-west orientation is to be implemented to provide route choices, and an enhanced pedestrian and cyclist environment. The modified grid concept is illustrated in the map below:

Map 3 – Circulation Concept Plan



- As the Latimer neighbourhood develops, better connectivity will be achieved as arterial and collector roads are built or improved. The completion of a modified grid network will facilitate travel within the neighbourhood by providing alternatives to motorists and thus distributing vehicular traffic across several routes.
- Future plans identify 202 Street as an arterial road that provides an alternate parallel route to 200 Street between Highway 10 and Highway 1. Additional transit service should be provided along 202 Street to serve a number of school sites and higher residential areas along it.
- 80 Avenue will continue to provide a strong east-west linkage in the future as an arterial road adjacent to the neighbourhood's business office park, mixed-use development and high-density residential areas. It is anticipated that a four-lane cross section will be needed along 80 Avenue.
- The transit mode share is expected to be around 7-8% in the full plan build-out of Latimer.

Title	Yorkson Neighbourhood Plan (No. 4030)
Author	Township of Langley
Client	N/A
Date	July 16, 2001 (amended on October 1, 2018)
Location	Yorkson
Horizon Year	2036

Land Use and Transportation Goals

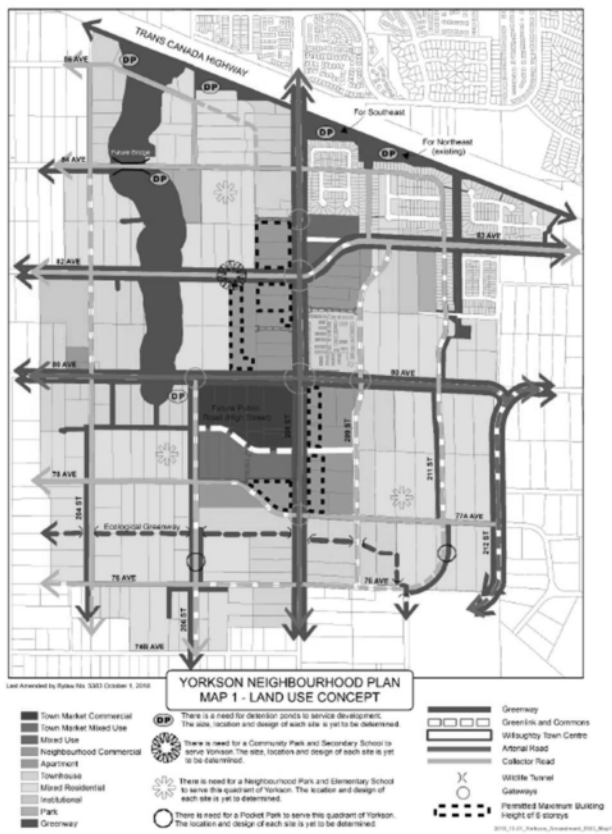
Yorkson is intended to be a livable and complete community with a centrally located neighbourhood core offering a range of living, work, shopping, and entertainment opportunities, as well as strategically located neighbourhood commercial centres.

Existing Land Use

- Yorkson is characterized by rural and suburban development patterns at low to medium densities, including estate properties and large lot hobby farms. Pockets of relatively small lots are found in some locations. Institutional uses in Yorkson include elementary schools, a community hall, a community park, and several churches.
- Higher density residential developments are located in a neighbourhood centre (downtown) whereas lower density developments are found closer to the neigbourhood's edge.
- Commercial support services for the neighbourhood is provided in the form of a Town Market and neighbourhood commercial area. The Town Market area is located at 208 Street and 80 Avenue.
- Apartments and townhouses providing high density residential usage is located just outside of the town centre along the arterial roads and around smaller commercial nodes.
- Yorkson is located between two large business or office park areas, the Carvolth area to the west and Singer area to be developed in the future.

- A map of Yorkson's land uses is shown below:

MAP 1 - LAND USE CONCEPT



Future Land Use

- A residential build-out population of 25,000 to 30,000 in 12,000 dwelling units need to be accommodated. The following is a breakdown of the various housing types in Yorkson:
  - 20% single family, including single family homes with suites, coach houses and granny flats.
  - 5% attached housing in single family areas.
  - 25% townhouses / rowhouses.
  - 50% apartments.
- A neighbourhood-centered commercial area is planned to be accessible within 500 m of all residential areas.
- While there is already one secondary school in the Yorkson neighbourhood, it is anticipated that another secondary school will be required in the future.

Existing Transportation Network

- Yorkson's road network is characterized by two-lane rural roads and relatively light traffic volumes. The road system is sufficient to meet the demands of the predominantly semi-rural level of development.
- The major arterials in Yorkson are 208 Street, 212 Street, and 80 Avenue.
- Fully functioning road network are in place, including 200 Street which provides access to Highway 1 and 208 Street which provides access to major shopping and employment opportunities in Willowbrook and the City of Langley and to services and facilities in Walnut Grove.

Future Transportation Network
• Key road improvements in the Yorkson Neighbourhood include: o Provision of roundabouts at all collector / collector intersections. o Realigning 83 Avenue and 82 Avenue at 208 Street. o Realigning 78 Avenue and 77A Avenue west of 208 Street. o Extending 204 Street from 80 Avenue to 86 Avenue. o Extending 206 Street south from 80 Avenue to 74B Avenue. o Provision for two collector routes west of 208 Street (209 and 211A Streets). • Several new road cross sections are proposed, including for 208 Street and 80 Avenue and other roads in the Town Market and Mixed Use areas. • An efficient interconnected street system that provides choice and incorporates traffic calming is to be created. • The neighbourhood is planned to eventually have a transit stop within 800 m of each household and business.

Title	Official Community Plan (No. 1842)
Author	Township of Langley
Client	N/A
Date	October 1, 1979 (amended on October 1, 2018)
Location	Township of Langley
Horizon Year	2043

Land Use and Transportation Goals

The Township is intended to be a self-contained "community of communities" with several urban centres that are separated by agricultural land. Urban land uses and major transportation networks are to be provided within the urban development area while rural areas are to be protected for agricultural, rural, and conservation purposes.

The Township also has transportation-specific objectives, which are to improve the safety of all road users, to maintain the efficient movement of goods while minimizing impacts on local neighbourhoods, and to maintain the integrity of the existing road network.

Existing Land Use

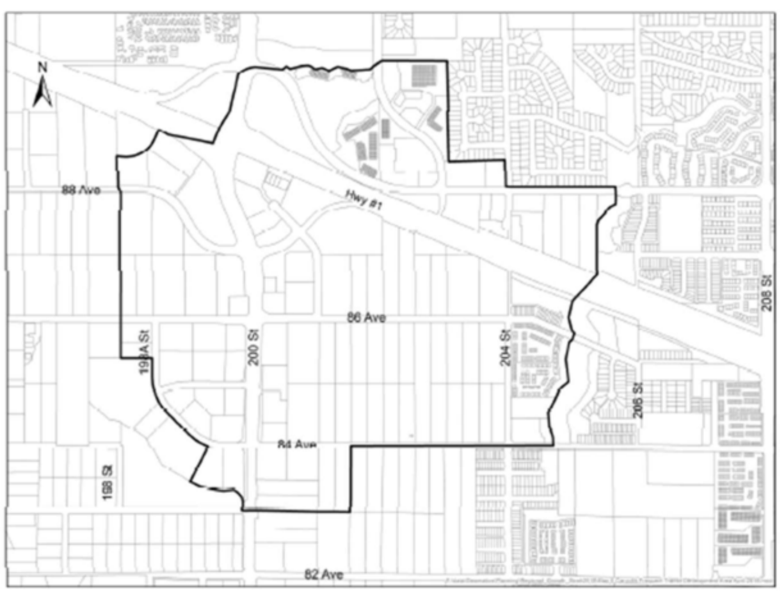
- Approximately 75% of the Township's land base is in the ALR.
- Land use designations in the Township of Langley falls under two categories: rural and urban. The rural land use designations are Agriculture, Rural, Rural Commercial Centre, and Conservation and Recreation. Urban land use is contained within urban centres, which include Regional Centre, Town Centres, Community Centres, Neighbourhood Centres, and Frequent Transit Development Areas (FTDAs). Within these centres, urban designations are Urban, Industrial, Mixed Employment, and University District.
- Langley's urban area consists of six communities: Aldergrove, Brookswood-Fernridge, Fort Langley, Murrayville, Walnut Grove, and Willowbrook / Willoughby.
- The following are the Township's urban centres:
    - The Willowbrook Regional Centre, which is intended to be a regional-scale commercial and mixed employment hub and a sub-regional transportation hub.
    - The Willoughby and Aldergrove Town Centres, which are intended to provide commercial, institutional, and entertainment activities, community amenities, and medium to high density housing.
    - The Brookswood-Fernridge, Fort Langley, Murrayville, and Walnut Grove Community Centres, which provide a similar function to Town Centres.
    - Neighbourhood Centres as specified in community and neighbourhood plans, which are intended provide small-scale commercial development and provide lower-density forms of multi-family housing.
    - The Carvolth FTDA, which is one of the focal points along TransLink's FRN containing higher density residential, commercial, and mixed-use development.

- A map of the Township's centres is shown below:

MAP 3 – CENTRES

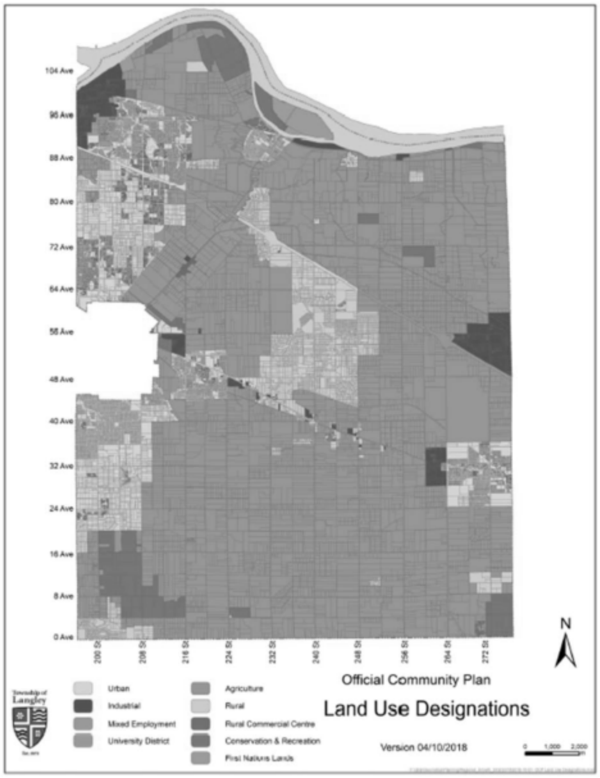
- The map below shows the boundaries of the Carvolth FTDA.

MAP 6 – CARVOLTH FREQUENT TRANSIT DEVELOPMENT AREA



- The Township's land use map can be found below:

MAP 1 – LAND USE



Future Land Use

- In 2041, the population of the Township is projected to be 211,000.
- The projected population for the Regional Centre, the Town Centres, and the Frequent Transit Development Area are shown in the table below:

Area	2013	2021	2031	2041
Regional Centre (Willowbrook)	1,375	1,700	3,400	5,100
Willoughby Town Centre	10	2,100	3,000	2,925
Aldergrove Town Centre	680	1,100	2,000	3,520
Carvolth FTDA	1,460	4,500	6,335	6,962

Table 4 Projected Population for Areas in Langley (2011 to 2041)

- The number of dwelling units in 2041 is expected to be 78,000, with approximately 37,000 new dwelling units to be constructed between 2014 to 2041. Of these, 85% are projected to be either single-family, rowhouse, or townhouses, and the remaining 15% to be apartment units.

- The Township also aims to provide approximately 1:1 ratio between the number of jobs in the Township and the number of residents in the labour force. In 2041, 100,000 residents are projected to be employed in the Township of Langley. The table below summarizes employment targets in the Township:

Year	MV Projection (High)	Township Projection
2021	69,000	76,000
2031	88,000	91,000
2041	100,000	100,000

Table 7 Employment Targets in Langley (to 2041)

The following table also presents employment projections by area:

Area	2011	2021	2031
Regional Centre	17,400	20,000	20,400
Willoughby Town Centre	25	300	700
Carvolth FTDA	875	5,200	6,400
Aldergrove Core	1,800	2,400	2,600
Total	**20,100**	**27,900**	**30,100**

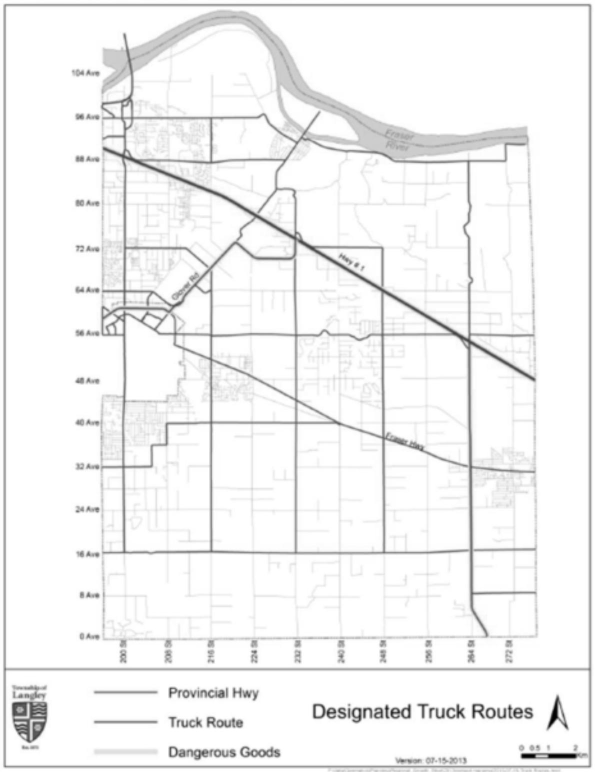
Table 8 Employment Targets for Areas in Langley (to 2041)

- The following are rural land use policies adopted by the Township:
  - Rural Commercial Centres are intended to provide retail and commercial services for the rural area. The Agro-Service Centre is intended to provide industrial and commercial operations related to agriculture.
  - Consider assembly uses (e.g. places of worship and schools) for Rural Commercial Centres.
  - New commercial development is to be directed to the Rural Commercial Centres.
- The following are general urban land use policies adopted by the Township:
  - Higher density residential and commercial developments are encouraged to be within the Town Centres and FTDAs. Small-scale commercial developments are allowed in neighbourhood centres to serve the local area.
  - Residential development is to be clustered within a five-minute walk (400 m to 500 m) of an urban centre. Urban centres can provide commercial retail, service, office, and mixed-use developments. Connections between centres and surrounding neighbourhoods are provided using an integrated grid road system.
  - Encourage mixed-use development in all centres, including mixed-used building forms.
  - Consider mid and high-rise residential developments along 200 Street in the Willoughby area.
  - Encourage the location of assembly uses on a collector or arterial road.
  - Continue the service commercial uses designated as Mixed Employment at 264 Street and Fraser Highway (in Aldergrove) but discourage expansion to new parcels.
  - Encourage industrial and business park development in the Willowbrook area in conformity with the Willowbrook Community Plan.

Existing Transportation Network

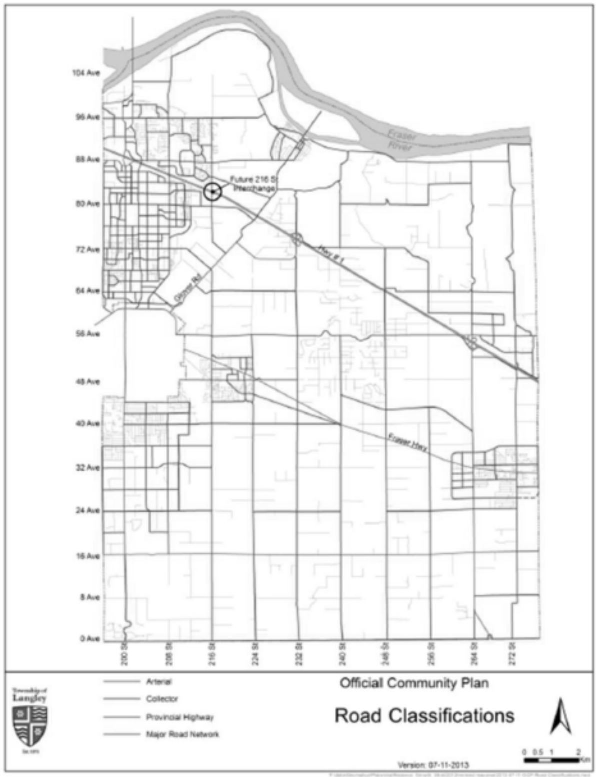
- There is one transit exchange in the Township, namely the Carvolth Transit Exchange on 202 Street. Another exchange exists close to the Willowbrook Regional Centre, specifically near the Glover Road and Logan Avenue intersection in the City of Langley.
- There are a number of designated truck routes within the Township; they are shown below:

MAP 8 – DESIGNATED TRUCK ROUTES



- A map showing classification of roads within the township can also be found below:

MAP 7 – ROAD CLASSIFICATIONS



Future Transportation Network

- The Township has established the following policies for developments in the transportation network:
  - Work towards a multi-modal transportation system that includes walking, cycling, transit, goods movement, and auto.
  - Implement the Master Transportation Plan and Road Classifications.
  - Create a fine-grained and well-connected network of streets with short blocks.
  - Identify portions of the road network deemed appropriate for priority transit use and / or high occupancy vehicles.
  - Consider implementation of demand management strategies such as ridesharing, carsharing programs, and transit priority measures.
  - Recognize the significance of the Trans-Canada Highway, the Fraser Highway and 16 Avenue in their capacity as major transportation corridors in ensuring the sustainable growth of the community. Develop plans that ensure efficient transportation is maintained along these routes with consideration of land uses that require access to transportation.
  - Explore opportunities for new park-and-ride facilities near transit exchanges, including new exchanges.
  - Facilitate safe and efficient goods movement to key industrial and commercial areas, primarily through designated truck routes.
  - Encourage transit improvements in all centres and FTDAs.

Title	Williams Neighbourhood Plan (No. 5335)
Author	Township of Langley
Client	N/A
Date	October 1, 2018
Location	Township of Langley
Horizon Year	Not Specified

Land Use and Transportation Goals

The Williams neighbourhood is envisioned to be a "vibrant, walkable, and connected community that maintains its natural assets and views" while being a gateway to the Township and Willoughby community. Williams will remain a quiet and family friendly neighbourhood that provides jobs close to home. At full build-out, Williams is projected to accommodate approximately 4,600 residents in 1,470 dwelling units.

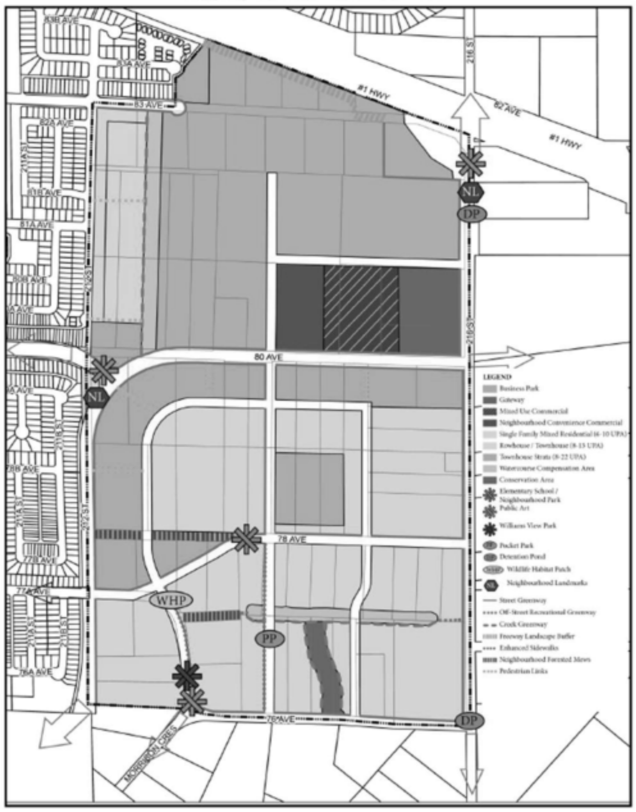
The neighbourhood's transportation goals include enhancing the road capacity on arterials and providing a fine-grain grid network that encourages walking and cycling for local trips. The neighbourhood's objective is to ultimately support mobility for all modes of travel, including general purpose traffic, goods movement, and transit, walking, and cycling.

Existing Land Use

- The Williams neighbourhood is located in the northeastern portion of Willoughby and is within close proximity to community parks, trails, and other amenities and services. It is also immediately adjacent to Highway 1 in the north, bordered by urban neighbourhoods to the west and north (separated by Highway 1), and rural lands in the ALR to the east and south.
- The predominant existing land use is rural residential and some established single-family estates on small acreage parcels. Existing land parcels range from 0.17 to 7.73 hectares (0.42 to 19.11 acres) in size.
- Presently, there are no elementary schools in the neighbourhood. However, a future elementary school site is anticipated to be developed at such time that the population growth warrants the establishment of a new school.

- The map below shows land uses within the Williams neighbourhood:

Map 1 | Williams Land Use Plan



Future Land Use

- The following policies are outlined in the Neighbourhood Plan to guide the design and development of block and street patterns in residential areas of the neighbourhood:
  - Design block perimeters and block face lengths that result in a street network with high connectivity, that balances pedestrian and bicycle comfort and mobility, emergency response times, transit accessibility, freight delivery, and automobile movement
  - Design residential areas with a network of walkable streets on a modified grid road and block pattern to increase route options and connections
- Williams can be divided into three main districts: Employment, Transition and Residential, that define the spatial structure of the neighbourhood.
- The Employment District is located near the 216 Street Interchange and supports commercial and business employment that will provide jobs close to home and commercial services for local residents, employees, students, and the travelling public. As such, uses include restaurants, overnight accommodations, gas station, vehicle repair, and other comparison retail. A modestly-sized shopping area will also be provided in this District. Shops, offices, and services, including a grocery outlet, are envisioned here.
- The Transition District provides a linear band of single-family residential development along 212 Street and 83 Avenue, followed eastward by rowhomes and townhomes, a greenway and environmental conservation areas that combine to create a multi-feature transition between existing residential areas in Yorkson and the Employment District in Williams.

- The Residential District includes predominantly a range of lower-density, compatible forms of residential development including single-family and semi-detached homes on compact and more traditional lot sizes, as well as townhouse forms of housing along the 80 Avenue and 212 Street corridors. An elementary school and other public amenities can be found in this District.
- An estimate of the future population in the neighbourhood at full build-out is provided in the table below:

Table 5.1 | *Distribution of Dwelling Units and Population*

Land Use Designations	Approximate Area		Density	Population Density	Approximate Number of Dwelling Units	Approximate Population	Maximum Storeys from Grade
	Ha	Ac	Units Per Acre (UPA)	Person Per Unit			
Single Family Mixed Residential	38.6	95.4	6 - 10	3.8	763	2,900	2
Rowhouse / Townhouse	3.5	8.7	8 - 15	2.5	100	250	3
Townhouse	16.2	40.1	8 - 22	2.5	604	1,504	3
TOTAL					**1,465**	**4,654**	

Existing Transportation Network

- Within the neighbourhood, the network consists of one north-south corridor along 216 Street and a partial corridor along 212 Street and three east-west corridors along 76 (Morrison Crescent), 78, and 80 Avenues.
- The local road network has served the rural nature of the area and historically has not had a direct route to the north over or onto Highway #1.
- Currently main access to Willoughby Town Centre in Yorkson is on 80 Avenue, and access to Highway 10 (Glover Road) is from 216 Street.
- The remaining road network in the Williams area is characterized by a disconnected grid street network that serves large blocks.
- 80 Avenue, 212 Street, and 216 Street are arterial roads, while the collector roads for Williams are 76, 78, 79A and 81 Avenues and 212A (including Morrison Crescent), and 214 Street.
- Public transit service is not currently provided in the Williams neighbourhood. However, it is anticipated as development occurs service could likely serve the area, possibly along 80 Avenue and the 212 Connector.

Future Transportation Network

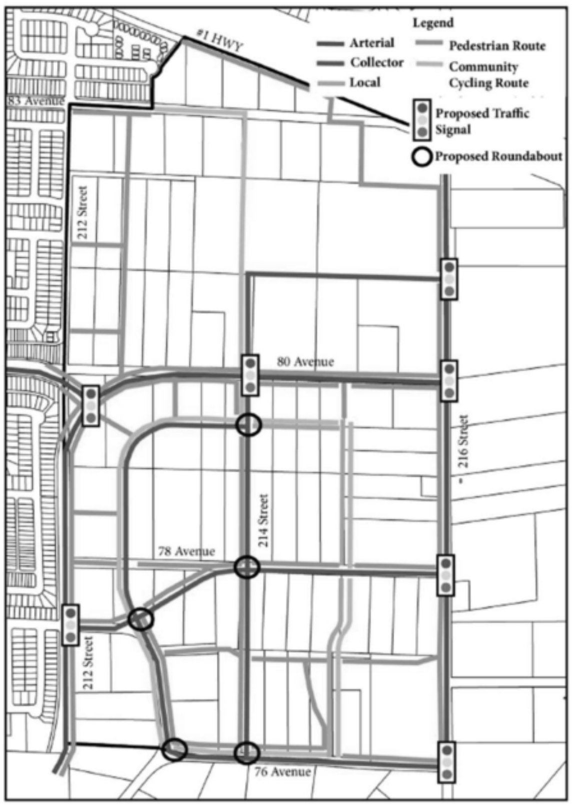
- Some of the transportation policies adopted by the Neighbourhood are:
  - Develop an interconnected local road network that conforms to the arterial, collector and local street hierarchy of roads in Williams as delineated in the Circulation Concept Plan (Map 3). The alignment of the collector route of 78 Avenue to 77A Avenue is required to ensure connectivity. The local road alignment as illustrated in the Circulation Concept Plan that provides connection between 76 Avenue and 79A Avenue shall be incorporated as part of subdivision design.
  - While TransLink's South Fraser Area Transit Plan does not currently indicate any specific new transit routes through the Williams neighbourhood, transit ridership is expected to grow and it is reasonable to assume that transit services will likely operate on major arterial roads such as 216 Street, 212 Street, and 80 Avenue. Williams' goal is to enable active transportation by

implementing a convenient pedestrian and cycle network which will connect residents' homes to transit stops in the short and medium term until transit is available in the area.

- Provide a street design standard along 78 Avenue to integrate future community shuttle transit service.

- A map showing the transportation network in Williams is shown below:

Map 3 | Williams Circulation Concept Plan



- Significant improvements are planned to the road network with the construction of the 216 Street interchange, the 80 Avenue Extension and 212 Street Connector that will improve north-south and east-west connections.

Title	Smith Neighbourhood Plan (No. 5265)
Author	Township of Langley
Client	N/A
Date	June 26, 2017
Location	Township of Langley
Horizon Year	2040

Land Use and Transportation Goals

The vision for the Smith neighbourhood is to be a walkable community with integrated uses and a mix of high and low densities while preserving the natural landscape that encompasses the area. The neighbourhood is intended to maintain and enhance road capacity on arterials and provide a grid network and street design that encourages alternative modes such as cycling, walking and transit use.

Existing Land Use

- The predominant existing land use is rural residential with a large natural area and the ALR to the east. The majority of existing land parcels are large lots of two to six acres and smaller lots of approximately one acre over 169 acres area.
- At present, there are no elementary schools in the neighbourhood. However, growth in population is anticipated to warrant new school sites. Schools will be constructed when required.
- Existing land uses within the Smith neighbourhood is shown in the figure below:

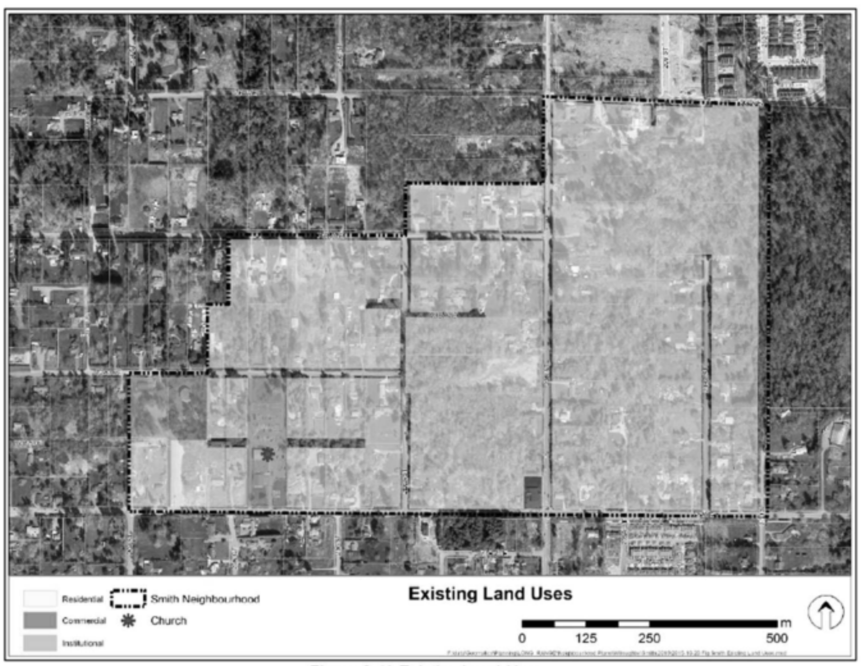
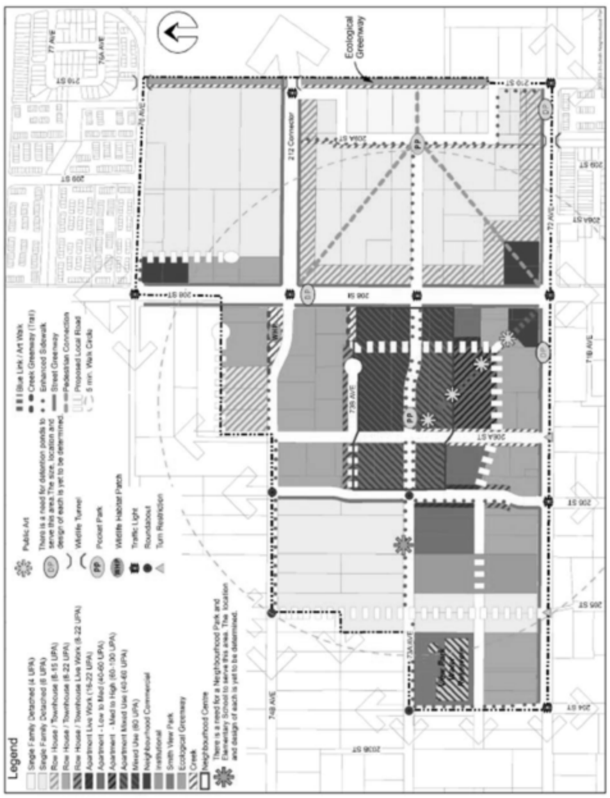


Figure 2.1 | Existing Land Uses

Future Land Use

- A neighbourhood centre is proposed along 73a Avenue west of 208 Street. This area is intended to be the focal point of the neighbourhood as well as serve the surrounding areas. A walkable urban village is envisioned here.
- The area surrounding 73a Avenue and 206a Street is proposed to have increased density and mixed-use development supporting transit stops on the 208 Street corridor and 72 Avenue corridor.
- A map showing the Smith neighbourhood land use is shown below:

Map 1 | Smith Land Use Plan

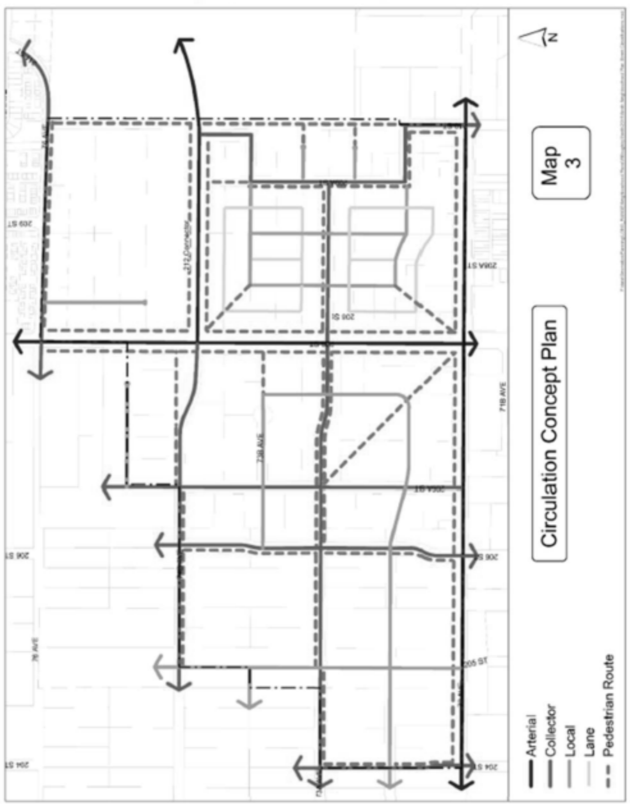


- The following general policies for land usage are adopted by the neighbourhood:
  -

Existing Transportation Network

- Within the Smith neighbourhood, the transportation network consists of one major north-south corridor. 208 Street provides important connections between Langley City Centre, Willoughby, and Walnut Grove. The existing transportation network also includes 72 Avenue, which is an important east-west corridor providing a connection to the Willoughby area and the City of Surrey. The remaining road network in the study area is characterized by a disconnected grid street network with large blocks.
- Presently, there is one bus route (Route 595) on 208 Street with expansion to service anticipated as development unfolds.
- Arterials within the neighbourhood include 72 Avenue, and 208 Street. Collector roads include 204 Street, 206 Street, 206A Street, 73A Avenue, 74B Avenue, and 76 Avenue.

Future Transportation Network

• Smith is envisioned as a walkable neighbourhood where people can walk to local services, transit or other frequent destinations with comfort, safety, and convenience. This is generally accomplished by locating housing within a 5 minute or 400 metre walking radius from local, frequent destinations and connected by continuous, active pedestrian paths.
• Some of the neighbourhood's transportation objectives and policies are:
  ○ Provide a modified grid network that will facilitate travel within the neighbourhood by providing alternatives to motorists and thus distributing vehicular traffic across several routes.
  ○ The Neighbourhood Centre development on the west side of 208 Street between 72 Avenue and 74b Avenue should feature high quality transit stops and appropriate passenger amenities.
• 212 Street is proposed to be extended south through the Smith neighbourhood as an arterial road.
• The map below outlines the planned road network:
Map 3 | Circulation Concept Plan

 	
• The South of Fraser Area Transit Plan includes 208 Street as a Frequent Transit Network (FTN) route candidate in the long term. Since transit ridership is expected to grow, higher order transit along 208 Street is also expected.

Appendix F

Macro-scopic Base Year Model Refinement and Validation

PARSONS

Carvolth Traffic Study

Macro-scopic Base Year Model Calibration

October 2019

PARSONS

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This document is divided into two parts – Part A, and Part B. Part A shows initial model comparison related to the Carvolth study area using TransLink's Regional Transportation Model (RTM). Part B documents various model updates, and additional model comparisons related to the Carvolth study area using the refined model.

PART A – MODEL COMPARISON

This section beings with a high-level examination of regional travel patterns in the model by comparing daily trips by mode. Subsequently, a more detailed examination of travel patterns within the study area is conducted by comparing peak hour trip assignment.

A.1 INTRODUCTION

As part of the Carvolth Traffic Study, the regional transportation network in TransLink's Regional Transportation Model (RTM) Phase 3.2 are to be updated in the Carvolth study area for a more accurate representation of travel patterns. The purpose of this memo is to describe the initial model review and compare the accuracy of the model, which led to further refinement. The memo starts with comparisons on the regional scale, and then focuses specifically on the study area.

A.2 DAILY TRIPS BY MODE

The main purpose of the daily trip comparisons is to demonstrate that trip patterns modelled by the RTM are reasonable on the daily level at the regional scale, as well as to highlight some of the differences related to the Carvolth study area.

Data Source

The primary data source is TransLink's Regional Trip Diary which contains information on 24-hour weekday travel from a random sample of residents in the Lower Mainland. Because the 2017 Trip Diary Survey results were not available at the outset of this project, the 2011 Trip Diary Survey data is used. The 2011 Regional Trip Diary survey used a combination of online and mail-out questionnaire options and was conducted from September 15 to December 12, 2011. The study area includes the entire Lower Mainland and the survey data represents 2.2% of households. The survey sample was expanded to regional totals in order to provide daily trip estimates and regional travel characterises. For more information, please refer to TransLink's *2011 Metro Vancouver Regional Trip Diary Survey Analysis Report (2013)*.

In order to use the 2011 Trip Diary Survey data for comparison, the data has to be normalized to 2016, since 2016 is the base year for this study. The normalization used the readily available RTM Phase 3 model, which has both 2011 and 2016 horizon years. The resulting differences in model daily trips between 2011 and 2016 were applied directly to the 2011 Trip Diary Survey, accounting for the land use growth, transportation policy, and infrastructure changes during these 5 years.

It should be noted that TransLink has been working on the 2017 Trip Diary Survey, which was released in fall 2019 but was not available for use during this phase of work.

RTM vs. Normalized Trip Diary Survey Comparison

A set of seven diagrams, one for each transportation mode, is used to demonstrate the differences in daily trips between the RTM and the normalized trip diary survey. The advantage of these diagrams is to effectively compare the first three stages of the 4-step demand forecasting model – trip generation, distribution and mode choice. For each diagram, in addition to the usual 15 subregions of the Lower Mainland, the Carvolth study area was further divided into three subregions, as shown in *Figure 1*, to facilitate comparisons of model outputs in a local context more suitable for the study. The subregions, corresponding to the numbering in *Figure 1*, are represented in each diagram.

Figure 1: Subregions (GV)

Figure 2 shows a comparison of the differences in daily trips between the RTM and the normalized trip diary survey. Each diagram is in matrix format showing trip production (Y-axis) against trip attraction (X-axis). The cells are color formatted with stronger colors corresponding to higher differences. In each diagram, the separation lines are set up to distinguish those related to the Carvolth study area (i.e. GV 72, 75, 83), and those not related to the Carvolth study area. The top left part of each diagram represents trips from the Carvolth study area residents to destinations outside the Carvolth study area, the top right part of each diagram represents trips from the Carvolth study area residents to the Carvolth study area, the bottom left part of each diagram represents trips from residents outside the Carvolth study area to destinations outside the Carvolth study area, while the bottom right part of each diagram represents trips from residents outside the Carvolth study area to the Carvolth study area. This study should be particularly interested in the top left, top right, and bottom right part of each diagram.

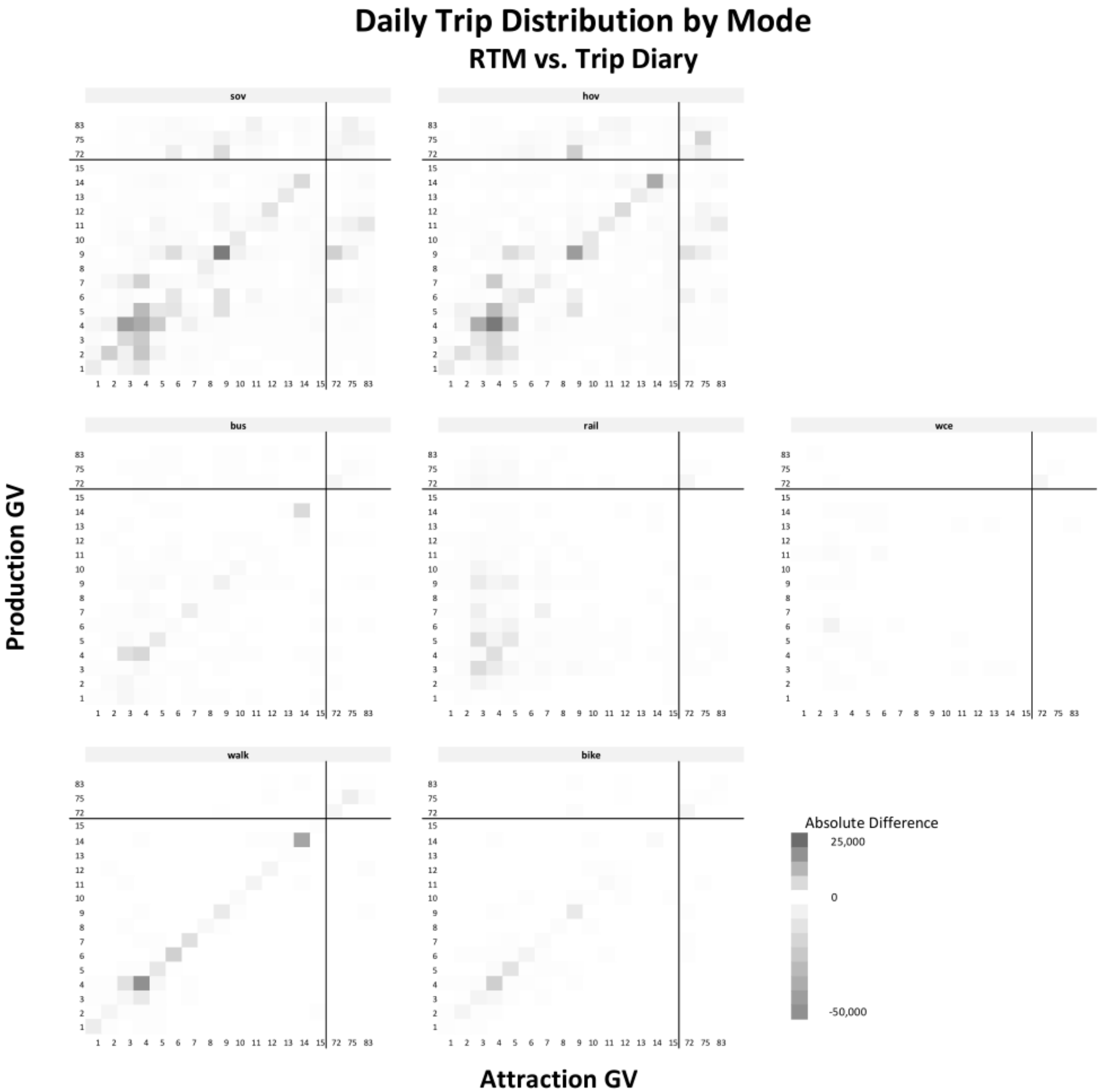

Figure 2: RTM vs. Trip Diary Comparison

These differences are very similar to those presented in the last RTM Stakeholders Workshop in March 2017. For more information, please refer to slide 40 of the *RTM Stakeholders Workshop – Static Validation (March 2017)*.

In general, differences are less noticeable for study area trips compared to the rest of the region. For auto trips, slightly lower auto trips within the Carvolth study area are demonstrated by the model. Slightly higher auto trips between the Carvolth study area and Surrey are demonstrated by the model.

A.3 PEAK HOUR TRIP ASSIGNMENT COMPARISON

The final step in the travel demand model is Trip Assignment, which determines the route or path trips take in the model network from origin to destination. Auto assignment is the assignment of auto trips on the auto network. User equilibrium is reached when all trips are distributed in the auto network under the condition that no users could reduce their travel costs (times) by switching to a different route. Transit assignment is the assignment of transit trips on the transit network. The multipath transit assignments are based on the concept of a strategy, in which the traveller chooses a set of paths before embarking on the trip, and then lets the vehicles that arrive first at a stop determine which of these paths to take. The optimal strategy is the one that minimizes the total expected travel time including walking, waiting, boarding, and riding. The latest enhancement of the RTM has incorporated the effect of crowding and pass-ups into transit assignment.

The results of a trip assignment are used to determine usage and performance. Road usage results include vehicle volumes. Road performance results include auto travel times.

This section includes a description of the observed data sources, and comparison statistics of the RTM to these observed data.

Data Sources

Two sources of observed data are described in this section – Auto Link Volumes, and Auto Travel Times. They include detailed descriptions of the locations chosen, the scope and time frame of the data, assumptions and methodologies, and the processing of these data.

Auto Link Volumes

Link locations with available count data are shown in *Figure 3*. They were obtained from multiple sources, as listed in *Table 1*.

Table 1: Observed Data Sources

Source	Location	Collection Period	Data Type	Processing
Township of Langley Tube	196 St., 202A St., 208 St., 210 St., 203 St., 204 St., 208 St., 211 St., 212 St., Glover Rd., 72 Ave., 77A Ave., 80 Ave., 84 Ave., 86 Ave., 88 Ave., 91A Ave., 92A Ave., 96 Ave	2016-2017	Multiday 24 Hours	TWTh
Township of Langley Camera	198 St., 199A St., 200 St., 201 St., 202 St., 202A St., 208 St., Walnut Grove Dr., 210 St., 211 St., 212 St., 213 St., 216 St., 80 Ave., 88 Ave., 91 Ave., 96 Ave	2015-2017	Single-day Peak Hour (M)	None
BCMoTI	Highway 1 at 200 St., 202 St., and Glover Rd.	Oct 2016	Multiday 24 Hours	TWTh

Figure 3: Links for Volume Comparison

The majority of the auto volume data was provided by the Township of Langley. The data received included a catalogue of 82 intersection traffic counts along with 42 section traffic counts. These count data ranged in date from 2015 to 2017.

For count data processing of continuous or multiday count data sources, Tuesday, Wednesday, and Thursday (TWTh) counts excluding holidays were averaged to represent the typical weekday as appropriate.

Auto Travel Times

Travel times for a selection of key origins and destinations are collected as follows:

- Walnut Grove Neighbourhood Centre
- Willoughby Town Centre
- Highway 1 at Highway 17 / Highway 15
- Highway 1 at 232 St.

Auto travel times data was based on Google Maps API travel times. The travel times collected represent typical weekday peak hour conditions in September 2019.

RTM vs. Observed Comparison

This section is presented as a series of comparisons of model results to observed data, which includes bar charts for visual comparisons, as well as metrics used by the industry. The GEH statistics are sometimes used in comparison of model outputs for a more local application, given by this formula:

$$GEH = \sqrt{\frac{2(M - C)^2}{M + C}}$$

Where:
M = Modelled Traffic Volume (vehicles per hour)
C = Observed Traffic Volume (vehicles per hour)

It is an empirical formula that is useful for observed and modelled comparisons because it is tolerant of relative and absolute errors, e.g. larger percentage differences on lower counts and larger absolute differences on higher counts. Values less than 5 are considered to be good, between 5 and 10 to be adequate, and above 10 as cause for concern with either the data or the model.

Auto Link Volumes

Modelled peak hour auto link volumes are compared to the observed data for all locations where traffic counts are available previously shown in *Figure 3*. *Figure 4* is a scatterplot comparing model volumes and observed volumes for the three modelled peak hours. Also shown are the statistics for the best fit lines. *Table 2* is the same comparison of model volumes and observed volumes, with additional statistics such as percentage differences, GEH, and %RMSE.

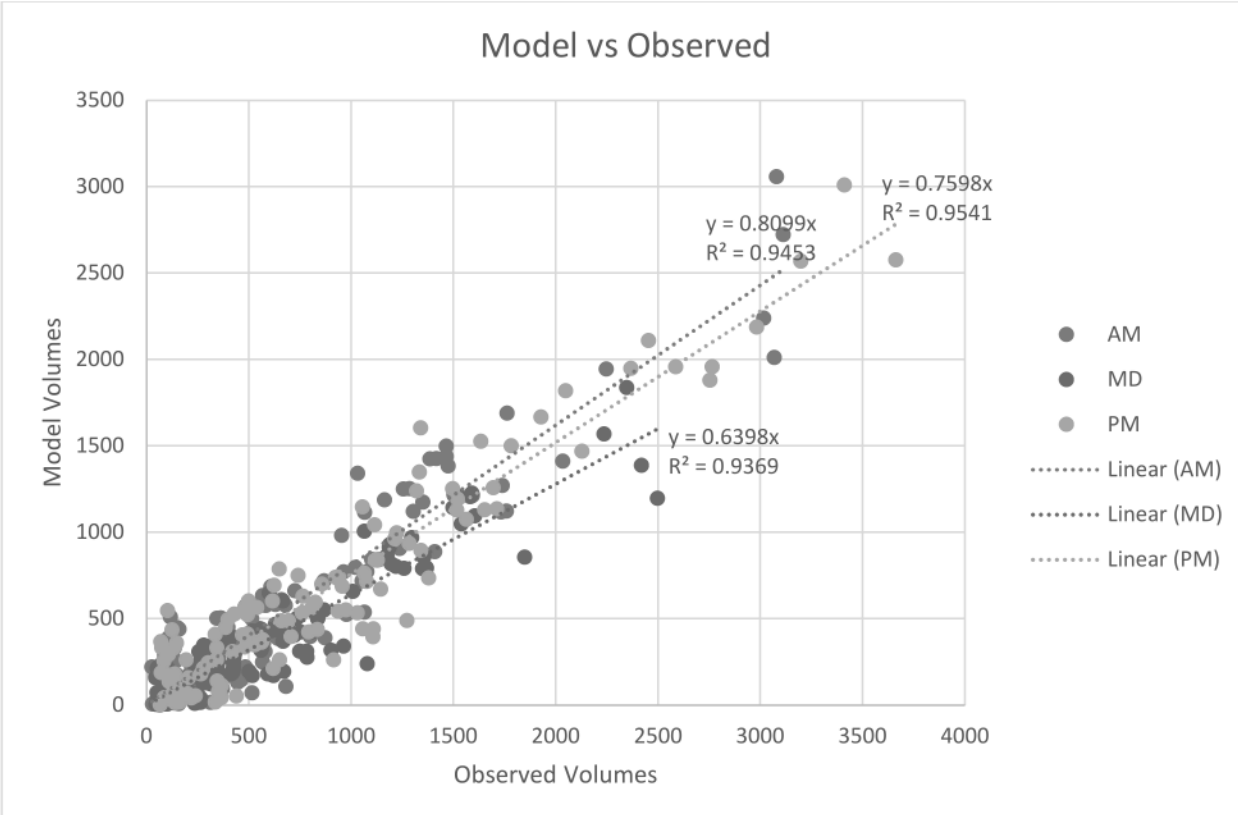

Figure 4: Model vs. Observed Auto Link Volumes

Table 2: Model vs. Observed Auto Link Volumes

Statistic	AM	MD	PM
All Link GEH<5	37%	21%	23%
All Link GEH<7.5	48%	29%	43%
All Link GEH<10	59%	51%	55%
All Link <700 diff within 100	50%	44%	45%
All Link 700-2700 diff within 15%	41%	3%	18%
All Link >2700 diff within 400	50%	n/a	0%
R Square	0.89	0.87	0.90
Line of Best Fit tolerance	0.19	0.36	0.24
% RMSE	38%	55%	40%

In general, auto volumes are much too low. The overall total traffic level for roads within the study area seems to be around 20% too low in both the AM and PM peak hours, while it is short by 36% in the midday.

Auto Travel Times

Modelled peak hour auto travel times are compared to the Google Maps API travel times for a selection of key origins and destinations as follows:

- Highway 1 at Highway 15 / Highway 17 (1W)

- Highway 1 at 232 St (1E)
- Walnut Grove Neighbourhood Centre (G)
- Willoughby Town Centre (W)

The bar charts in *Figures 5* and *6* illustrate AM and PM peak hour model versus observed auto travel times for these key origins and destinations.

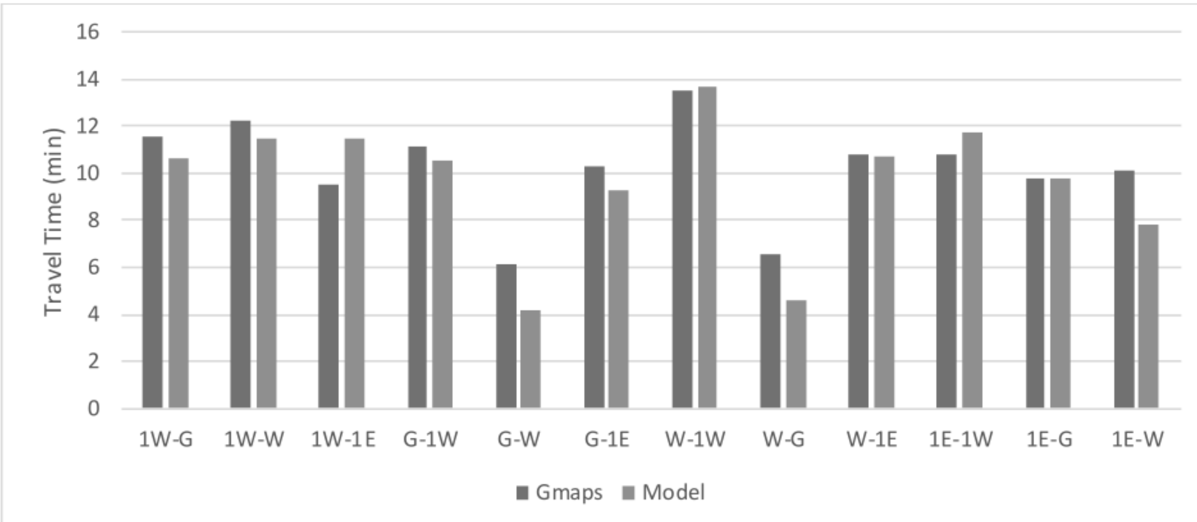

Figure 5: AM Peak Hour Model vs. Observed Travel Times on Key Origin-Destinations

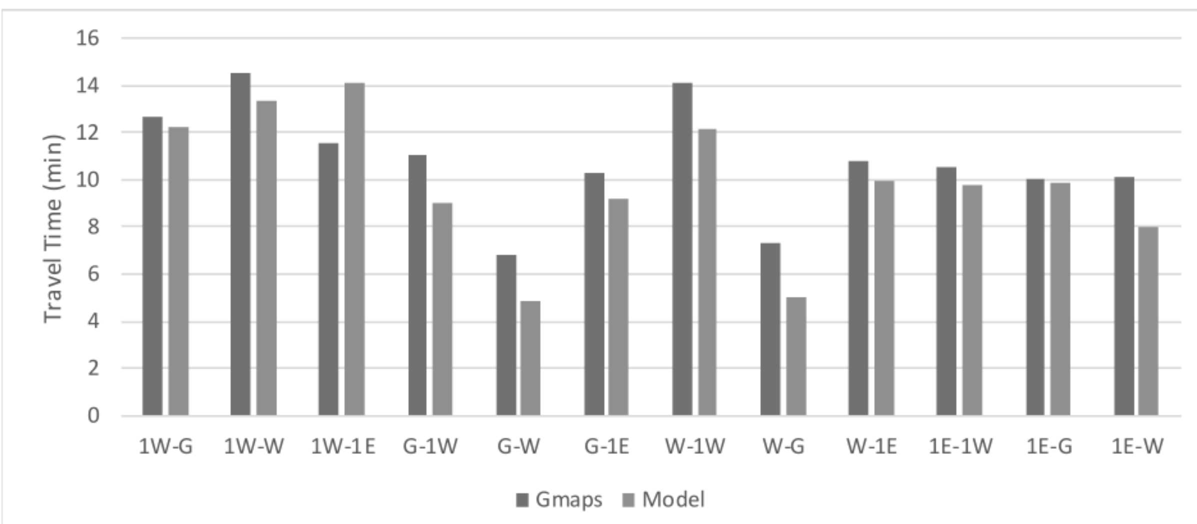

Figure 6: PM Peak Hour Model vs. Observed Travel Times on Key Origin-Destinations

In the AM peak hour, 67% of the key origins and destinations are within 20% differences. In the PM peak hour, 67% of the key origins and destinations are within 20% differences.

PART B – MODEL UPDATE

This section starts with detailed descriptions of updates and refinements to various components of TransLink's RTM. Then, the latter part of this section includes a more detail examination of travel patterns within the study area by comparing peak hour trip assignment.

B.1 MODEL REFINEMENTS

During the refinement process, a series of comparisons such as those described in Part A would indicate shortcomings and warrant further efforts. Each identified shortcoming and the corresponding improvements and implementation are further described below.

Various Model Network Refinements

RTM Shortcoming

- Lack of network refinements at the local level.

Improvement

- After a review of the following in the model network within the study area, any discrepancies found were corrected in the model network accordingly:
  - Check number of through and auxiliary lanes on all major routes;
  - Check that all signalized intersections have been included;
  - Check that all turn restrictions have been included;
  - Check volume delay functions;
  - Check HOV lanes have been included; and
  - Check posted speed on all major routes.
- Every change was made to better represent reality and was verified by aerial photos.
- A thorough review of the following link attributes was undertaken within the study area against aerial photos and Google Streetview:
  - The number of lanes (lanes) are determined by the number of travel lanes mid-block on a roadway.
  - The volume delay function (vdf) numbers are determined by the traffic control, and the number of extra lanes approaching an intersection.
  - Turn penalty function (tpf) numbers identify turn movements on the road network that are either permitted or prohibited.
  - Posted speed (posted_speed) identify the posted speed on a roadway.
- *Figure 7* and *8* illustrate locations of modified number of lanes, and vdf numbers.

Implementation

- Auto network changes included number of lanes, volume-delay function numbers, turn restrictions, and posted speed were incorporated in the base network.

Figure 7: Base Year Network Modifications to Number of Lanes

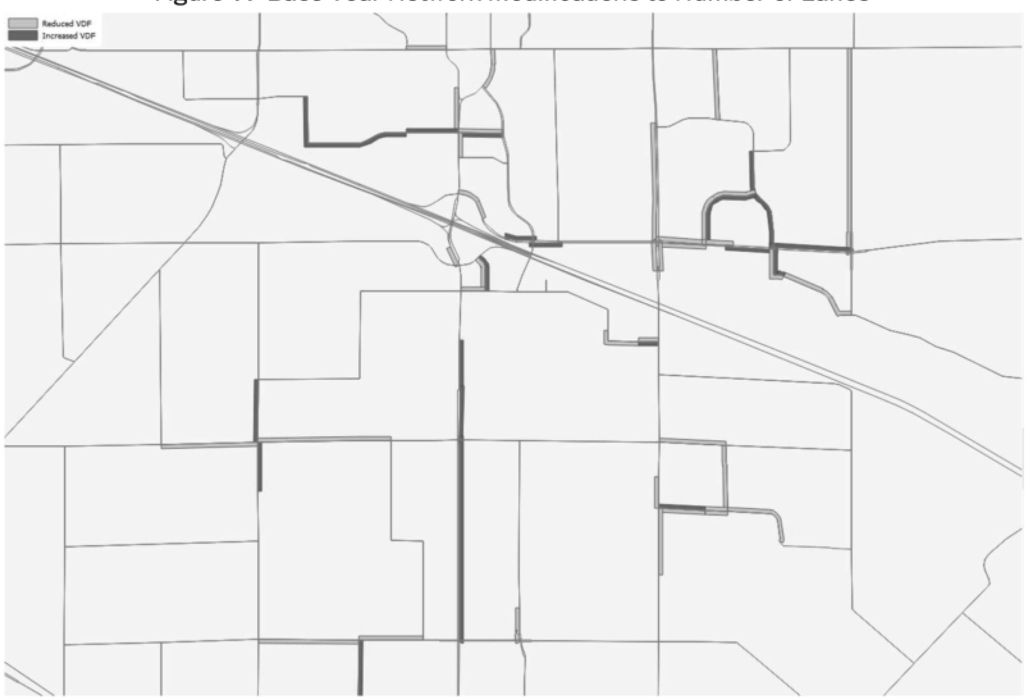

Figure 8: Base Year Network Modifications to VDF Numbers

Trip Generation Adjustment Factors - Carvolth Study Area

RTM Shortcoming

- Model daily person trips generated in the Carvolth study area were slightly low.

Improvement

- The Carvolth study area produced and attracted slightly more Home-based Work (HBW) trips, Home-based School (HBSch) trips, and Home-based Escort (HBEsc) trips than the rest of the region. Adjustment factors could be applied to increase the number of daily person trips generated in the Carvolth study area. The adjustment factors were based on differences in *Figure 2* - RTM versus normalized trip diary survey.

Implementation

- New trip generation adjustment factors were tested for HBW trips, HBSch trips, and HBEsc trips produced in and attracted to the Carvolth study area. The test results showed a positive improvement to the shortcoming. The component was therefore implemented in the model.

Trip Generation Adjustment Factors - Langley and Abbotsford

RTM Shortcoming

- Model daily person trips generated in Langley and Abbotsford were slightly low.

Improvement

- Langley and Abbotsford produced and attracted slightly more Home-based University (HBU) trips, Home-based Escort (HBEsc) trips, Home-based Personal Business (HBPB), and Non Home-based Other (NHBO) trips than the rest of the region. Adjustment factors could be applied to increase the number of daily person trips produced in Langley and Abbotsford. The adjustment factors were based on differences in *Figure 2* - RTM versus normalized trip diary survey.

Implementation

- New trip generation adjustment factors were tested for HBU trips, HBEsc trips, HBPB trips, and NHBO trips produced and attracted to Langley and Abbotsford. The test results showed a positive improvement to the shortcoming. The component was therefore implemented in the model.

Trip Distribution K Factors - Carvolth Study Area

RTM Shortcoming

- Model daily person trips within the Carvolth study area were slightly high, while between the Carvolth study area and Surrey were slightly high also.

Improvement

- Home-based Work (HBW) trips attracted to the Carvolth study area and to Surrey could be reduced. Trip distribution K factors could be modified and applied to daily person trips between the Carvolth study area and specific subregions. The modifications were based on differences in *Figure 2* - RTM versus normalized trip diary survey.

Implementation

- New trip distribution K factors were tested for HBW trips within the Carvolth study area, and for trips between the Carvolth study area and Surrey. The test results showed a positive improvement to the shortcoming. The component was therefore implemented in the model. The modified K factors did not exceed the threshold set by TransLink.

Trip Distribution K Factors - Langley and Abbotsford

RTM Shortcoming

- Model daily person trips within the Carvolth study area were slightly off.

Improvement

- Home-based School (HBSch) trips, and Home-based Escort (HBEsc) trips attracted to the study area could be increased or reduced. Trip distribution K factors could be modified and applied to daily person trips within the Carvolth study area. The modifications were based on differences in *Figure 2* - RTM versus normalized trip diary survey.

Implementation

- New trip distribution K factors were tested for HBSch trips, and HBEsc trips within the study area. The test results showed a positive improvement to the shortcoming. The component was therefore implemented in the model. The modified K factors did not exceed the threshold set by TransLink.

Time Slicing Factors - Carvolth Study Area

RTM Shortcoming

- Model peak hour person trips originated from or destined to the Carvolth study area were comparatively low in the peak hours.

Improvement

- For some purposes of trips originated from or destined to the study area, the relationship between daily and peak hour trips do not coincide with the rest of the region. Especially, for Home-based Work (HBW), Home-based School (HBSch), and Home-based Escort (HBEsc) trips, they are much more peaked in the peak hours than the rest of the region.

Implementation

- Time slicing factors are relationships between daily and peak hour trips. A new set of time slicing factors for the three trip purposes for trips originated from or destined to the Carvolth study area was tested. The test results showed a positive improvement to the shortcoming. The component was therefore implemented in the subarea model.

Time Slicing Factors - Langley and Abbotsford

RTM Shortcoming

- Model peak hour auto person trips originated from or destined to Langley and Abbotsford were comparatively low in the peak hours.

Improvement

- For some purposes of auto trips originated from or destined to Langley and Abbotsford, the relationship between daily and peak hour trips do not coincide with the rest of the region. Especially, for Home-based Personal Business (HBPB), Home-based Social (HBSoc), Non Home-based Work (NHBW), and Non Home-based Other (NHBO) trips, they are much more peaked in the peak hours than the rest of the region.

Implementation

- Time slicing factors are relationships between daily and peak hour trips. A new set of time slicing factors for the four trip purposes for auto trips originated from or destined to the Carvolth study area was tested. The test results showed a positive improvement to the shortcoming. The component was therefore implemented in the subarea model.

Auto Traffic Demand Adjustment

RTM Shortcoming

- Vehicle traffic was comparatively low for some roadways during the peak hours.

Improvement

- The addition of auto demand adjustments are improvements on auto usage on specific roadways during the peak hours. After the adjustments are calculated, the factoring procedure follows NCHRP 255 Methodology.

Implementation

- New adjustments for auto trips within the Carvolth study area was applied and tested. The test results showed a positive improvement to the shortcoming. The component was therefore implemented.

B.2 PEAK HOUR TRIP ASSIGNMENT COMPARISON

Model vs. Observed Comparison

Following model refinement, this section is presented as a series of comparisons of model results to observed data, which includes bar charts for visual comparisons, as well as metrics used by the industry.

Auto Link Volumes

Modelled peak hour auto link volumes are compared to the observed data for all locations where traffic counts are available previously shown in *Figure 3*. *Figure 9* is a scatterplot comparing screenline model volumes and observed volumes for the three modelled peak hours. Also shown are the statistics for the best fit lines. *Table 3* is the same comparison of model volumes and observed volumes, with additional statistics such as percentage differences, GEH, and %RMSE.

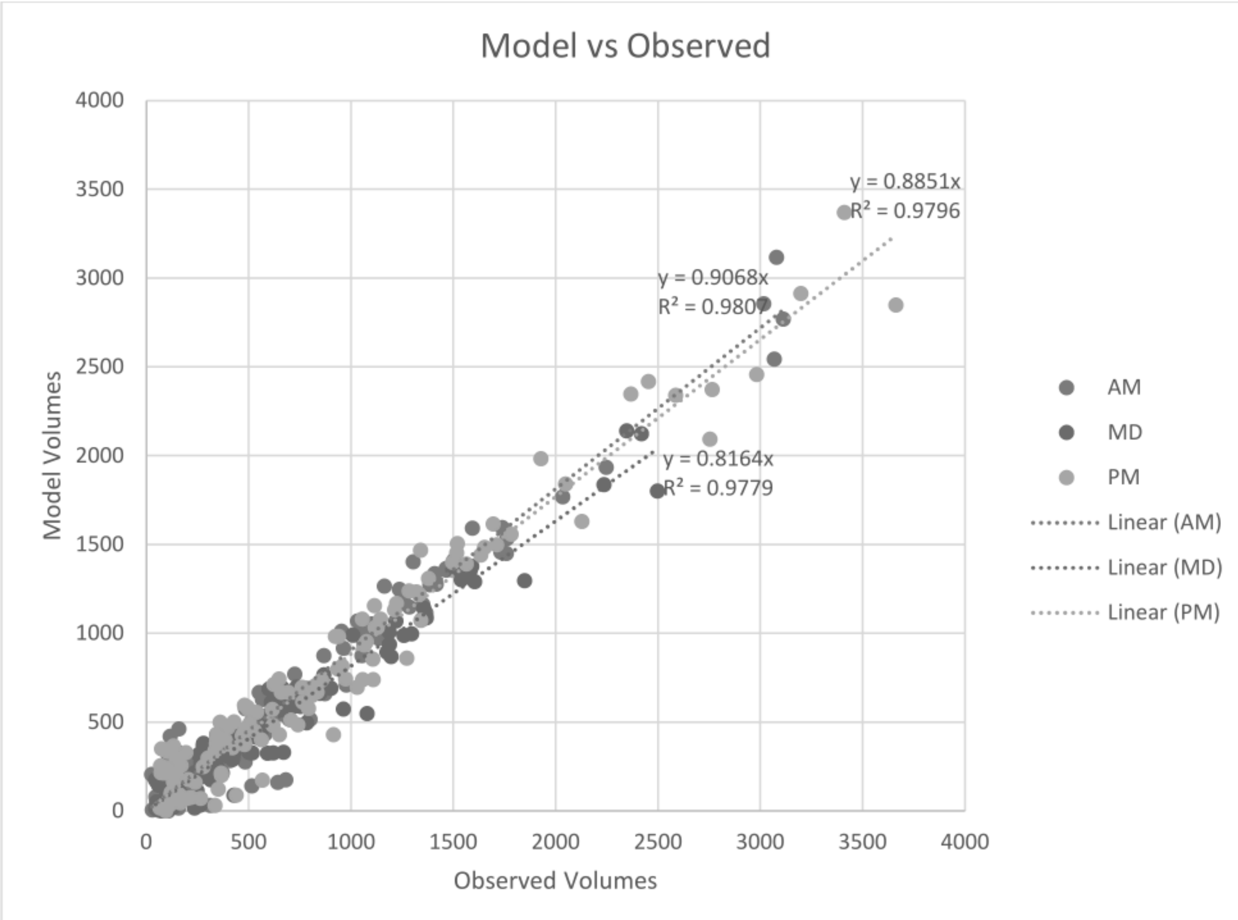

Figure 9: Model vs. Observed Auto Link Volumes

Table 3: Model vs. Observed Auto Link Volumes

Statistic	AM	MD	PM
All Link GEH<5	60%	46%	54%
All Link GEH<7.5	76%	66%	65%
All Link GEH<10	89%	80%	77%
All Link <700 diff within 100	70%	70%	60%
All Link 700-2700 diff within 15%	78%	33%	70%
All Link >2700 diff within 400	75%	n/a	50%
R Square	0.96	0.95	0.96
Line of Best Fit tolerance	0.09	0.18	0.11
% RMSE	22%	30%	23%

After the model refinements, links with GEH above 10 were reduced from 41% to 11% in the AM peak hour, and from 45% to 23% in the PM peak hour. Discrepancies for overall total traffic level for roads with the study area during all peak hours noted previously were reduced. R^2 improved from 0.89 to 0.96 in the AM peak hour, and from 0.90 to 0.96 in the PM peak hour.

Auto Travel Times

Modelled peak hour auto travel times are compared to the Google Maps API travel times for a selection of key origins and destinations as follows:

- Highway 1 at Highway 15 / Highway 17 (1W)
- Highway 1 at 232 St (1E)
- Walnut Grove Neighbourhood Centre (G)
- Willoughby Town Centre (W)

The bar charts in *Figures 10* and *11* illustrate AM and PM peak hour model versus observed auto travel times on key corridors.

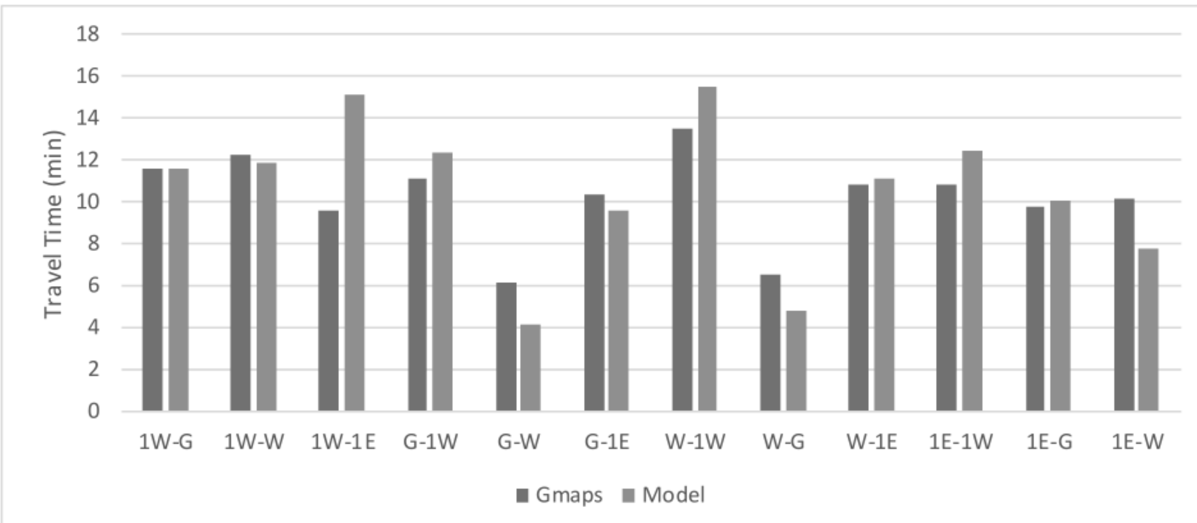

Figure 10: AM Peak Hour Model vs. Observed Travel Times on Key Origin-Destinations

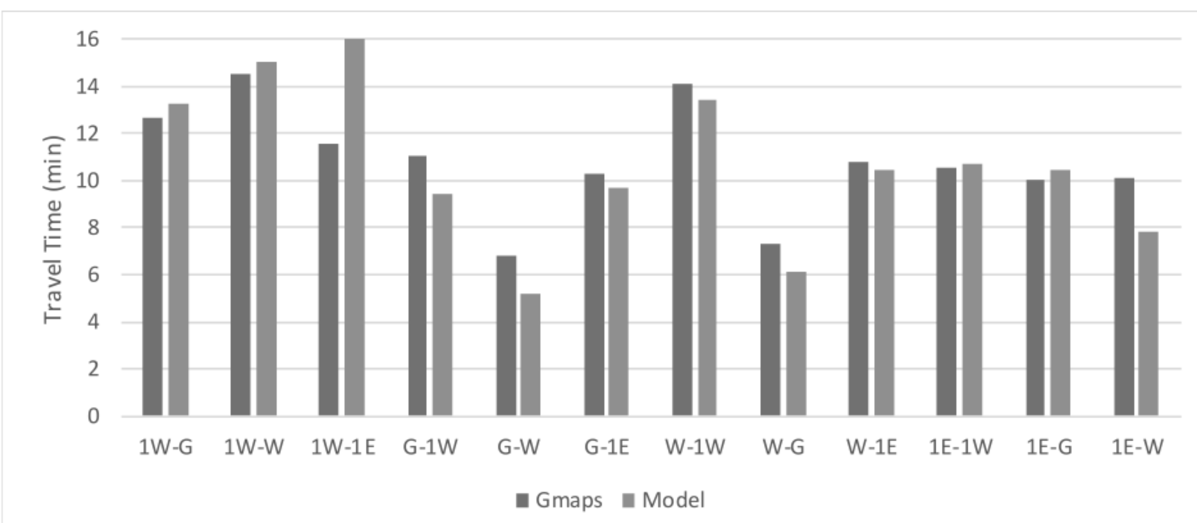

Figure 11: PM Peak Hour Model vs. Observed Travel Times on Key Origin-Destinations

In the AM peak hour, 67% of the key origins and destinations are within 20% differences. In the PM peak hour, 75% of the key origins and destinations are within 20% differences.

Based on current comparisons with the updated model, the model is fit for purpose and is ready to undertake scenario testing.

APPENDIX A: AUTO LINK VOLUME COMPARISON

On	From	To	Dir	AM Count	MD Count	PM Count	AM Model	MD Model	PM Model	AM GEH	MD GEH	PM GEH
Highway 1	200 St	202 St	EB	2035	1849	2755	1769	1296	2093	**6**	**14**	**13**
Highway 1	200 St	202 St	WB	2248	1604	2128	1933	1291	1630	**7**	**8**	**11**
Highway 1 Off-	Highway 1	200 St	EB	1237	1009	1928	1247	989	1982	**0**	**1**	**1**
Highway 1 On-	200 St	Highway 1	WB	1593	868	1283	1592	765	1238	**0**	**4**	**1**
Highway 1	202 St	208 St	EB	3068	2498	3663	2543	1801	2848	**10**	**15**	**14**
Highway 1	202 St	208 St	WB	3112	2236	2983	2769	1836	2457	**6**	**9**	**10**
Highway 1	Glover Rd	232 St	EB	3018	2420	3412	2855	2123	3370	**3**	**6**	**1**
Highway 1	Glover Rd	232 St	WB	3079	2347	3198	3117	2139	2913	**1**	**4**	**5**
80 Ave	202A St	208 St	EB	398	422	660	345	289	668	**3**	**7**	**0**
80 Ave	202A St	208 St	WB	400	315	342	386	234	379	**1**	**5**	**2**
83 Ave	208 St	211 St	EB	115	70	124	174	155	355	**5**	**8**	**15**
83 Ave	208 St	211 St	WB	107	61	85	315	144	242	**14**	**8**	**12**
83 Ave	211 St	216 St	EB	94	53	137	33	51	199	**8**	**0**	**5**
83 Ave	211 St	216 St	WB	172	63	132	145	50	164	**2**	**2**	**3**
93 Ave	208 St	212 St	EB	108	76	108	0	0	28	**15**	**12**	**10**
93 Ave	208 St	212 St	WB	135	76	95	47	3	0	**9**	**12**	**14**
216 St	91 Ave	88 Ave	NB	312	236	335	31	16	30	**21**	**20**	**23**
216 St	91 Ave	88 Ave	SB	115	142	239	118	38	161	**0**	**11**	**6**
216 St	Glover Rd	64 Ave	NB	352	347	468	306	245	424	**3**	**6**	**2**
216 St	Glover Rd	64 Ave	SB	425	339	480	400	245	372	**1**	**5**	**5**
80 Ave	208 St	216 St	EB	90	61	87	41	32	213	**6**	**4**	**10**
80 Ave	208 St	216 St	WB	84	67	120	174	32	89	**8**	**5**	**3**
86A Crescent	212 St	Telegraph Trail	EB	47	59	111	79	29	58	**4**	**5**	**6**
86A Crescent	212 St	Telegraph Trail	WB	86	51	72	66	51	215	**2**	**0**	**12**
88 Ave	196 St	200 St	EB	220	201	277	267	176	248	**3**	**2**	**2**
88 Ave	196 St	200 St	WB	26	45	75	205	174	350	**17**	**12**	**19**
210 St	96 Ave	93 Ave	NB	61	47	67	3	13	15	**10**	**6**	**8**
210 St	96 Ave	93 Ave	SB	89	57	103	202	173	334	**9**	**11**	**16**
213 St	93B Ave	96 Ave	NB	116	52	70	420	164	255	**19**	**11**	**14**
213 St	93B Ave	96 Ave	SB	96	62	121	57	32	104	**4**	**4**	**2**
216 St	80 Ave	Glover Rd	NB	142	105	194	145	100	328	**0**	**0**	**8**
216 St	80 Ave	Glover Rd	SB	147	93	147	204	74	210	**4**	**2**	**5**
216 St	88 Ave	Telegraph Trail	NB	100	91	160	26	14	92	**9**	**11**	**6**
216 St	88 Ave	Telegraph Trail	SB	161	108	170	164	80	256	**0**	**3**	**6**
80 Ave	211 St		EB	135	121	365	41	32	213	**10**	**10**	**9**
80 Ave	211 St		WB	124	69	140	80	9	63	**4**	**10**	**8**
211 St	80 Ave		NB	214	81	165	138	36	46	**6**	**6**	**12**
96 Ave	198 St		EB	872	1079	1273	659	547	860	**8**	**19**	**13**
96 Ave	198 St		WB	1408	963	792	1335	572	577	**2**	**14**	**8**
198 St	96 Ave		SB	134	315	301	67	175	297	**7**	**9**	**0**
72 Ave	200 St		EB	1101	537	936	1052	415	798	**1**	**6**	**5**
72 Ave	200 St		WB	599	425	834	544	318	670	**2**	**6**	**6**
200 St	72 Ave		NB	1135	1258	1496	971	987	1399	**5**	**8**	**3**
200 St	72 Ave		SB	1256	1538	2049	1203	1302	1840	**2**	**6**	**5**
80 Ave	208 St		EB	313	340	693	345	289	668	**2**	**3**	**1**
80 Ave	208 St		WB	681	264	439	174	32	89	**25**	**19**	**22**
208 St	80 Ave		NB	630	548	764	576	488	612	**2**	**3**	**6**
208 St	80 Ave		SB	726	734	1075	770	698	954	**2**	**1**	**4**
84 Ave	208 St		EB	204	138	421	243	176	355	**3**	**3**	**3**
208 St	84 Ave		NB	953	666	1115	1011	689	1156	**2**	**1**	**1**
208 St	84 Ave		SB	583	665	940	666	610	982	**3**	**2**	**1**
208 St	87 Ave		NB	868	630	1117	874	609	1033	**0**	**1**	**3**
208 St	87 Ave		SB	552	612	924	666	610	982	**5**	**0**	**2**
72 Ave	202A St		EB	608	353	741	643	410	485	**1**	**3**	**10**
72 Ave	202A St		WB	352	271	492	305	224	469	**3**	**3**	**1**
202A St	72 Ave		NB	338	270	619	334	191	480	**0**	**5**	**6**
202A St	72 Ave		SB	240	147	361	190	73	500	**3**	**7**	**7**
72 Ave	210 St		EB	485	287	480	574	336	595	**4**	**3**	**5**
72 Ave	210 St		WB	335	267	398	301	272	468	**2**	**0**	**3**
88 Ave	204 St		EB	513	836	1563	481	704	1390	**1**	**5**	**4**
88 Ave	204 St		WB	1503	848	957	1411	662	815	**2**	**7**	**5**
204 St	88 Ave		SB	263	238	336	245	216	341	**1**	**1**	**0**
88 Ave	Walnut Grove Dr		EB	568	785	1379	641	689	1309	**3**	**4**	**2**
88 Ave	Walnut Grove Dr		WB	801	670	914	515	330	428	**11**	**15**	**19**
Walnut Grove Dr	88 Ave		SB	462	278	345	429	365	433	**2**	**5**	**4**
88 Ave	212 St		EB	417	517	1057	315	326	740	**5**	**9**	**11**
88 Ave	212 St		WB	371	249	367	214	114	199	**9**	**10**	**10**
212 St	88 Ave		NB	159	100	132	461	268	365	**17**	**12**	**15**
212 St	88 Ave		SB	215	167	265	118	98	70	**8**	**6**	**15**
96 Ave	199A St		EB	571	748	1144	482	622	1079	**4**	**5**	**2**
96 Ave	199A St		WB	1366	783	706	1113	495	512	**7**	**11**	**8**
199A St	96 Ave		SB	1762	1065	1340	1534	945	1467	**6**	**4**	**3**

On	From	To	Dir	AM Count	MD Count	PM Count	AM Model	MD Model	PM Model	AM GEH	MD GEH	PM GEH
96 Ave	201 St		EB	659	753	1342	670	588	1073	**0**	**6**	**8**
96 Ave	201 St		WB	1078	541	616	965	445	571	**4**	**4**	**2**
201 St	96 Ave		NB	1286	1188	1634	1148	938	1440	**4**	**8**	**5**
96 Ave	203 St		EB	370	564	1214	396	495	1132	**1**	**3**	**2**
96 Ave	203 St		WB	1020	420	499	991	445	571	**1**	**1**	**3**
203 St	96 Ave		SB	29	82	115	5	12	37	**6**	**10**	**9**
96 Ave	204 St		EB	362	515	1222	401	507	1168	**2**	**0**	**2**
96 Ave	204 St		WB	963	398	507	916	431	491	**2**	**2**	**1**
204 St	96 Ave		NB	148	106	135	185	99	181	**3**	**1**	**4**
96 Ave	208 St		EB	398	445	1064	442	402	935	**2**	**2**	**4**
96 Ave	208 St		WB	567	256	385	627	316	399	**2**	**4**	**1**
208 St	96 Ave		NB	515	264	351	140	69	123	**21**	**15**	**15**
208 St	96 Ave		SB	158	130	218	15	20	75	**15**	**13**	**12**
80 Ave	200 St		EB	445	286	528	320	257	453	**6**	**2**	**3**
80 Ave	200 St		WB	400	275	343	372	272	403	**1**	**0**	**3**
200 St	80 Ave		NB	1739	1355	1695	1595	1141	1615	**4**	**6**	**2**
200 St	80 Ave		SB	1416	1582	2368	1276	1353	2348	**4**	**6**	**0**
92A Ave	200 St		EB	315	563	624	180	459	712	**9**	**5**	**3**
92A Ave	200 St		WB	216	228	198	122	80	69	**7**	**12**	**11**
200 St	92A Ave		NB	1350	1197	1056	1162	868	1079	**5**	**10**	**1**
200 St	92A Ave		SB	1032	1176	1334	1068	894	1219	**1**	**9**	**3**
72 Ave	208 St		EB	559	303	539	512	296	554	**2**	**0**	**1**
72 Ave	208 St		WB	343	299	428	429	313	502	**4**	**1**	**3**
208 St	72 Ave		NB	580	560	809	433	433	649	**7**	**6**	**6**
208 St	72 Ave		SB	977	722	974	709	589	743	**9**	**5**	**8**
77A Ave	208 St		WB	143	62	101	340	153	243	**13**	**9**	**11**
208 St	77A Ave		NB	678	560	857	623	531	735	**2**	**1**	**4**
208 St	77A Ave		SB	654	667	826	544	570	705	**4**	**4**	**4**
88 Ave	208 St		EB	551	804	1516	535	656	1453	**1**	**5**	**2**
88 Ave	208 St		WB	1064	902	1107	937	691	854	**4**	**7**	**8**
208 St	88 Ave		NB	1054	694	1128	874	609	1033	**6**	**3**	**3**
208 St	88 Ave		SB	642	428	568	159	87	173	**24**	**21**	**21**
88 Ave	210 St		EB	447	620	1108	315	326	740	**7**	**14**	**12**
88 Ave	210 St		WB	699	502	650	515	330	428	**7**	**8**	**10**
88 Ave	201 St		EB	483	592	1030	276	324	695	**11**	**13**	**11**
88 Ave	201 St		WB	838	425	479	710	343	386	**5**	**4**	**4**
88 Ave	202 St		EB	240	412	762	276	324	695	**2**	**5**	**2**
88 Ave	202 St		WB	1163	600	649	1265	687	742	**3**	**3**	**4**
202 St	88 Ave		NB	365	279	494	376	381	584	**1**	**6**	**4**
202 St	88 Ave		SB	240	330	479	181	245	443	**4**	**5**	**2**
200 St	84 Ave		NB	1758	1350	1653	1450	1082	1483	**8**	**8**	**4**
200 St	84 Ave		SB	1465	1590	2586	1356	1377	2339	**3**	**6**	**5**
86 Ave	200 St		EB	150	153	206	293	119	177	**10**	**3**	**2**
86 Ave	200 St		WB	408	399	562	284	308	400	**7**	**5**	**7**
200 St	86 Ave		NB	1305	1220	1520	1402	1068	1505	**3**	**4**	**0**
200 St	86 Ave		SB	1465	1498	2454	1365	1358	2417	**3**	**4**	**1**
91A Ave	200 St		WB	56	69	147	157	174	292	**10**	**10**	**10**
200 St	91A Ave		NB	1474	1186	1319	1361	1008	1233	**3**	**5**	**2**
200 St	91A Ave		SB	1066	1296	1782	1004	996	1557	**2**	**9**	**6**
200 St	82 Ave		NB	1733	1368	1712	1456	1087	1499	**7**	**8**	**5**
200 St	82 Ave		SB	1385	1529	2766	1273	1356	2372	**3**	**5**	**8**

Appendix G

Traffic Operations Micro-simulation Refinement and Validation

BRITISH COLUMBIA | Ministry of Transportation and Infrastructure

Township of Langley BC Est. 1873

Carvolth Traffic Study

Micro-simulation Calibration Memorandum

October 2019

PARSONS

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1.0 INTRODUCTION

This document provides a summary of the micro-simulation model development and micro-simulation model calibration associated with the traffic operations model and forms one part of the Carvolth Traffic Study.

The purpose of Carvolth Traffic Study is to evaluate alternative land use scenarios being considered in the Carvolth and Willoughby neighbourhoods along with potential removal of the restrictive covenants in the Gateway area of the 200 Street Interchange and to determine their impact on the Provincial and Regional transportation network in the study area. The BC Ministry of Transportation and Infrastructure (BC MOTI) and Township of Langley is interested in developing short, medium, and long-term infrastructure improvement strategies that can mitigate increased trip making resulting from changes to the land use within the study area. Potential improvements include but are not limited to widening of roadways, intersection modifications, or turning and access upgrades amongst others. The study area is shown in *Figure 1* and is bounded by 192 Street and 216 Street along Highway 1 and between 72 Avenue and 96 Avenue in the north-to-south direction.

The surrounding lands in the vicinity of the 200 Street interchange are currently under development or planned for future development with the aim to create a sense of arrival to the Carvolth and Willoughby communities and to encourage development of landmark buildings at this high-profile location. With the increased development interest in these areas in the vicinity of the 200 Street interchange and the potential to vary from previously established land use policies, there is a need to understand the associated impacts to the transportation network.

This study will assist the Ministry and the Township of Langley to process current and future development applications and will provide support for addressing concerns with respect to the restrictive covenants.

FIGURE 1: STUDY AREA

Purpose

As part of the Carvolth Traffic Study, detailed analysis of traffic operations in the vicinity of the 200 Street interchange is required. To conduct this analysis, a micro-simulation model was developed using the Aimsun software platform. The purpose of this memorandum is as follows:

- Identify the assumptions used in the development of the existing conditions micro-simulation traffic model as discussed in Section 2.0; and
- Demonstrate the model is calibrated and suitable for traffic analysis as discussed in Section 3.0.

2.0 MICRO-SIMULATION MODEL DEVELOPMENT

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. This document focuses on the second of the two models; the micro-simulation model.

The following aspects of the model development process are discussed in this section:

- Micro-simulation Model Overview
- Data Sources;
- Model Spatial Extents;
- Model Temporal Extents; and
- Model Demand Assumptions.

2.1 Micro-simulation Model Overview

To provide a detailed operational assessment of forecast network conditions, a micro-simulation model was developed on the Aimsun platform. The Aimsun model built for the study area 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;
- 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.

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. The Aimsun model was calibrated to ensure it was capable of reasonably replicating baseline traffic volumes, travel times and congestion. Travel demands were obtained from an origin-destination traversal matrix sourced from a study-area refined macroscopic model using TransLink's Regional Transportation Model (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, travel times, and qualitative traffic congestion. 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.

2.2 Model Spatial Extents

The model spatial extents are shown in *Figure 1* below. For clarity, 200 Street is north-south and Highway 1 is east-west. The immediate traffic analysis study area is bounded by 92a Ave to the north, 84 Ave to the south, and extending for two kilometres along Highway 1 in the east and west directions from 200 Street. The adjacent commercial / residential network including 202 street was also coded into the model allowing for the evaluation of alternative routes that connect directly to the primary 200 Street corridor if such routes were to become more viable given future travel demand increases. Lastly, HOV lanes on Highway 1, including the HOV exit and entrance ramps adjoining 202 Street have been coded into the model with restricted lane properties.

The traffic model also features a high level of zone disaggregation. Each circle in *Figure 1* represents an individual traffic sink / source. This provides added flexibility as assumptions for major blocks in the study area can be independently adjusted and modified.

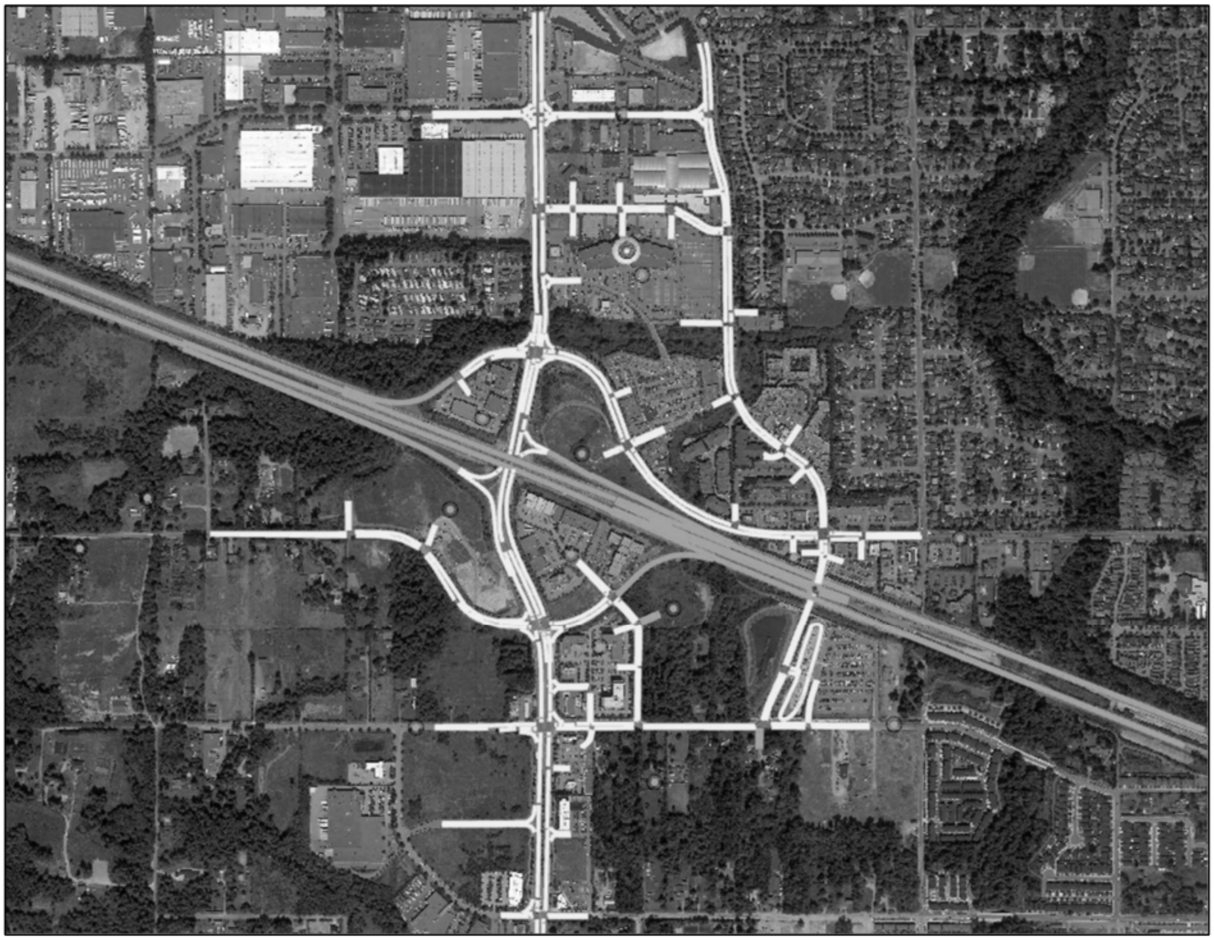


Figure 1: Micro-simulation Model Extents

2.3 Data Sources

The micro-simulation model was developed using several different sources of data including traffic counts provided by the BC Ministry of Transportation and Infrastructure (BC MOTI) and Township of Langley (ToL). Supplemental traffic data collection activities and site observations were also conducted.

BC MOTI provided traffic counts along the mainline of Highway 1 as well as the immediate on-ramps and off-ramps adjacent to the 200 Street interchange. Data along Highway 1 was sourced from permananent count stations and was recorded in 15-minute increments. Manual turning movement counts were conducted during the Summer of 2019 which included AM, Midday, and PM volume data at signalized intersections adjoining the Highway 1 on-ramps and off-ramps. Signal timing data was also provided for all intersections within MOTI jurisdiction.

Township of Langley provided turning movement count data along 200 Street, 201 Street, and 202 Street. Data was sourced from signal controller downloads and was supplemented with historic manual turning movement count surveys between 2018 and 2019. Signal timing data was also provided for all intersections within Township of Langley jurisdiction.

A data gap exercise was also conducted in the early stages of the project that determined four intersections required additional data collection. These four identified intersections were subsequently surveyed in late September 2019 and are as follows:

1. 201 St / 88 Ave W;
2. 202 St / 86 Ave;
3. NW Quadrant Access / 88 Ave E; and
4. 202 St / Hwy 1 Roundabout.

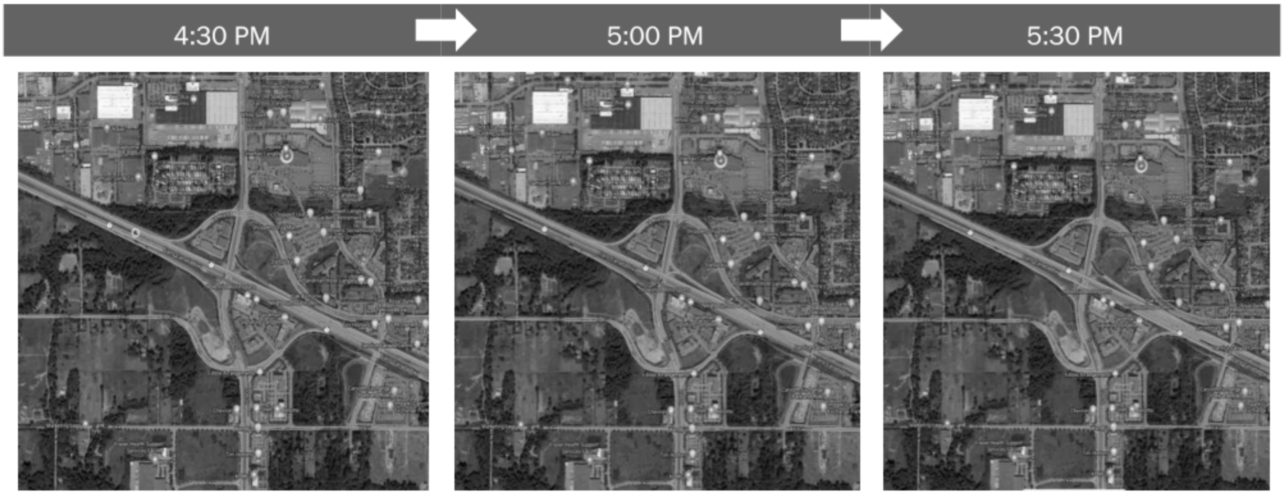
Travel time data was gathered via Google Maps API which provided historic travel time data during the AM and PM peak hours for ten routes travesing the study area. The ten travel time routes are as follows:

1. NB 200th Street from 84 Ave to 92a Ave;
2. SB 200th Street from 92a Ave to 84 Ave;
3. EB 88 Ave E from 200 St to 202 St;
4. WB 88 Ave E from 200 St to 202 St;
5. NB 202 Street from 86 Ave to 91a Ave;
6. SB 202 Street from 86 Ave to 91a Ave;
7. WB Hwy 1 Off-ramp to 92a Ave;
8. EB Hwy 1 Off-ramp to 84 Ave;
9. WB Hwy 1 Off-ramp to 84 Ave; and
10. EB Hwy 1 Off-ramp to 92a Ave.

In addition, screenshots of Google traffic conditions for the study area were gathered for 72 consecutive hours from Tuesday to Thursday (September 17th to 19th) at 15-minute intervals to provide an understanding of the general congestion and queueing within the study area. A sample of the traffic congestion in the PM peak hour is shown below in *Figure 2*.

A site visit was also conducted in September 2019. The purpose of the visit was to observe localized traffic operations and confirm discrepancies between modelled and observed behaviour. Construction along Highway 1 was observed during the site visit and was noted to affect traffic operations along Highway 1. Numerous photos and video footage of overall study area operations were documented.

Figure 2: Sample Google Maps Traffic Congestion during Weekday PM Peak Hour



2.4 Model Temporal Extents

The Carvolth Traffic Study micro-simulation model is a peak period model featuring the AM and PM peak hours spanning from 7:00 AM to 9:00 in the morning and 3:30 PM to 5:30 PM in the afternoon. The two hour peak period simulation includes a "shoulder" period adjacent to the peak hour of interest. Noting that these periods experience the most congestion and overall traffic demand; this ensures that the critical interactions within the road network could be modelled appropriately.

2.5 Model Demand Assumptions

Traffic demands were supplied from the study area refined macroscopic Regional Transportation Model (RTM) using the EMME 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 centers. 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. For more information on the macroscopic demands obtained from the RTM and the refinement procedure to generate them, refer to the technical memorandum titled "*Macroscopic Base Year Model Comparison and Refinement*".

Travel demands were exported from the RTM into the Aimsun model for each origin-destination pair. The macroscopic demands provide the initial origin-destination routing and mode split. Traffic demands were developed for the following vehicle types:

- Single Occupancy Vehicles (SOV)
- High Occupancy Vehicles (HOV)
- Light Trucks (LGV)
- Heavy Trucks (HGV)

For each parcel associated with a covenant zone as shown in *Figure 3* below, discrete traffic zones were coded to enable the ability to alter traffic demand for each parcel independently. Manual traffic counts at the ingress and egress points for each covenant zone provided baseline demands while maximum covenant trip generation limits were prescribed by BC MOTI based on previous analysis conducted by Bunt & Associates in 2001.

Figure 3: Covenant Parcels and PM Peak Hour Maximum Trip Generation

3.0 MICRO-SIMULATION MODEL CALIBRATION

The traffic operations micro-simulation model was calibrated to match existing traffic operations conditions. The calibration metrics are identified in this section. Model statistics and observations are also shown to provide a comparison of modelled traffic operations and actual traffic operations.

3.1 Calibration Metrics

Metrics were extracted based on the average of seven discrete micro-simulation model runs which were conducted to account for the impact of variability of vehicle arrival rates and volumes. In each run, the vehicle release rate and traffic demand are varied slightly.

The micro-simulation model was calibrated using the following metrics:

- Turning movement volumes;
- Route travel time for ten routes travesing 200 Street and 202 Street;
- Qualitive link congestion comparison to Google Maps Traffic

The calibration metrics are described in further detail below.

TURNING MOVEMENT VOLUMES

The existing vehicle turning movement volumes were established using the traffic volume data provided by BC MOTI and TOL. Manual traffic count surveys also provided vehicle length classification which were used to develop traffic profiles for different classifications of vehicles including passenger vehicles and trucks. Modelled traffic volumes were extracted from the micro-simulation model and compared to the collected traffic data. A comparison in terms of absolute volume difference as well as the GEH statistic are made.

The GEH Statistic avoids some pitfalls that occur when using simple percentages to compare two sets of volumes. This is because the traffic volumes in real-world transportation systems vary over a wide range. For example, the mainline of a freeway/motorway might carry 5000 vehicles per hour, while one of the on-ramps leading to the freeway might carry only 50 vehicles per hour (in that situation it would not be possible to select a single percentage of variation that is acceptable for both volumes). The GEH statistic reduces this problem; because the GEH statistic is non-linear, a single acceptance threshold based on GEH can be used over a fairly wide range of traffic volumes. For reference, the formula to calculate GEH is as follows:

$$GEH = \sqrt{\frac{2(M-C)^2}{M+C}}$$

Where:
M = Modelled Traffic Volume (vehicles per hour)
C = Observed Traffic Volume (vehicles per hour)

It should be noted that due to the variety of traffic data sources (in terms of collection method and temporal extents), there are moderate imbalances in the observed data set between adjacent intersections. Therefore, it is expected that the modelled volumes will not match the observed data set perfectly.

ROUTE TRAVEL TIMES

Ten travel time routes along 200 Street and 202 Street were extracted from the traffic model. Comparisons to Google Maps travel times during similar peak periods was made. A variety of routes were chosen to cover both east-west and north-south trips across the study area. It should be noted that Google maps travel times represent an average of the historic travel times and real-world conditions may be better or worse on any given day.

Note that the model base includes the 216 interchange which is currently under construction as of the time this memorandum was submitted. Therefore, while comparisons have been made to observed travel times, it must be acknowledged that the completion of the 216 interchange will alter some of the underlying travel patterns within the study area. As such, metrics such as travel time along Highway 1 are not compared to existing conditions due to construction conditions impacting traffic.

QUALITITIVE COMPARISON OF CONGESTION TO GOOGLE MAPS TRAFFIC

Using the Google Maps Traffic feature, a collection of 72 hours of images at 15-minute increments showing traffic congestion within the study area was compared to the model traffic congestion for the peak periods. This metric is qualitive in nature; however, it does provide a relative comparsion of link congestion and an indication of the most congested areas.

3.2 Calibration Results

The calibration results are summarized in this section.

TURNING MOVEMENT VOLUMES

In *Figure 5* and Figure 6, the modelled and observed vehicle volumes are shown graphically for the AM and PM peak periods with each blue dot indicating volume data with the horizontal axis measuring observed volume and the vertical axis measuring modelled volume. As shown, there is a good fit between the observed and modelled datasets as evidenced by the R-Square value of 0.96 in the AM and 0.97 in the PM (whereby a R-Square of 1.00 indicates a perfect fit). There are some variations in the data which are to be expected as real-world volumes were sourced from multiple collection methodologies (signal downloads, manual counts, loop counts) and there are temporal and seasonal fluctuations which induce imbalances when comparing adjacent intersections.

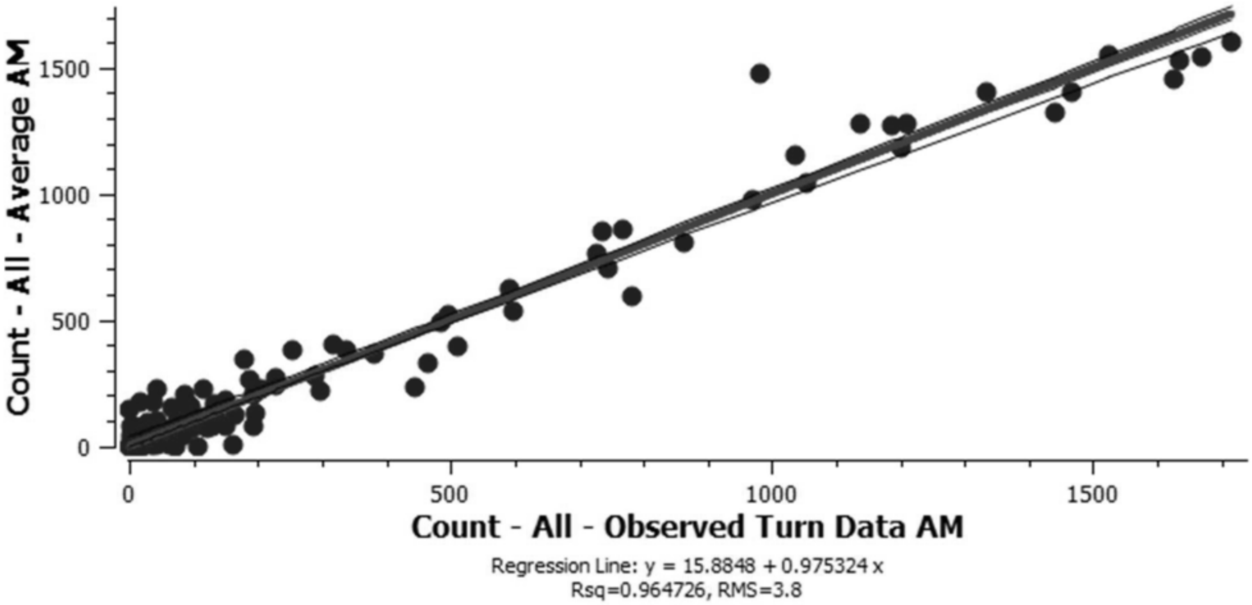


Figure 4: AM Peak Period Turning Movement R-Square Plot

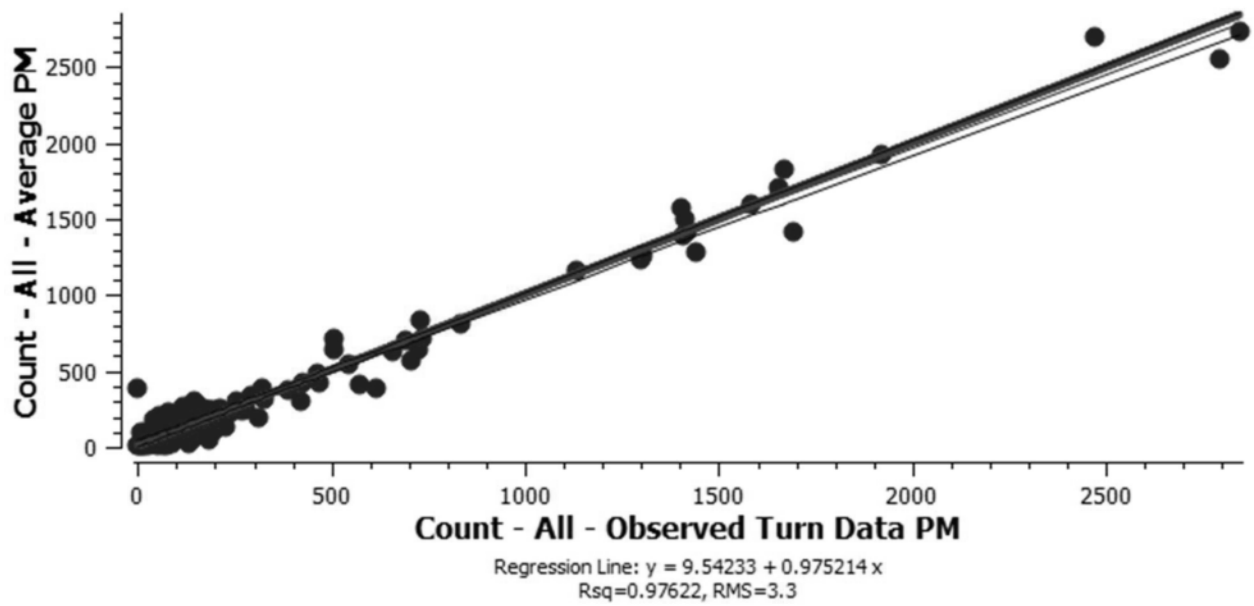


Figure 5: PM Peak Period Turning Movement R-Square Plot

As shown in *Table 1*, a target GEH < 10 has been achieved for all links in the study area with approximately 75% of turning movements exhibiting a GEH less than 5.

Table 1: GEH Summary

Metric	AM Base	PM Base
GEH <10	100 %	100%
GEH <5	75%	76%

ROUTE TRAVEL TIME

Ten travel time routes were established to compare model travel times to observed travel times. As stated previously, observed travel times were extracted from the Google Maps API for the AM and PM peak periods. The ten routes for comparison are as follows:

1. NB 200th Street from 84 Ave to 92a Ave;
2. SB 200th Street from 92a Ave to 84 Ave;
3. EB 88 Ave E from 200 St to 202 St;
4. WB 88 Ave E from 200 St to 202 St;
5. NB 202 Street from 86 Ave to 91a Ave;
6. SB 202 Street from 86 Ave to 91a Ave;
7. WB Hwy 1 Off-ramp to 92a Ave;
8. EB Hwy 1 Off-ramp to 84 Ave;
9. WB Hwy 1 Off-ramp to 84 Ave; and
10. EB Hwy 1 Off-ramp to 92a Ave.

A comparison of the modelled and observed travel times for the ten routes is shown in *Figure 6* and *Figure 7* below for the AM and PM peak hours, respectively. As indicated by the graphic, the calibration process has produced model travel times that are close to observed travel times for both AM and PM peak periods.

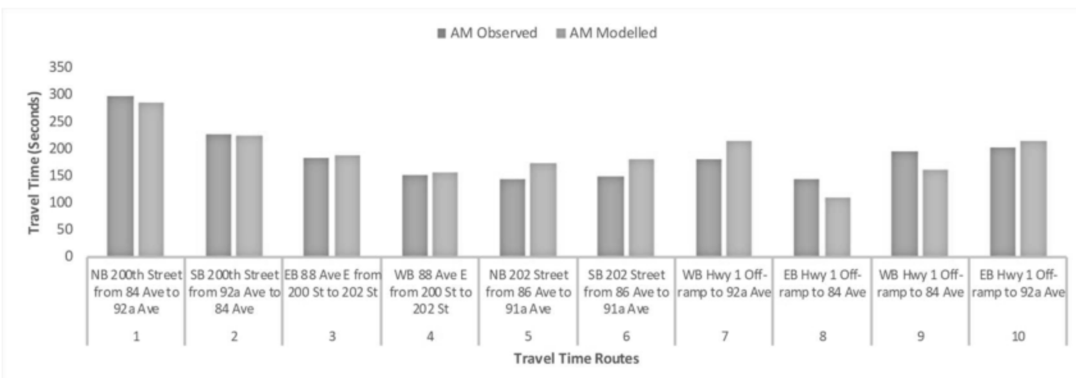


Figure 6: AM Peak Period Route Travel Time Comparison

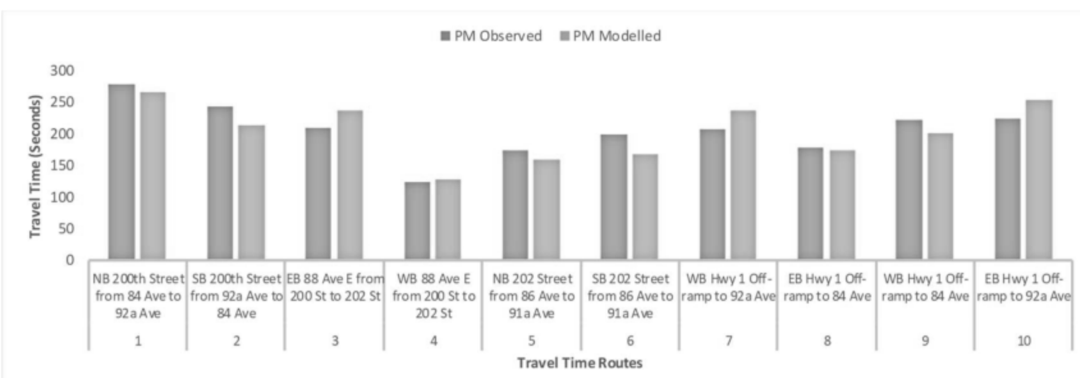


Figure 7: PM Peak Period Route Travel Time Comparison

QUALITITIVE COMPARISON OF CONGESTION

A comparison of the general traffic congestion between Google Maps Traffic conditions and the Aimsun model during the peak AM and PM hours is provided in *Figure 8* below. Dark red links indicate high delays above free-flow travel time while green links indicate minimal delays with travel speeds close to free-flow conditions. As shown, links with high traffic congetion such as northbound on 200 Street at the single-point interchange intersection and the westbound off-ramp from Highway 1 have similar relative levels of congestion between the observed Google Maps traffic and the micro-simulation model.

It should be noted that construction downstream at the future 216 Street interchange was shown to affect Highway 1 operations, particularly in the eastbound direction. Therefore, while Google Maps traffic indicates significant congestion along eastbound Highway 1, this congestion was not as pronounced prior construction activities related 216 interchange beginning.

Period	Google Maps Traffic	Aimsun Color-coded Link Delays
AM		
PM		

Figure 8: Qualitative Traffic Congestion Comparison

4.0 CONCLUSION

The existing conditions traffic model replicates most observed traffic patterns and behaviour. The calibration process has verified turning movement count volumes, route travel times, and observed traffic congestion from Google Maps and a site visit. Based on the above data presented in this document, the traffic operations micro-simulation model is fit-for-purpose to conduct a traffic operations assessment of the study area.

Appendix H

Performance Metrics and Evaluation Framework

BRITISH COLUMBIA | Ministry of Transportation and Infrastructure

Township of Langley BC Est. 1873

Carvolth Traffic Study

Performance Metrics and Evaluation Framework

October 2019

PARSONS

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Introduction

In order to evaluate the different land use and transportation network scenarios as part of the Carvolth Traffic Study and identify the potential impacts of modifications to the restrictive covenant, an evaluation framework needs to be established. This document provides the framework that will be used to evaluate the transportation network. The proposed framework outlines the quantitative measures of performance selected based on the modelling tool used, the methodology used to obtain these performance metrics, and other evaluation criteria developed from key stakeholder objectives contained in relevant community plans and engineering documents.

To quantify the operating performance of the study area, two sets of performance metrics are established based on the level of detail capable by each evaluation software, one for macroscopic analysis using the refined Regional Traffic Model (RTM) and another for micro-simulation traffic operations analysis performed through Aimsun. These performance metrics can also be used to evaluate the different mitigation options that will be developed in subsequent phases of the study.

This document forms one part of the Carvolth Traffic study which intends to understand the impact of changes to land use on the surround transportation network. In particular. the area surrounding the 200 Street Interchange within the Carvolth and Willoughby neighbourhood has seen an increase in development interest, with some areas already undergoing development and others planned for future development. However, the land use assumptions used in the development applications may vary from the assumptions included in the relevant neighbourhood plans. A restrictive covenant limiting trip generation to the 200 Street Interchange quadrants also exists, and potential modifications to or removal of the restrictive covenant is being considered. As such, the Carvolth traffic study is intended to analyze the potential impacts to the surrounding transportation network caused by possible changes to the restrictive covenant as well as land use assumptions in the Carvolth and Willoughby neighbourhood plans. In addition, the study will help identify potential improvements that may be required to the transportation network surrounding the 200 Street Interchange. The study area is bounded by 192 Street and 216 Street along Highway 1 and between 72 Avenue and 96 Avenue in the north-to-south direction, as shown in *Figure 1*.

The identified performance metrics are anticipated to be applied to the 2020 base case models, as well as 2035 and 2050 future network models.

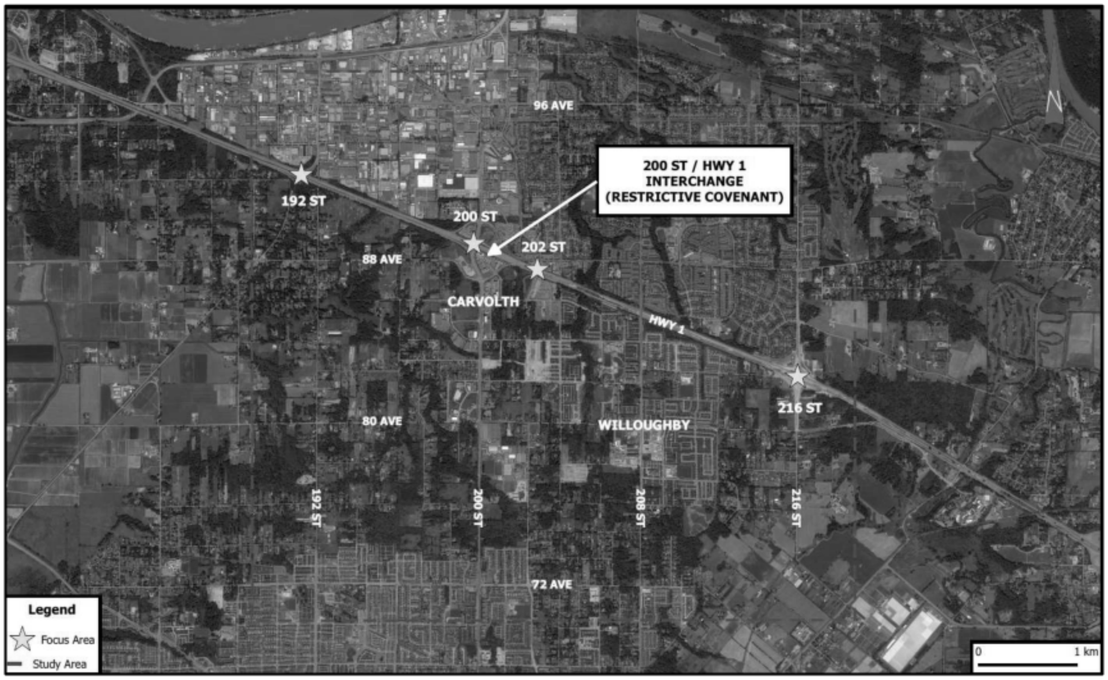

Figure 1: Study Area

Evaluation Framework

As stated previously, two levels of analysis have been established for this study, namely macroscopic and microscopic traffic analysis. As such, two separate levels of metrics have been adopted to capture the type of detail afforded by each evaluation software. This section discusses the metrics within the macroscopic and microscopic evaluation framework.

Macroscopic Analysis

The refined RTM is an Emme-based transportation forecasting model used to conduct the macroscopic analysis portion of the study. Since the study is focused on identifying the potential impacts to the study area due to changes in the restrictive covenant or land use assumptions, performance metrics relevant to travel demand and traffic patterns will be used. The performances metrics selected are described below.

Network Travel Distance (kilometres)

The network travel distance represents the total distance travelled during the peak hour in the model and is presented in terms of Vehicle Kilometers Travelled (VKT) and Passenger Kilometers Travelled (PKT), for transit. For auto trips, network travel distance is an effective way of quantifying the usage of the transportation network. VKT will be reported separately for single-occupancy vehicles, high-occupancy vehicles, and trucks. This metric is a result of trip assignment performed in the RTM and is a direct output from the model.

Network Travel Time (hours)

Network travel time represents the total travel time travelled during the peak hour and is represented by Vehicle Hours Travelled (VHT) and Passenger Hours Travelled (PHT) for transit. The total hours a vehicle is in operation is the VHT for auto while the total amount of time a passenger or a group of passengers spend travelling is the PHT. Network travel time is an important metric to measure the quality of service of a transportation network and is useful in comparing different model scenarios. VHT will be reported separately for single-occupancy vehicles, high-occupancy vehicles, and trucks. Similar to network travel distance, network travel time is a direct output from the RTM.

Volume to Capacity Ratios

To further measure the performance of the network, volume to capacity ratios (v/c) will be used. Volume to capacity ratios identify the ability of a roadway to accommodate traffic volumes based on geometry and traffic demand. A v/c ratio greater than 0.95 will be applied to the analysis results to indicate deficient operations. The 0.95 v/c ratio is based on the "at capacity" value found in the 2010 Highway Capacity Manual (HCM). A v/c ratio will be obtained for each link on the model and this metric is a direct output from the RTM.

Roadway Usage (vehicles per hour)

The volumes accommodated by the transportation network is another performance metric that will be obtained from the RTM. Roadway usage is a metric that can be used to measure traffic flow within a network and identify the level of congestion experienced. Traffic volumes, which are the result of trip assignment, will be obtained for each link in the model. Therefore, this metric is a direct output from the model.

All of the above metrics will be compared to the base scenarios to provide a relative comparison of the changes to the transportation network performance.

Traffic Operations Micro-simulation Analysis

A traffic operations micro-simulation model will provide an assessment of the road network at a more granular level than the RTM. Simulating the network at a microscopic level allows for a more comprehensive evaluation of the performance of the transportation network. The performance metrics included in the traffic operations analysis are detailed below. The extents of the micro-simulation model are shown in *Figure 2* below.

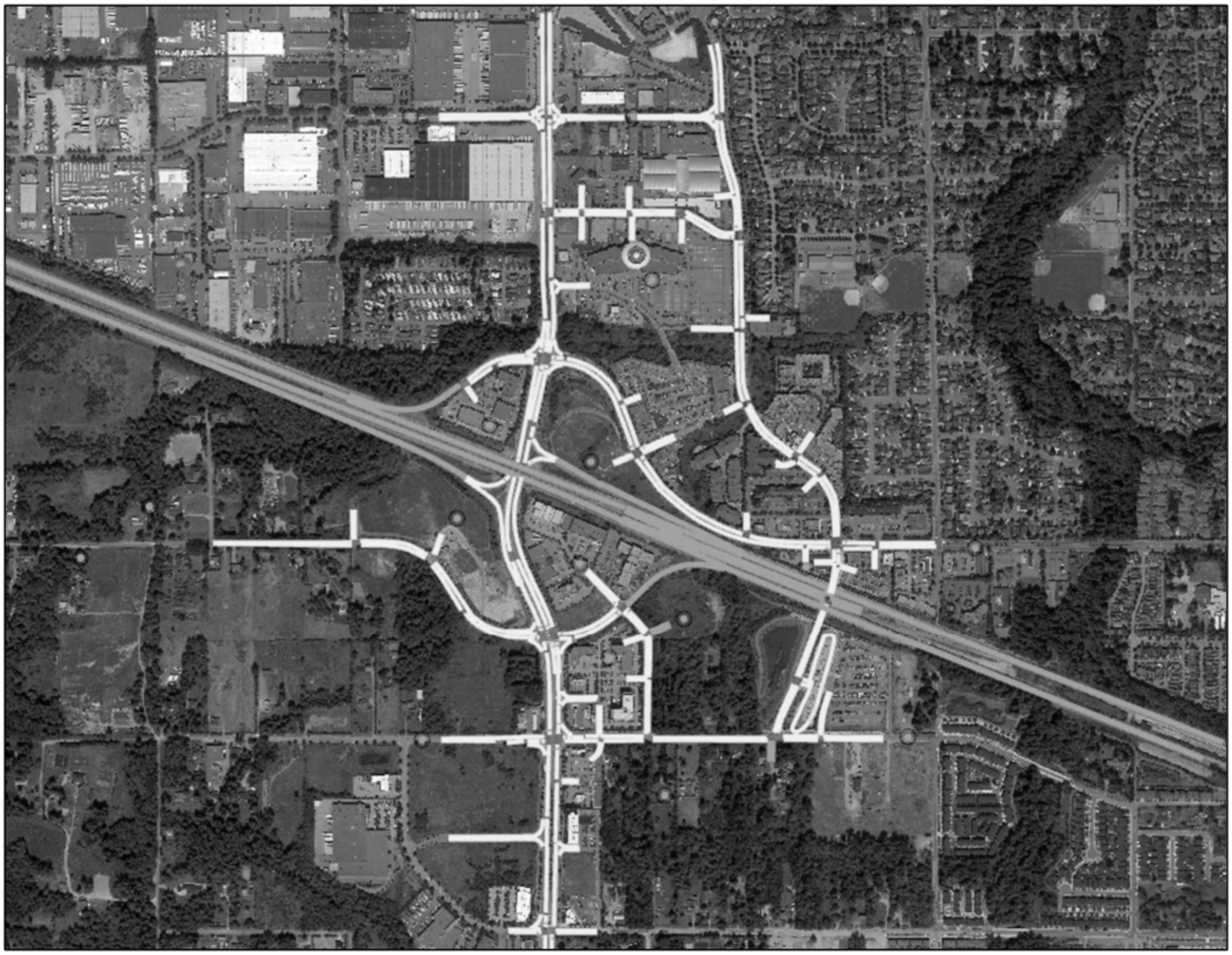

Figure 2: Micro-simulation Model Extents

Four key micro-simulation metrics will be extracted as part of the evaluation framework. The metrics evaluate both overall network performance and individual intersection performance. In particular, the following focus intersections will be evaluated in detail:

- 91a Avenue / 200 Street;
- 91a Avenue / 202 Street;
- 84 Avenue / 200 Street;
- 86 Avenue / 200 Street;

- 88 Avenue E / 200 Street;
- 88 Avenue W / 200 Street;
- 200 Street Interchange off-ramp / on-ramp signals; and
- 88 Avenue E / 202 Street.

It should be noted that intersections at the extent of the traffic analysis study area may be excluded from evaluation as they are coded to provide appropriate traffic metering into the model only.

The selected micro-simulation metrics are described in detail below:

Network Travel Time (hours)

Similar to the macroscopic analysis, network travel time represents the total travel time travelled during the peak hour and is represented by Vehicle Hours Travelled (VHT). Network travel time is an important metric to measure the quality of service of a road network and is useful in comparing different model scenarios.

Approach Delay (seconds)

The delay experienced by a driver can be used to identify issues affecting the operating performance of a network. Delay is comprised of two different values: control and queue delays. Control delay is the component of delay caused by the downstream control device, while queue delay is the additional delay associated with the capacity reduction of short links and turning bays due to queue spillbacks. This metric is a direct output from the traffic operations micro-simulation model.

Level of Service

Level of Service (LOS) ratings is another means to measure the performance of an intersection. LOS represents the quality of service experienced by the driver, based on the delays experienced. While the same ratings, between A to F, apply to both signalized and unsignalized intersections, the ratings have different delay thresholds depending on the intersection control type. *Table 1* below shows the LOS ratings for both signalized and unsignalized intersections based on the 2010 HCM.

Table 1: Level of Service Ratings

LOS	CONTROL DELAY (SECONDS/VEHICLE)	
	SIGNALIZED INTERSECTION	UNSIGNALIZED INTERSECTION
A	≤10	≤10
B	>10 and ≤20	>10 and ≤15
C	>20 and ≤35	>15 and ≤25
D	>35 and ≤55	>25 and ≤35
E	>55 and ≤80	>35 and ≤50
F	>80	>50

Typically, LOS D or better indicates an acceptable level of operation, whereas LOS E or F indicates unacceptable intersection operations. For the purpose of this study in identifying the impacts of potential modifications to the restrictive covenant, LOS analysis will be applied to approach movements to each intersection of interest.

Representative Route Travel Time (minutes)

Travel time is a key metric in determining the level of congestion in a transportation network and is therefore another means of measuring operations performance. Travel times will be obtained for a designated route and will subsequently be used to compare the effects of different traffic demands on the road network. Ten travel times routes have been identified as candidate routes for comparison and are as follows:

1. NB 200th Street from 84 Ave to 92a Ave
2. SB 200th Street from 92a Ave to 84 Ave
3. EB 88 Ave E from 200 St to 202 St
4. WB 88 Ave E from 200 St to 202 St
5. NB 202 Street from 86 Ave to 91a Ave
6. SB 202 Street from 86 Ave to 91a Ave
7. WB Hwy 1 Off-ramp to 92a Ave
8. EB Hwy 1 Off-ramp to 84 Ave
9. WB Hwy 1 Off-ramp to 84 Ave
10. EB Hwy 1 Off-ramp to 92a Ave

All of the above metrics will be compared to the base scenarios to provide a relative comparison of the changes to the transportation network performance.

Summary of Evaluation Framework

The performance metrics used for each evaluation tool are summarized in this section. The key performance metrics, methodology used to obtain them, and range of values adopted can be found in *Table 2* below, forming the evaluation framework.

Table 2: Summary of Evaluation Framework

EVALUATION TOOL	PERFORMANCE METRICS	VALUE RANGE	MEASUREMENT METHODOLOGY
RTM (Emme)	Network Travel Distance (VKT / PKT)	N/A	Direct output from RTM
	Network Travel Time (VHT / PHT)	N/A	Direct output from RTM
	V/C Ratio	Good: >0 to <=0.85 Congested:>0.85 to <= 1.00 Over-capacity: >1.00	Direct output from RTM
	Roadway Usage	N/A	Direct output from RTM
Micro-simulation Model (Aimsun)	Network Travel Time (VHT)	N/A	Direct output from Aimsun
	Total Delay	N/A	Direct output from Aimsun
	Level of Service	Relative to Base Conditions however LOS exceeding “E” typically not desirable	Based on total delay and HCM 2010 guidelines
	Representative Route Travel Time	N/A	Direct output from Aimsun