VISSIM DOCUMENTATION REPORT

CITY OF BELLEVUE/SOUND TRANSIT
CH2MHILL

DOWNTOWN BELLEVUE
LIGHT RAIL ALTERNATIVES ANALYSIS

FEBRUARY 2010

ACKNOWLEDGEMENTS

City of Bellevue

Kevin O'Neill
Judy Clark
Hu Dong
Dave Tallent
Sean Wellander
Mark Poch
Fred Liang
Kevin McDonald

Brant Lyerla
Sue Comis

Craig Grandstrom
Tony Woody
Joshua Johnson
Grahm Satterwhite
Monica Joyce

Peer Review Panel

Nate Larson
Alan Lehto
Bell Lorenz
Randy McCourt
Sanjeev Tandle
John Haggerty
Jim Parsons

Table of Contents

1. Downtown Bellevue LRT - VISSIM Documentation

1.1 What is VISSIM

VISSIM is a traffic modeling software product of PTV. VISSIM can simulate all vehicle types and pedestrian and bicycle interactions as well. According to its manufacturer:

> *VISSIM is a microscopic, time step and behavior based simulation model developed to model urban traffic and public transit operations. The program can analyze traffic and transit operations under constraints such as lane configuration, traffic composition, traffic signals, transit stops, etc., thus making it a useful tool for the evaluation of various alternatives based on transportation engineering and planning measures of effectiveness.*

1.2 Introduction and Purpose of Report

This report provides an overview of the use of the VISSIM micro-simulation traffic model in the traffic analysis of Sound Transit East Link light rail transit (LRT) alternatives in Downtown Bellevue. Figure 1 shows the Downtown Bellevue Study Area boundaries, and the three LRT alternative alignments included in this traffic analysis. The alternative labeled C9T is a tunnel alternative that represents grade-separated alternatives, including an elevated alternative C14E that is not shown in this figure. C9A and C11A are surface alternatives. Figure 2 shows a smaller Southeast Downtown Study Area where the differences between the alternatives were expected to be the most apparent. This report documents the collaborative effort undertaken by the City of Bellevue, Sound Transit and CH2MHill in using VISSIM to simulate the transportation system impacts of the Downtown Bellevue light rail alternatives. This documentation report includes the model inputs and assumptions for 2030, and model results that help differentiate between light rail alternatives. Components reported from the February 2, 2010 VISSIM results are preliminary and significant questions remain pertaining to individual measures.

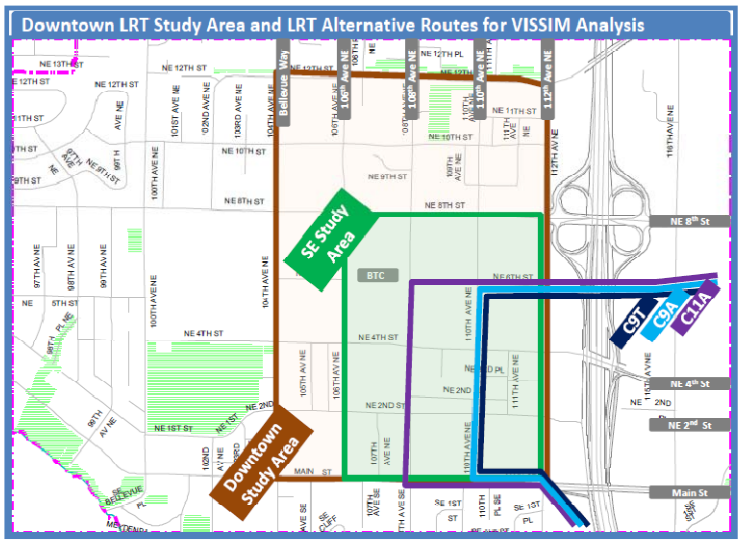

Figure 1
Downtown LRT Study Area and LRT Alternatives

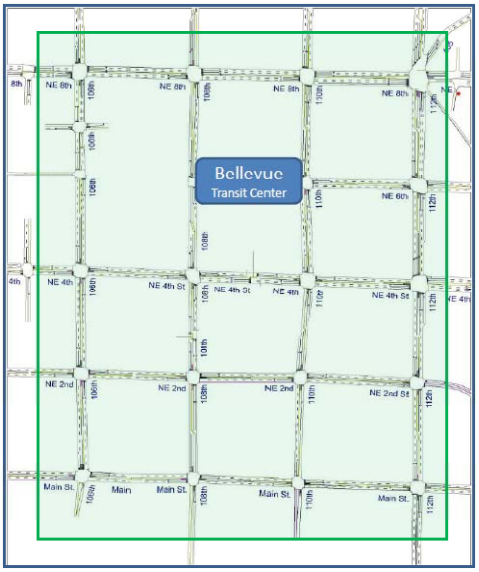

Figure 2
Southeast Downtown Study Area

2. Downtown Bellevue LRT Analysis - Project Overview

2.1 Sound Transit Board

In May of 2009, the Sound Transit Board identified its preferred East Link light rail alignment and stations for analysis in the Final Environmental Impact Statement (FEIS). For Segment C through Downtown Bellevue, the Board's preferred alternative was the C4A Couplet. The Board allowed for further consideration of the City's preference, the C3T tunnel alternative, and stipulated that any additional funding needed for tunnel construction would be Bellevue's responsibility. The C4A and C3T alternative alignments and stations are shown in Figure 3. The Board recognized Bellevue's concern regarding potential traffic impacts with the C4A Couplet and directed Sound Transit staff to work with the City of Bellevue to conduct a analysis and subsequent peer review of the effects on traffic and light rail operations issues of C4A and consider a sensitivity analyses of reasonably foreseeable changes over time such as increases in light rail frequency. The Board also stipulated that if the City of Bellevue performs a separate traffic analysis of C4A, a peer review of the City's analysis of that work should be conducted.

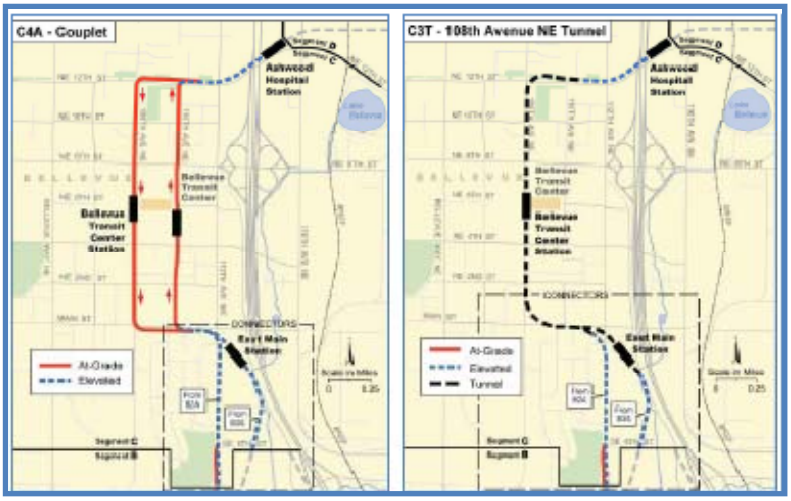

Figure 3 Alternatives C4A and C3T

2.2 Peer Review Panel

Following direction from the Sound Transit Board, Sound Transit and City of Bellevue staff, and consultants from Parametrix worked to develop the membership of a seven-member peer review panel and its scope of work. The primary objective of the panel's work was to review the studies and analyses performed by Sound Transit and the City of Bellevue of the traffic, vehicular access and transit operational impacts of the at-grade light rail alternative in downtown Bellevue – which at the onset of the work, consisted of the C4A Couplet Alternative.

This peer review was intended to provide advice to Sound Transit and the City of Bellevue on the adequacy and completeness of on-going studies of the C4A Couplet and to recommend additional studies and possible modifications to the concept to improve its performance and/or reduce impacts on the transportation system and overall quality of the environment in Downtown Bellevue.

Sound Transit convened a meeting of the Peer Review Panel on October 19 and 20, 2009 in Bellevue. Attachment A is a list of the members of the peer review panel, its facilitator and their professional affiliations. The two-day event consisted of background presentations, field

tours, workshops with planners and traffic modelers, and a session for documenting findings and developing recommendations. Comments and recommendations from the peer review panel included the following:

- The Panel commended Sound Transit and the City of Bellevue on their collaborative efforts, recognizing that both agencies have thought critically about how light rail transit can best serve the area, and that both agencies were working closely to align key assumptions and inputs for their respective traffic modeling efforts.
- The Panel recommended that a comparison matrix of modeling inputs and assumptions be developed for the Sound Transit and City of Bellevue micro-simulation models. Both parties would develop joint modeling inputs and assumptions to provide a framework for model output comparisons.
- The Panel believed that closer coordination and collaboration would be required at the technical staff level during the analysis and impact evaluation process in order to develop comparable information. While the Panel noted that Sound Transit and City of Bellevue staff had been in regular contact, the Panel recommended an increased level of coordination to develop comparative traffic analyses.
- The Panel recommended the City Bellevue and Sound Transit each complete then compare separate micro-simulations of the modeled 2030 traffic and light rail operations for downtown Bellevue for both the C4A Couplet Alternative and the C3T Tunnel Alternative.
- The Panel suggested that Sound Transit and the City of Bellevue consider a shorter surface LRT alignment utilizing a two way operation on 108th Avenue NE or 110th Avenue NE between Main Street and NE 6th Street.

2.3 Evolving Downtown Light Rail Alternatives

Expanding on the recommendations from the Peer Review Panel, staff from Sound Transit and the City of Bellevue jointly refined potential light rail alternatives. Upon presentation of these to the Sound Transit Board in November, 2009, the Board approved further analysis for two new at-grade alternatives that would be shorter than the C4A Couplet and one modified tunnel alternative that would be shorter than C3T, as described below and shown in Figure 2:

- C9T: A tunnel alternative running under 110th Avenue NE with portals on Main Street and NE 6th Street. This is a shorter tunnel alternative than C3T that has portals on Main Street and NE 12th Street.
- C9A: A two-way median-running at-grade alternative on 110th Avenue NE and NE 6th Street.

- C11A: A two-way median-running at-grade alternative on 108th Avenue NE and NE 6th Street.

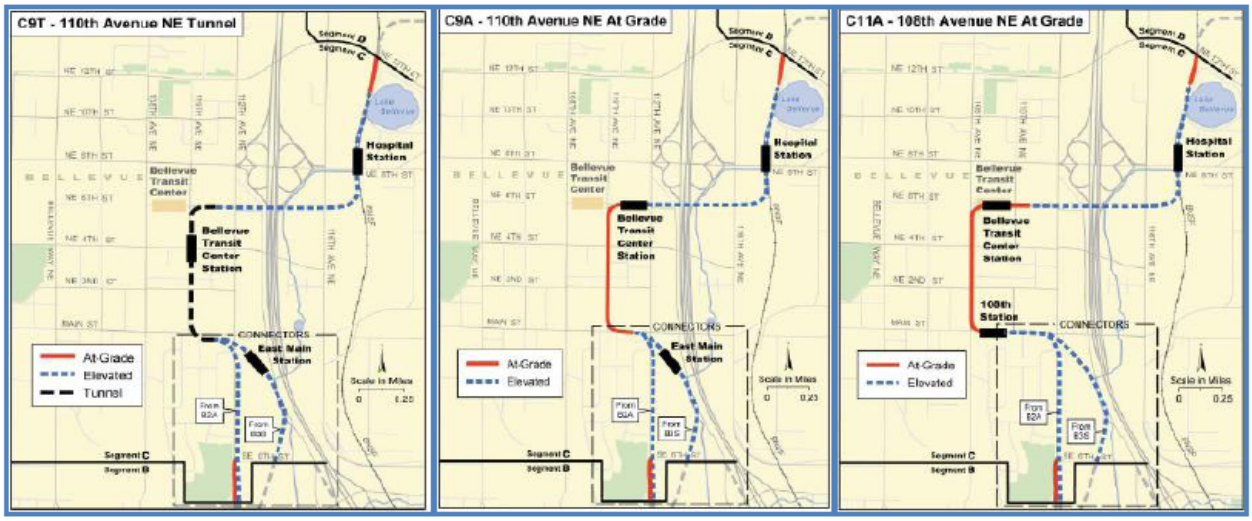

Figure 4 Downtown Bellevue LRT Alternatives

In December 2009, at the request of the Bellevue City Council, the Sound Transit Board added Alternative C14E for analysis. As shown in Figure 5, this is an elevated guideway alignment running on the 114th Avenue NE corridor parallel to I-405 with a station platform between NE 4th Street and NE 6th Street. The station would be connected to the Bellevue Transit Center with a covered, moving sidewalk along NE 6th Street.

For traffic analysis purposes only, the C9T Alternative represented all grade-separated alternatives, including the elevated C14E Alternative.

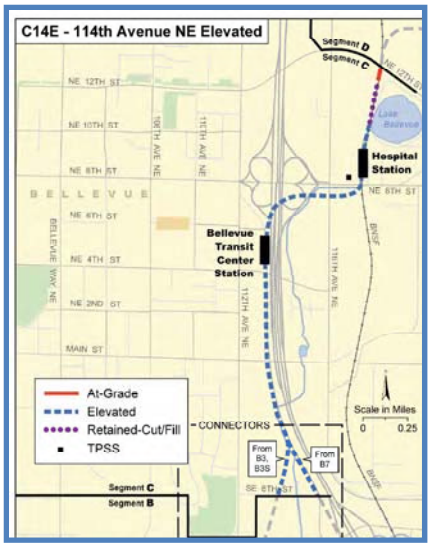

Figure 5 Alternative C14E

2.4 Traffic Modeling Process – LRT Alternatives Analysis

In consideration of the peer review panel recommendations, and significantly, on the reality of resource and time constraints, Sound Transit and the City of Bellevue decided to abandon the parallel approach that required each agency to develop and compare separate traffic modeling results. Instead the agencies embarked on a collaborative approach to jointly develop a VISSIM traffic model for each alternative and a subsequent traffic analysis report. Figures 6 and 7 graphically illustrate this comprehensive and collaborative approach to the VISSIM traffic analysis for Downtown LRT (Figure 6) and the resource allocation and coordination (Figure 7).

Through December 2009 and into early February 2010, Bellevue staff and Sound Transit staff and consultants from CH2MHill collaborated and worked side-by-side in Bellevue City Hall to build the VISSIM models for alternatives C9T, C9A and C11A. Weekly – and often more frequently - coordination meetings and e-mail correspondence ensured that all key participants were kept informed of progress, provided direction, and reviewed model output.

The jointly developed VISSIM traffic analysis results are documented in this report. These were combined with other mutually agreed upon evaluation criteria in a joint report released on February 5, 2010 titled: *Downtown Bellevue Light Rail Alternatives Concept Design Report, February 2010*. This report compiled data in seven categories - of which traffic operations was one - to help decision makers differentiate between a broad range of impacts and opportunities related to the Downtown Bellevue light rail alternatives.

The jointly developed VISSIM models for each LRT alternative were based on the City of Bellevue BKR travel demand model which was updated for this effort to a base year of 2008 and a forecast year of 2030. The *BKR Documentation Report, February 2010* documents the BKR model assumptions and output.

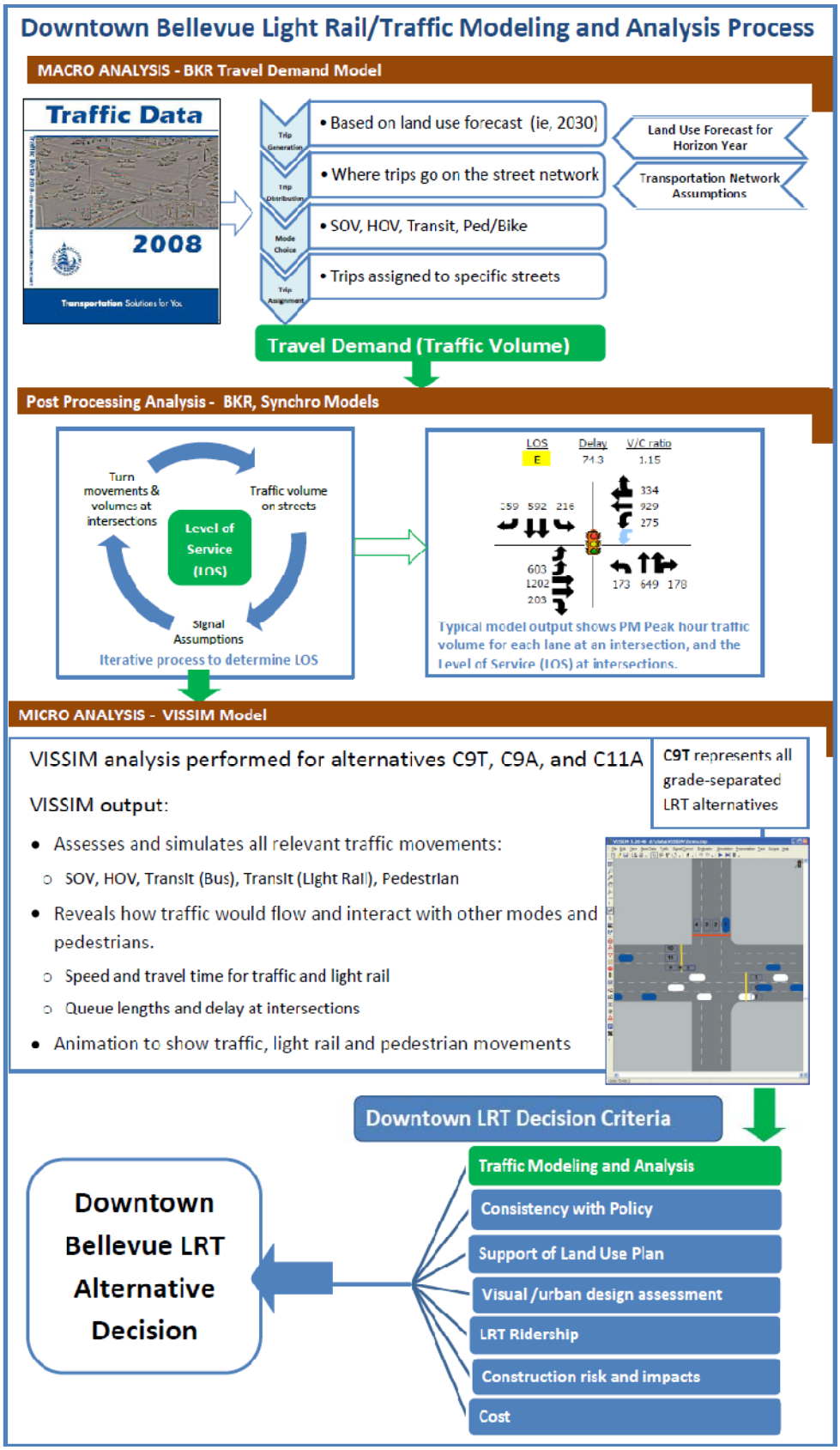
Downtown Bellevue Light Rail/Traffic Modeling and Analysis Process
MACRO ANALYSIS - BKR Travel Demand Model
Traffic Data
2008
Trip Generation
• Based on land use forecast (ie, 2030)
Trip Distribution
• Where trips go on the street network
Mode Choice
• SOV, HOV, Transit, Ped/Bike
Trip Assignment
• Trips assigned to specific streets
Land Use Forecast for Horizon Year
Transportation Network Assumptions
Travel Demand (Traffic Volume)
Post Processing Analysis - BKR, Synchro Models
Turn movements & volumes at intersections
Traffic volume on streets
Level of Service (LOS)
Signal Assumptions
Iterative process to determine LOS
LOS
Delay
V/C ratio
E
74.3
1.15
Typical model output shows PM Peak hour traffic volume for each lane at an intersection, and the Level of Service (LOS) at intersections.
MICRO ANALYSIS - VISSIM Model
VISSIM analysis performed for alternatives C9T, C9A, and C11A
C9T represents all grade-separated LRT alternatives
VISSIM output:
Assesses and simulates all relevant traffic movements:
SOV, HOV, Transit (Bus), Transit (Light Rail), Pedestrian
Reveals how traffic would flow and interact with other modes and pedestrians.
Speed and travel time for traffic and light rail
Queue lengths and delay at intersections
Animation to show traffic, light rail and pedestrian movements
Downtown LRT Decision Criteria
Traffic Modeling and Analysis
Consistency with Policy
Support of Land Use Plan
Visual /urban design assessment
LRT Ridership
Construction risk and impacts
Cost
Downtown Bellevue LRT Alternative Decision

Figure 6

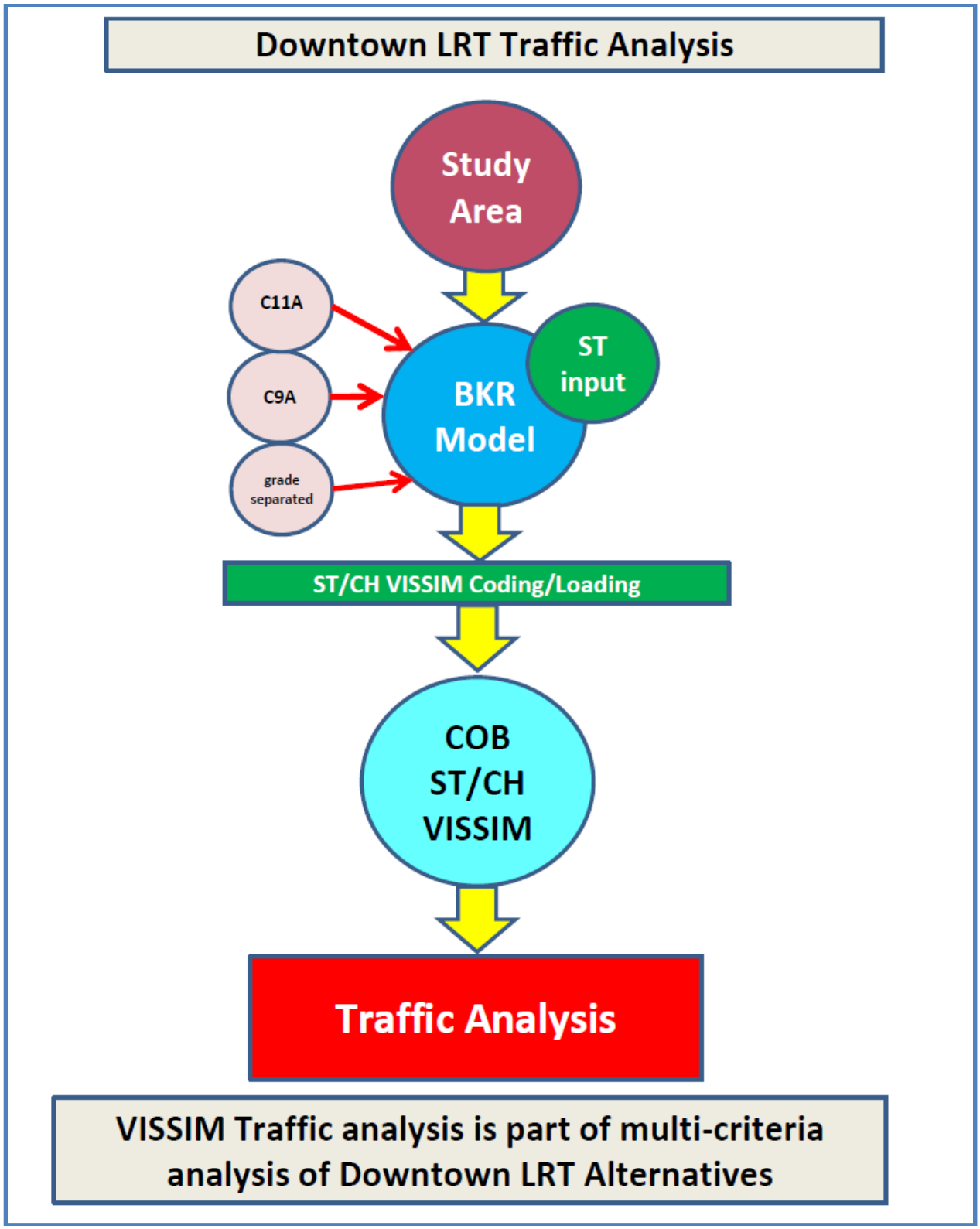
Downtown LRT Traffic Analysis
Study Area
C11A
C9A
grade separated
BKR Model
ST input
ST/CH VISSIM Coding/Loading
COB ST/CH VISSIM
Traffic Analysis
VISSIM Traffic analysis is part of multi-criteria analysis of Downtown LRT Alternatives

Figure 7

3 Land Use and Travel Demand Assumptions

Information presented in this section represents summary points of the travel demand model. For more information refer to the *BKR Documentation Report, February 2010*.

3.1 Downtown Bellevue Growth: 2008 - 2030

Fulfilling its regional role as a designated Urban Center, Downtown Bellevue will accommodate its share of regional growth in employment and households as described in PSRC VISION 2040 and the Bellevue Comprehensive Plan. Both the number of employees and the households in Downtown Bellevue are expected to more than double during the time frame for this analysis - 2008 to 2030. Refer to Table 1 for current and projected land use.

Table 1

	2008	2030	Growth
Employment	34,000	79,000	2.32/132%
Households	4,500	14,600	3.24/224%

3.2 Travel Demand: 2008 - 2030

Table 2 provides a snapshot of the current traffic and the expected growth in vehicle trips in Downtown Bellevue, both single occupant vehicles (SOV) and high occupant vehicles (HOV).

Table 2

PM Peak Hour Auto Volumes	2008	2030	Growth
All Trips to Downtown	6,956	12,099	1.74/74%
All Trips out of Downtown	11,439	19,229	1.68/68%

Figures 8 and 9 portray the growth in total daily person trips between 2008 and 2030 - in motorized modes - in Downtown Bellevue, categorized by type of trip. Home based trips in 2008 represent 60% of the total, while in 2030, the figure increases slightly to 62%

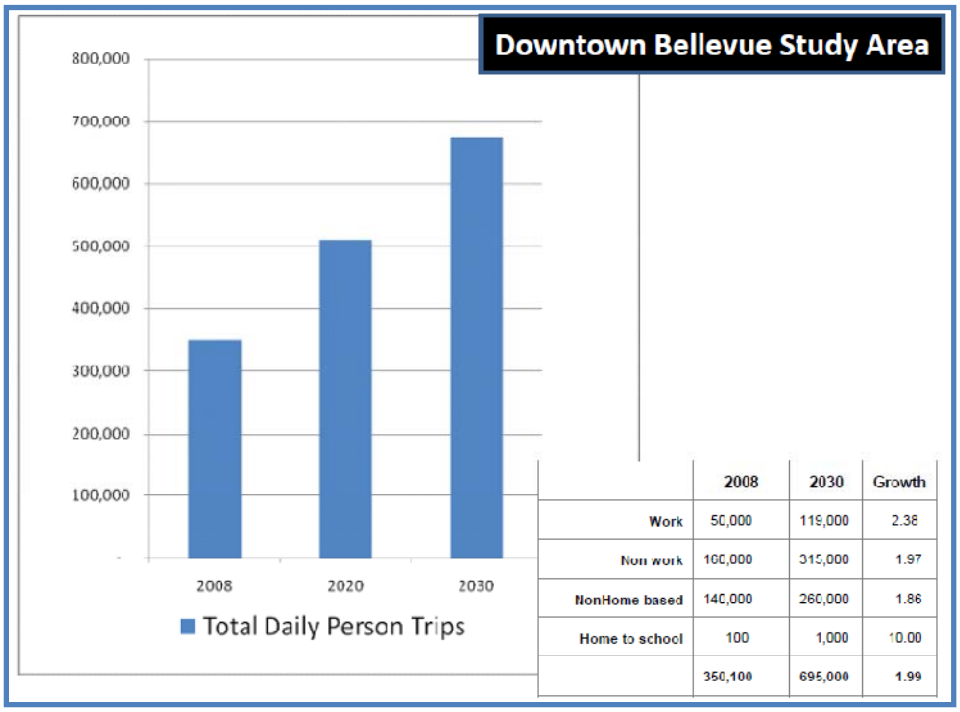

Figure 8

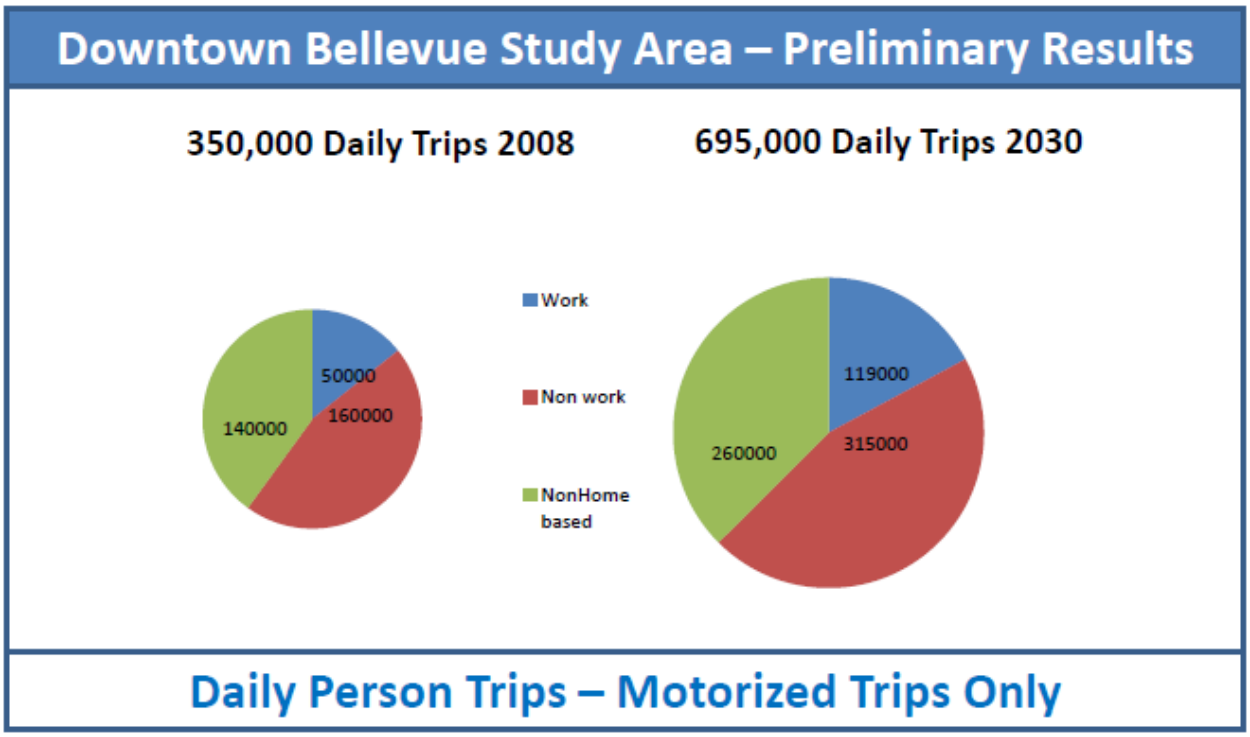

Figure 9

4 Transportation System Assumptions: 2008 – 2030

4.1 Roadway Network 2008

The 2008 roadway network reflects the existing roadway network at the end of 2007. This network includes regional highways, roadways in Bellevue, roadways in Redmond and Kirkland, and other roadways in the region. Refer to the *BKR Documentation Report* for more details about the 2008 roadway network.

4.2 Roadway Network 2030

The assumed 2030 roadway network consists primarily of funded or committed projects by the State, regional and local agencies, combined with other projects that were considered to be "reasonably foreseeable" by 2030. The "reasonably foreseeable" transportation project list was the agreed-upon result of discussions between the City of Bellevue, Sound Transit and the Washington State Department of Transportation. Refer to the BKR Documentation Report for more details about the 2030 roadway network.

4.3 Signalized Intersections

4.3.1 Roadways

While the VISSIM model encompassed a larger network than the Downtown study area, results focused mainly on the intersections shown in Figure 10.

Level of Service (LOS) was reported from the 2/2/2010 VISSIM results for 35 of the 43 roadway intersections in Downtown Bellevue – these are the signalized intersections shown in Figure 10.

4.3.2 Driveways

In addition to the signalized intersections, the VISSIM model included 4 signalized driveways, three of which are shown in Figure 10.

- Bellevue Way @ Westin driveway (NE 5th Street)
- NE 8th @ Lincoln Square driveway (105th Avenue NE)
- 106th Avenue NE @ NE 7th St.
- 4th @ JCPenny driveway (NE 2nd Street) *(not on map)*

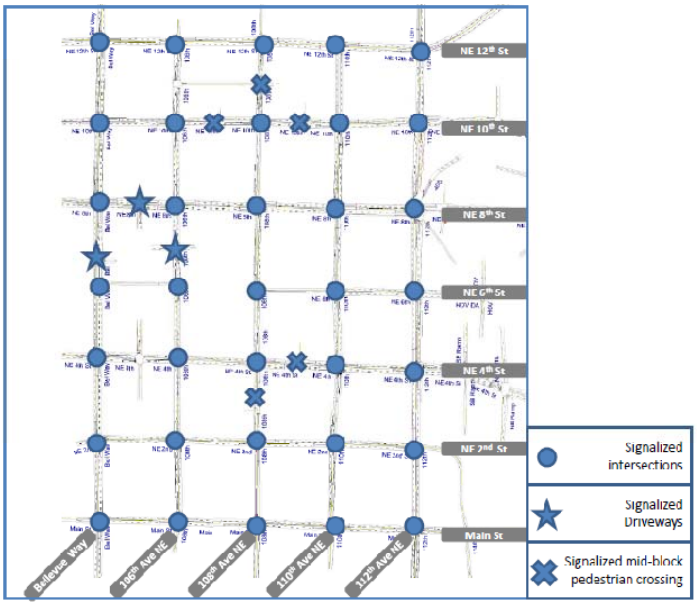

Figure 10 Signalized Intersections and Mid-Block Pedestrian Crossings in 2030

4.3.3 Downtown Mid-Block Pedestrian Crossings

New mid-block pedestrian crossings in Downtown Bellevue – as defined in the Downtown Subarea Plan - will help make pedestrian mobility easier in an environment of 600-foot superblocks. These planned signalized crossings will be installed at locations where there is a strong pedestrian demand – shown in Figure 10. Traffic operational impacts of these five assumed mid-block crossings were considered in Downtown Bellevue traffic modeling for light rail analysis.

4.4 Alternative–Specific Roadway and Intersection Configurations

For the 2030 East Link Downtown LRT alternatives analysis, the scenarios for roadway configurations and operational details vary somewhat for each alternative. The 2030 roadway network in C9T includes the "reasonably foreseeable" projects discussed in section 4.2, the two at-grade alternatives slightly modify the lane configurations on 108th Avenue NE and 110th Avenue NE. These modifications are due primarily to the different configurations of the at-grade LRT alignments and station locations. The assumptions for the 2030 roadway network for each alternative have been developed by staff from the City of Bellevue, Sound Transit and CH2MHill.

Alternative C9T was assumed to represent the "base" 2030 roadway network, since the tunnel alternative would have no direct physical or operational impact on the surface roadways. Table 3 describes the C9T roadway network that was assumed for VISSIM modeling and the modifications to that network for the two at-grade alternatives, C9A and C11A. As an example of the roadway network detail differences, refer to Figure 11. This figure shows the Bellevue Transit Center on NE 6th Street between 108th Avenue NE and 110th Avenue NE. Alternative C9A does not use the Transit Center and the 2030 bus platform/roadway channelization is the same as in 2008. C9A features a pedestrian scramble at NE 6th Street/110th Avenue NE. In Alternative C11A, trains run through a rebuilt transit center with a center platform LRT station, and share the facility with buses, with a modified 2030 roadway network as shown. C11A retains the pedestrian scramble at its current location at NE 6th Street/108th Avenue NE.

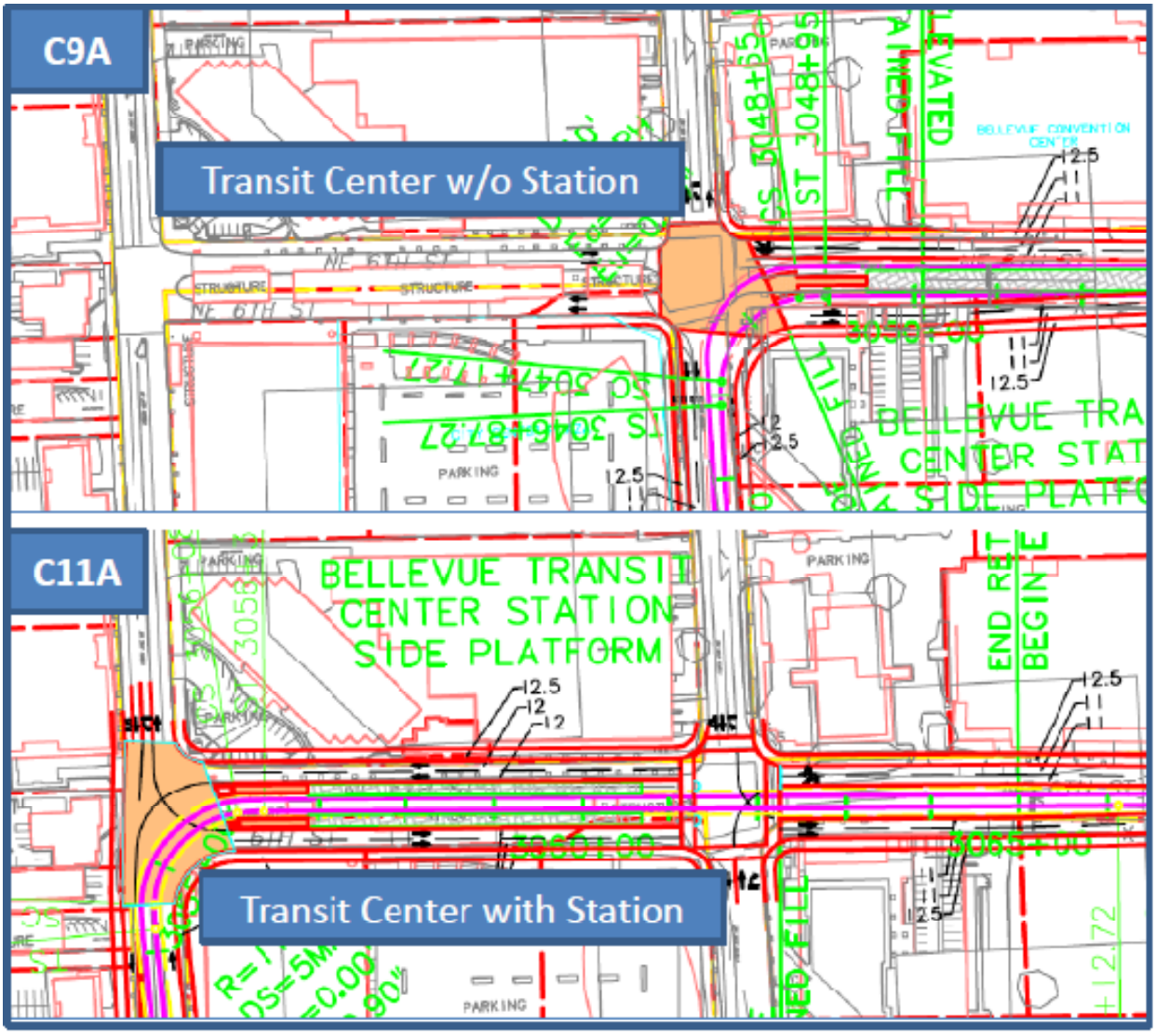

Figure 11 Bellevue Transit Center Channelization: C9A without LRT and C11A with LRT

Table 3 Roadway Assumptions and Modifications for Downtown Bellevue Study Area

Roadway	Alternative C9T/C14E	Alternative C9A	Alternative C11A
106th Ave. NE	• 2 lanes in each direction with left-turns at signalized intersections from Main Street to NE 6th Street	• No change	• No change
108th Ave. NE	• 2 SB lanes and 1 NB lane with left turns at signalized intersections from Main Street to NE 6th Street • Retain pedestrian scramble @ NE 6th Street	• No change	• One through lane in each direction from Main Street to NE 6th Street • Between Main and NE 6th Street northbound left turns are eliminated at NE 2nd Street and NE 4th Street
110th Ave. NE	• 1 lane in each direction with left-turns at signalized intersections from Main Street to NE 6th Street	• Between Main and NE 6th Street northbound left turns are eliminated at NE 2nd Street and NE 4th Street	• No Change
112th Ave. NE	• 2 lanes in each direction with left-turns at signalized intersections from Main Street to NE 6th Street	• No change	• No change
Main Street	• 2 lanes in each direction with left-turns at signalized intersections from 106th Ave. NE to 112th Ave. NE	• No change	• No change
NE 2nd Street	• 1 lane in each direction with left-turns at signalized intersections from 106th Ave. NE to 112th Ave. NE	• No change	• No change
NE 4th Street	• 2 lanes in WB direction and 2/3 lanes in EB direction with left-turns at signalized intersections from 106th Ave. NE to 112th Ave. NE	• No change	• No change
NE 6th Street	• Pedestrian Corridor and Transit Center platform from 106th Avenue NE to 110th Avenue NE • 2 lanes in each direction with left-turns at signalized intersections from 110th Avenue NE to 112th Avenue NE • Retain pedestrian scramble @ 108th Avenue NE	• A pedestrian scramble at 110th Avenue NE & NE 6th Street/BTC has been assumed. This would allow access to/from the center LRT platform to/from any leg of the intersection. Due to longer FDW times on the east and south legs and split phasing, pedestrian minimum times may require a longer cycle length.	• The WB LT at 110th/BTC would be maintained. WB approach channelization would be 1 WB LT and one WB TH/RT lane.
Bellevue Transit Center	• Bus movements would continue within the BTC between 108th Avenue NE 110th Ave. NE. Bus movements would not occur for the northbound left movement from 110th Avenue NE to the BTC @ at NE 6th Street	• No change	• Pedestrians would be able to access center platform from either end of BTC (108th and 110th) and at one mid-block location within BTC • The direction of the bus routes and stops would run parallel to the movement of the trains through the Bellevue Transit Center.
NE 8th Street	• 3 lanes in each direction with left-turns at signalized intersections from 106th Avenue NE to 112th Avenue NE	• No change	• No change
NE 10th Street	• 2 lanes in each direction with left-turns at signalized intersections from 106th Avenue NE to 112th Avenue NE	• No change	• No change

4.5 Driveway Assumptions

The City of Bellevue evaluated the future development potential along specific streets to determine the assumed location for future driveways and generalized 2030 forecast traffic volumes for future driveways and higher loaded existing driveways. Refer to Figure 12 which is a map of existing and assumed driveways. The VISSIM micro-simulation model accounted for all movements in to and out of each driveway.

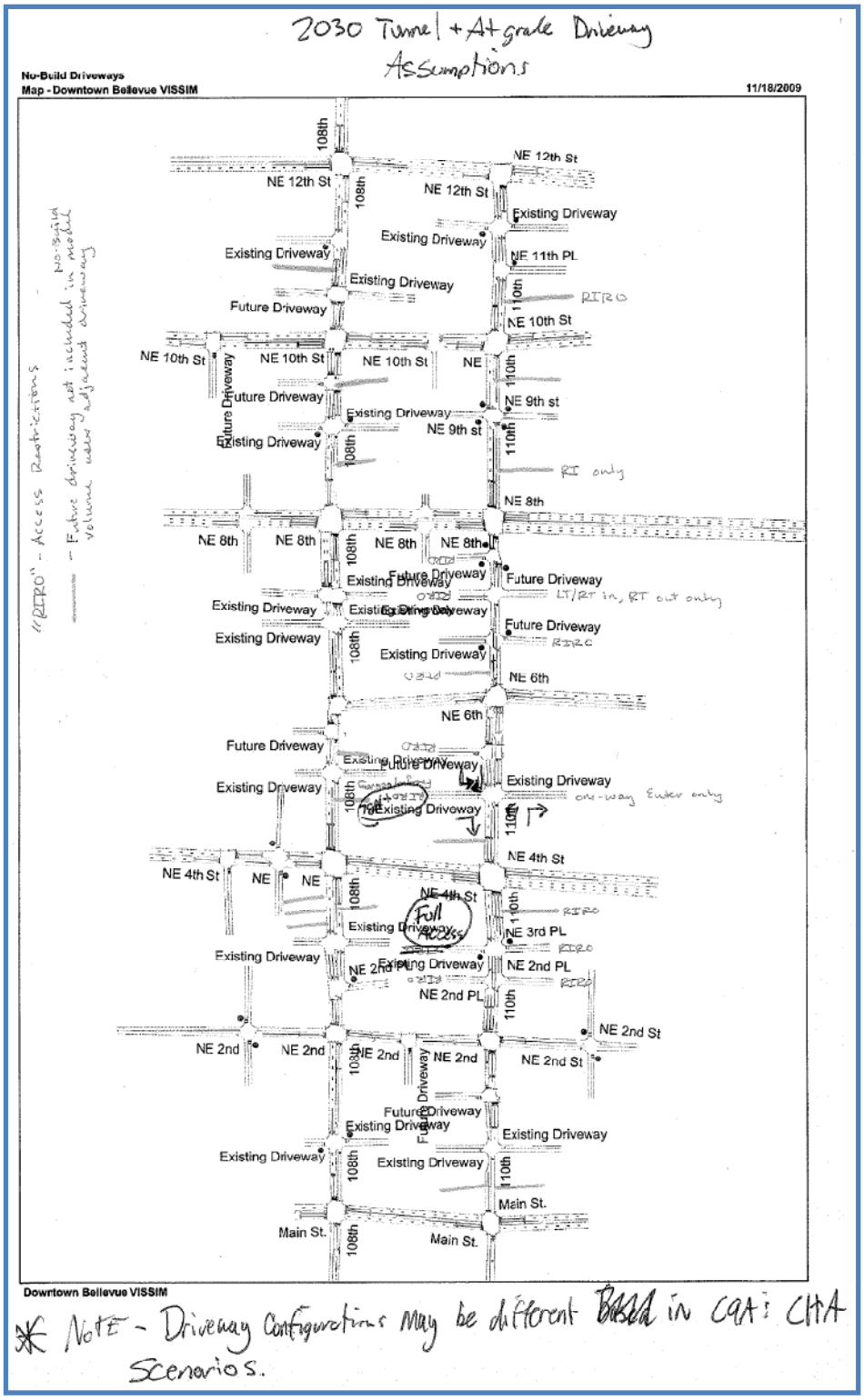

Figure 12 Existing Driveways and 2030 Assumptions

5 Transportation System Transit Network

The bus transit system operating on the surface streets in Downtown Bellevue is managed by several transit agencies: King County Metro Transit, Sound Transit, Community Transit, and Pierce Transit. A robust transit system, including a bus system that is well integrated with light rail, is essential to support the assumed growth in land use – both commercial and residential – in Downtown Bellevue. A plan to integrate bus transit with light rail was developed by the transit agencies for the East Link Draft EIS.

5.1 2008 Base Year Transit Network

The Downtown Bellevue transit network reflected in the BKR 2008 Base Year Model, was based on the Fall 2007 service plan provided by King County Metro Transit, Sound Transit, Community Transit, and Pierce Transit. Park and ride capacities and surveyed usage in the BKR model reflected the 2007 conditions. Refer to the *BKR Documentation Report* for more details about the 2008 transit network.

5.2 2030 Transit Network – Downtown Bellevue Routes and Headways

Transit service assumptions included the frequency, type of coach, dwell and layover times, and route number. The *BKR Documentation Report* provides additional information on transit service for the AM, mid-day and PM time periods, and a map of the assumed 2030 Downtown Bellevue transit routing. Future transit service assumptions were based upon the transit integration plan developed by the transit agencies for the East Link DEIS.

6 VISSIM Model Results

6.1 February 2, 2010 Milestone

At this milestone in the process of analyzing Downtown Bellevue traffic (February 2, 2010), VISSIM results are provided for the three alternatives at the system-wide and composite level. At this level of development the models cannot be used to draw conclusions about conditions on specific roads or at specific intersections. While specific intersection and corridor data is presented in this report – from the 2/2/2010 VISSIM results - staff continues to refine the VISSIM model to better understand and document conditions at specific locations and corridors.

6.2 Measures of Effectiveness

This VISSIM traffic analysis provides information that stakeholders may use to compare the Downtown East Link light rail alternatives with regard to specific measurable effects on the Downtown Bellevue transportation system.

Table 4 contains summary data that was produced for the *Downtown Bellevue Light Rail Alternatives Concept Design Report, February 2010* including data for both the Downtown transportation system as a whole and for specific intersections. The following system-wide or composite measures were reported for the 2030 PM peak hour:

- Vehicle Travel Time: Travel time was calculated between two points along key north-south and east-west arterials. The measures below describe the values presented in the *Concept Design Report*:
  - Eastbound and Westbound Vehicle Travel Time: This measure reports the average travel time for a composite of east-west Downtown arterials between Main Street and NE 12th Street, from Bellevue Way to 112th Avenue NE. Shown in Figure 13
  - Southbound and Northbound Vehicle Travel Time: This measure reports the average travel time for a composite of north-south Downtown arterials between Bellevue Way and 112th Avenue NE, from Main Street to NE 12th Street. Shown in Figure 14.
- Percent of Vehicle Demand Served Into and Out of Downtown Bellevue: This measure is the modeled percentage of vehicles able to enter or exit Downtown as compared to total expected number of trips based on the 2030 land use and travel demand forecasts. It was measured at arterials that form the perimeter of the core of Downtown Bellevue: Main Street; 112th Avenue NE; NE 12th Street; and Bellevue Way. Detailed information in Table 6.
- Average Vehicle Delay at Intersections: Intersection delay measures the amount of time a vehicle is expected to wait before being able to proceed through an intersection. This

measure is provided for two areas; the larger Downtown Bellevue street grid system bounded by the perimeter streets of Main Street, Bellevue Way, NE 12th Street, and 112th Avenue NE – referred to in Table 4 as 'Downtown'; and a more focused study area near the proposed light rail alignments and stations in southeastern area of downtown, which is an area bounded by Main Street, 106th Avenue NE, NE 8th Street, and 112th Avenue NE – referred to in Table 4 as 'subarea'. Individual vehicle intersection delay is weighted by the number of vehicles served at each intersection to provide a composite average delay reported for the Downtown and the subarea. Detailed information is in Table 6.

Table 4 VISSIM Analysis: Segment C Downtown Bellevue Alternatives

Measure	C9T	C9A	C11A	C14E
Southbound vehicle travel time (minutes) *NE12th Street to Main Street*	6.5	8	7.4	6.5
Northbound vehicle travel time (minutes) *Main Street to NE 12th Street*	5.8	6.5	5.6	5.8
Eastbound vehicle travel time (minutes) *Bellevue Way to 112th Avenue NE*	5	4.9	5.3	5
Westbound vehicle travel time (minutes) *112th Avenue NE to Bellevue Way*	4.9	5.2	5.8	4.9
Percent of vehicle demand served into and out of downtown Bellevue	78%	78%	77%	78%
Average Downtown vehicle delay at intersections (seconds) *Perimeter: Main St, Bellevue Way, NE 12th St, 112th Ave NE*	67	73	70	67
Average Subarea vehicle delay at intersections (seconds) *Perimeter: Main St., 106th Ave NE, NE 8th St, 112th Ave NE*	78	85	87	78

6.3 Peer Review Panel – VISSIM Measures of Effectiveness Reporting

Following the Peer Review Panel meeting in October 2009, the staff from Sound Transit, the City of Bellevue and Parametrix developed a spreadsheet to document the panel's specific recommendations for reporting the results of the VISSIM traffic model output. Table 5 lists the recommended performance measures that were specifically identified as having a VISSIM data source, and how those measures have been reported to date – 2/2/2010.

Sections 6.4, 6.5 and 6.6 provide, respectively, the preliminary VISSIM results for east/west travel time, north/south travel time, and the 2030 intersection level of service, delay and throughput. Updated VISSIM results are expected to be available for Peer Review Panel review.

Table 5 VISSIM Results: Measures of Effectiveness

Category	Proposed VISSIM Measures/Parameters	VISSIM Output Reported (based on the 2/2/2010 VISSIM run)
East/West auto travel time	NE 8th St: Bellevue Way – 116th Ave NE	Reported in Table 4 as a consolidated travel time across all major east/west arterials and terminated on the east at 112th Avenue NE because going to 116th Avenue NE introduced operations issues not related to LRT alternatives. Preliminary results for individual roadway east/west travel time are reported in Figure 13.
	NE 4th St: Bellevue Way – 116th Ave NE	
North/South auto travel time	Bellevue Way: Main St to NE 12th Street	Reported in Table 4 as a consolidated travel time across all major north/south arterials. Preliminary results for individual roadway north/south travel time are reported in Figure 14.
	112th Ave NE: Main St to NE 12th Street	
Typical trips: auto travel times	Bellevue Square to I-405	NE 8th Street: Preliminary results reported as a composite of east/west bi-directional travel time in Table 4 and Figure 13.
	Toys 'R' Us to Library	110th Avenue NE: Preliminary results reported as a composite of north/south bi-directional travel time in Tale 4 and Figure 14.
	NB and SB on 108th and 110th	108th Avenue and 110th Avenue NE: Preliminary results reported as a composite of north/south bi-directional travel time in Tale 4 and Figure 14.
	NE 2nd /108th to Hospital	N/A
Light rail: travel time	Between East Main and Ashwood/Hospital Stations	Not reported in the Concept Design Report or this VISSIM Documentation Report as a product of this VISSIM modeling effort. Sound Transit independently derived LRT travel time from a separate VISSIM modeling process together with an LRT operational model.
Transit: travel time	Metro Rapid Ride (NE 8th St.) and ST 535 (Transit Center and NE 6th Street.) bus route travel time to cite as representative routes	N/A
Vehicle throughput	East/West streets: Main, 2nd, 4th, 8th, 10th, and 12th	Reported in Table 4 as the percent of vehicle demand served into and out of downtown Bellevue. Measured as vehicle trips across the cordon line of Main Street, Bellevue Way, NE 12th Street, and 112th Avenue NE. Table 6 provides detailed preliminary (2/2/2010) measures of vehicle throughput for each roadway, plus a composite measure of throughput of all vehicles entering and departing Downtown Bellevue across the designated screenlines.
	Core capacity: 4th, 8th, 110th and 112th	
	108th and 110th: Visual inspection of lane capacity	Refer to Table 3, Roadway Assumptions and Modifications
Vehicle queue length	4th and 8th @ 106th, 108th, 110th	N/A
	Main and 12th@ 106th, 108th, 110th	N/A
Intersection Level of Service	All VISSIM intersections in the Downtown network, with focus on 106th, 108th, 112th@ Main, 4th, 8th, 12th	Reported as preliminary (2/2/2010) results in Table 6 as the intersection Level of Service – LOS E and F are highlighted as yellow and orange respectively. Note that while LOS E is defined as a range of delay between 55 and 80 seconds, LOS F is defined simply as being over 80 seconds of delay. Some intersections labeled LOS F barely meet the threshold while others have a significantly greater delay. Updated LOS results will be available for Peer Review Panel review.
Intersection Delay	Include as part of intersection Level of Service	Reported for two measures in Table 4: • Average Downtown vehicle delay • Average Subarea vehicle delay • Table 6 provides preliminary (2/2/2010) results for individual intersection delay, updated delay results are expected with further refinement of the models.

6.4 Downtown Corridor East-West Travel Time: Model Results from 2/2/2010

Eastlink - Downtown Bellevue Analysis
2030 Build Downtown Corridor Travel Times

INITIAL DRAFT - FOR INTERNAL REVIEW ONLY

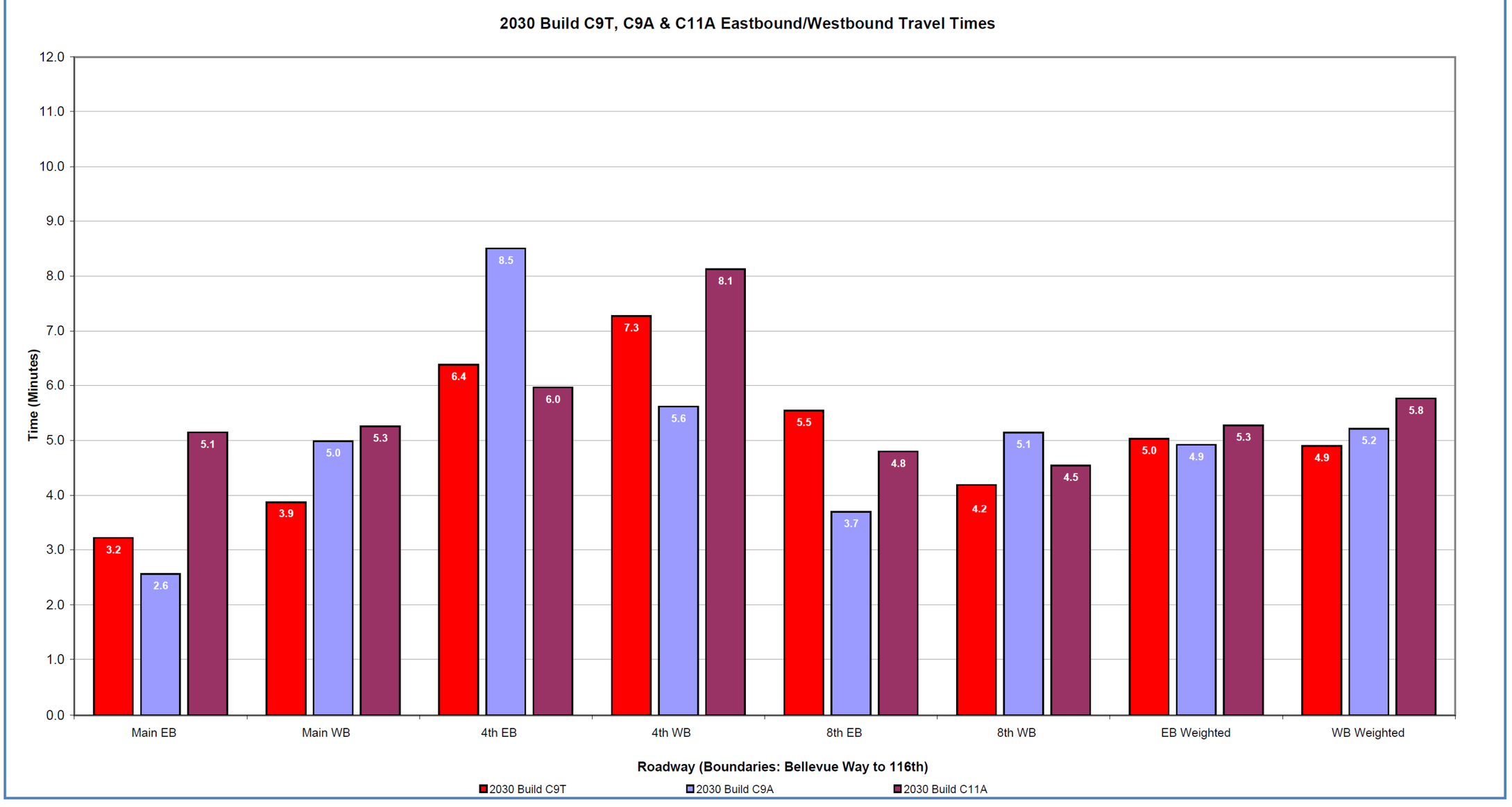

Figure 13 Downtown Corridor East-West Travel Time

6.5 Downtown Corridor North-South Travel Time: Model Results from 2/2/2010

Eastlink - Downtown Bellevue Analysis
2030 Build Downtown Corridor Travel Times

INITIAL DRAFT - FOR INTERNAL REVIEW ONLY

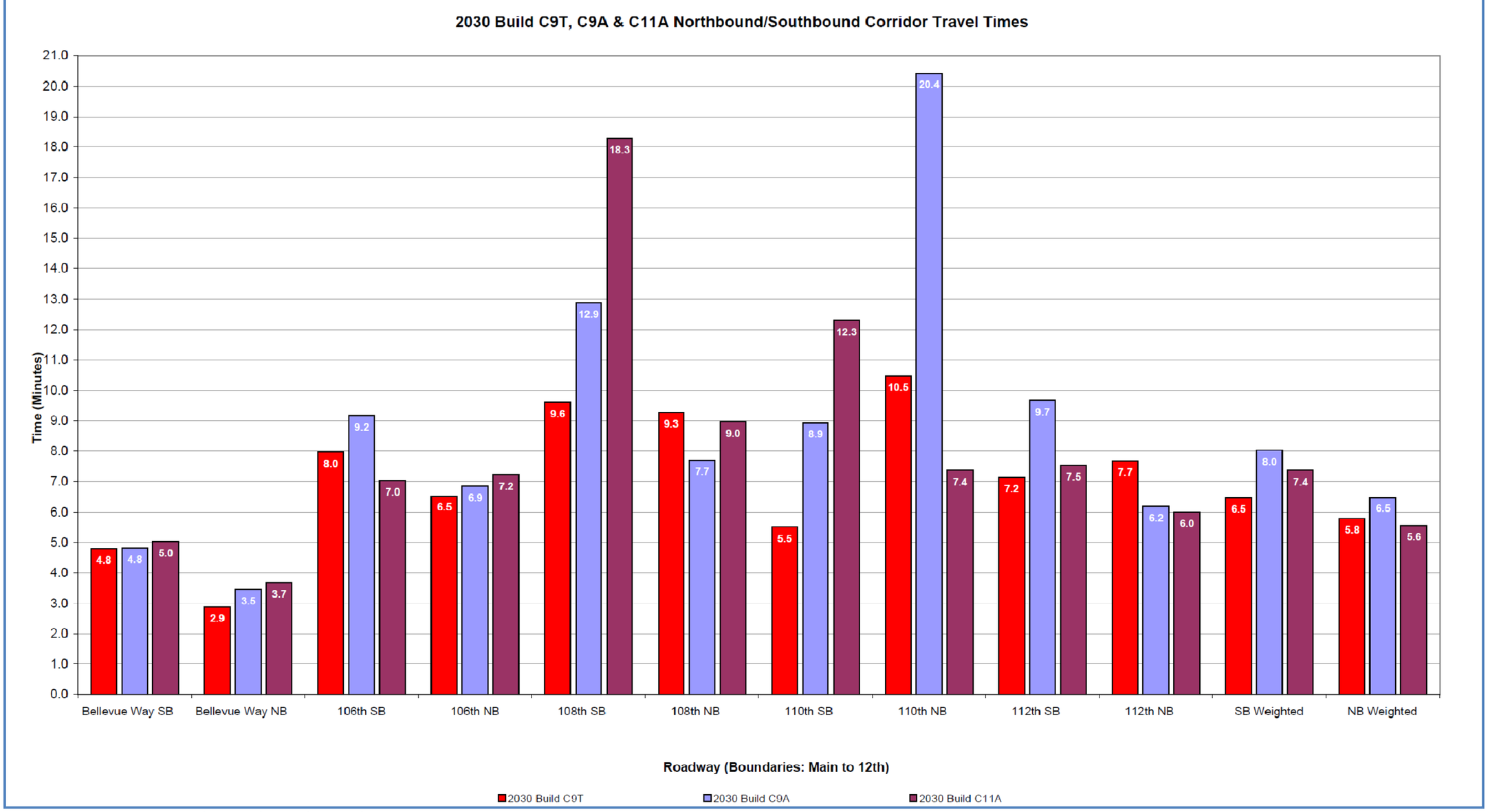

Figure 14 Downtown Corridor North-South Travel Time

6.6 2030 Intersection Level of Service, Vehicle Delay, and Throughput

Level of Service expressed in seconds of vehicle delay was calcualted for 35 select intersections in Downtown Bellevue. Table 6 provides the level of service calculation and the associated vehicle delay at intersections, expressed in seconds. Also shown in Table 6 is the calculation of model throughput (the number of vehicles that the intersection can accommodate in 2030), the calculated vehicle demand based on the 2030 BKR model travel demand forecast, plus the unserved demand which is expressed both as the difference between the vehicle demand and the model throughput and as a percent of the vehicle demand.

Table 6 Intersection Level of Service, Vehicle Delay and Throughput:

Eastlink - Downtown Belleuve Analysis
2030 Build Intersection Level of Service

INITIAL DRAFT - FOR INTERNAL REVIEW ONLY

	C9T Results						C9A Results						C11A Results					
Intersection	LOS	Delay	Model Throughput	Vehicle Demand	Unserved Demand	Percent Served	LOS	Delay	Model Throughput	Vehicle Demand	Unserved Demand	Percent Served	LOS	Delay	Model Throughput	Vehicle Demand	Unserved Demand	Percent Served
Bellevue Way/Main Street	E	71.6	4119	4728	609	87%	E	71.0	3968	4730	762	84%	E	73.8	3793	4764	971	80%
Bellevue Way/2nd Street	C	21.4	3312	3713	401	89%	C	23.9	3192	3737	545	85%	C	22.9	3096	3803	707	81%
Bellevue Way/4th Street	F	98.9	3727	4504	777	83%	F	86.1	3630	4624	994	79%	F	93.6	3501	4678	1177	75%
Bellevue Way/6th Street	B	12.4	2486	2803	317	89%	C	25.0	2376	2925	549	81%	B	15.9	2292	2882	590	80%
Bellevue Way/8th Street	D	49.9	4190	4962	772	84%	E	79.5	3996	5093	1097	78%	D	51.8	4106	5084	978	81%
Bellevue Way/10th Street	D	53.4	3626	4205	579	86%	E	57.9	3585	4286	701	84%	D	53.9	3701	4289	589	86%
Bellevue Way/12th Street	D	47.7	3760	4521	761	83%	D	54.3	3762	4533	771	83%	E	61.4	3956	4535	579	87%
106th Avenue/Main Street	D	49.3	2608	3264	656	80%	D	50.3	2516	3263	747	77%	E	56.1	2448	3314	866	74%
106th Avenue/2nd Street	D	45.7	2899	3597	698	81%	D	45.3	2762	3620	858	76%	D	43.0	2763	3670	907	75%
106th Avenue/4th Street	F	106.1	3383	4379	996	77%	F	101.7	3356	4635	1279	72%	F	102.7	3355	4766	1412	70%
106th Avenue/6th Street	F	92.6	1941	2899	959	67%	F	88.1	2069	2977	908	70%	F	83.9	2065	3032	967	68%
106th Avenue/8th Street	F	88.8	3968	5425	1457	73%	F	93.2	4006	5646	1641	71%	F	87.2	3963	5534	1571	72%
106th Avenue/10th Street	D	54.4	2550	3519	969	72%	E	76.7	2626	3507	881	75%	E	64.3	2542	3410	868	75%
106th Avenue/12th Street	C	31.4	2332	3189	857	73%	D	44.6	2414	3134	720	77%	C	34.6	2532	3121	589	81%
108th Avenue/Main Street	C	34.3	2489	3176	687	78%	D	41.0	2428	3213	785	76%	F	92.4	2350	3148	798	75%
108th Avenue/2nd Street	D	49.8	1989	2598	609	77%	F	102.8	1997	2832	835	71%	F	98.8	1863	2385	522	78%
108th Avenue/4th Street	F	84.5	2922	4086	1164	72%	F	125.8	2935	4514	1579	65%	F	126.8	2656	4264	1608	62%
108th Avenue/6th Street	F	89.4	1060	1497	437	71%	F	80.3	1053	1543	490	68%	F	129.8	892	1221	329	73%
108th Avenue/8th Street	F	92.9	3557	5125	1568	69%	E	76.3	3615	5142	1527	70%	F	88.6	3470	4951	1481	70%
108th Avenue/10th Street	D	41.3	1997	2829	832	71%	D	37.8	2130	2766	636	77%	D	37.3	2060	2683	623	77%
108th Avenue/12th Street	C	32.5	2645	3568	923	74%	C	34.3	2793	3563	770	78%	C	25.0	2939	3567	628	82%
110th Avenue/Main Street	C	28.3	2343	3098	755	76%	E	74.2	2185	2949	764	74%	D	54.3	2160	3160	1000	68%
110th Avenue/2nd Street	E	59.9	2150	2919	770	74%	F	150.0	1969	2990	1021	66%	D	45.4	2009	2978	970	67%
110th Avenue/4th Street	F	91.5	3522	4943	1421	71%	F	125.9	3229	4808	1579	67%	F	129.3	3178	5339	2161	60%
110th Avenue/6th Street	E	78.6	1513	2200	687	69%	E	79.2	1434	1769	335	81%	F	89.6	1694	2449	756	69%
110th Avenue/8th Street	F	86.3	4221	5882	1661	72%	E	61.1	4300	5667	1367	76%	F	92.5	4195	5851	1656	72%
110th Avenue/10th Street	D	40.3	2812	3557	745	79%	D	41.4	2868	3425	557	84%	D	45.5	2662	3338	676	80%
110th Avenue/12th Street	D	53.9	2748	3583	835	77%	C	33.2	2808	3572	764	79%	C	26.7	2936	3559	623	82%
112th Avenue/Main Street	D	54.6	4089	5247	1158	78%	E	71.2	3949	5380	1431	73%	F	82.5	3733	5347	1614	70%
112th Avenue/2nd Street	E	76.7	2983	3995	1012	75%	E	72.8	2824	4288	1464	66%	E	65.7	2816	4122	1306	68%
112th Avenue/4th Street	F	81.5	4503	6419	1916	70%	F	87.7	4434	6848	2414	65%	E	79.1	4213	6550	2337	64%
112th Avenue/6th Street	F	94.9	3065	4376	1311	70%	E	78.4	3083	4464	1381	69%	E	80.0	3071	4412	1341	70%
112th Avenue/8th Street	F	116.6	5527	7716	2189	72%	F	97.1	5545	7630	2085	73%	F	104.0	5375	7589	2214	71%
112th Avenue/10th Street	D	46.7	3286	4210	924	78%	E	59.8	3308	4264	956	78%	D	42.1	3210	4188	978	77%
112th Avenue/12th Street	F	84.6	3986	5180	1194	77%	F	88.0	4003	5156	1153	78%	E	63.8	4284	5174	890	83%
Downtown Area (Bell. Way/Main/112th/12th) Weighted LOS/Delay	E	66.9					E	72.7					E	70.4				
Subarea (106th/Main/112th/8th) Weighted LOS/Delay	E	78.4					F	85.1					F	87.0				
Throughput																		
Downtown Area (Bell. Way/Main/112th/12th) Entering Demand/Throughput			14059	17448	3389	81%			14306	17724	3418	81%			14020	17804	3784	79%
Downtown Area (Bell. Way/Main/112th/12th) Departing Demand/Throughput			15951	21127	5176	76%			15803	20973	5170	75%			15709	21026	5317	75%

Attachment A: Peer Review Panel Members Participating

October 19 and 20, 2009 Peer Review Panel Members		
Nate Larson, PE, PTOE URS Corporation	Alan Lehto Director of Project Planning TriMet	Bill Lorenz, PE San Diego MTS (retired)
Century Square 1501 4th Avenue, Suite 1400 Seattle, WA 98101	710 NE Holladay Street Portland, OR 97232	9230 Golondrina Drive La Mesa, CA 91941
Office: 206.438.2353 Cell: 206.227.4855 Fax: 866.495.5288	Office: 503.962.2136 Cell: 503-720-6549 Fax: 503-962-2281	Office: 619.466.3548
nate_larson@urscorp.com	lehtoa@trimet.org	b.lorenz@sbcglobal.net
Randy McCourt, PE Principal DKS Associates	Sanjeev Tandle, PE, PTOE Traffic Engineer City of Puyallup Development Services Dept.	John Haggerty Principal Engineer SANDAG
1400 SW Fifth Avenue, Suite 500 Portland, OR 97201	333 South Meridian Puyallup, WA 98371	San Diego, CA
Office: 503.243.3500 Cell: 503.753.8996 Fax: 503.243.1934	Office: 253.841.5591 Cell: 253.405.3377 Fax: 253.841.5484	Office: 619.699.6937 Cell: 619.726.1786
rsm@dksassociates.com	standle@ci.puyallup.wa.us	jhag@sandag.org
Administrator/Chairperson:	Jim Parsons, AICP Principal Consultant Parametrix 411 108th Avenue NE, Suite 1800 Bellevue, WA 98004 Office: 425.458.6341 Cell: 425.417.5622 Fax: 425.458.6363 jparsons@parametrix.com	

Technical Appendix VISSIM Model

General Description of the VISSIM Model
Version, 5.2
Time of day being modeled: PM peak period from 5:00-6:00 PM

VISSIM Model – 2008 Existing Conditions
This work built on the Sound Transit base model developed for the East Link DEIS.

- Base map
- Network Coding
  - vehicle classification
  - speed distribution
  - link types and driving behavior sets
  - geometry
  - traffic controls (signal heads, detectors, stop sign, yield sign)
  - intersection priority rules
  - vehicle input points
  - routes
  - pedestrian modeling
  - data collection points
  - travel time collection points
  - link evaluation setup
  - node evaluation setup
  - transit lines
  - transit stations

VISSIM Model – 2030 LRT Alternative Scenarios
For each of the Downtown Bellevue LRT 2030 micro-simulation for Alternatives C9T (also representing the C14E Alternative), C9A and C11A:

- 2030 Volume post-processing
- Network coding
  - Update network coded in the existing condition to reflect the 2030 C9T Alternative
  - Transit coding
  - Light rail line
  - Light rail station
  - Light rail dwelling distribution and headway
  - Priority rules along light rail line
  - Light rail preemption and other controls
  - Other necessary network changes to accommodate light rail

Modeled Features

- Signalized intersection operations and traffic progression
- Major driveways - consolidated with minor driveways in the same block
- Ramp metering and HOV bypass
- Transit routes and service frequency
- Pedestrian crossings

VISSIM Model Validation and Calibration

- Quantitative Measurements
  - Peak hour turning movement counts
  - Averaged field travel time (by segment and cumulative travel time)
- Qualitative Crosscheck
  - Queue length and spillback in major intersections
  - Pedestrian impact to left turning and right turning traffic
- Traffic progression (also reflected in segment travel time calibration
- Refer to the Technical Appendix for the VISSIM Model Calibration Report

Data Collection

<u>Vehicle Volume Data Sources</u>

- 2008 WSDOT Ramp and Roadway Report
- 2008 City of Bellevue Traffic Databook (turning movement counts and 24-hour tube counts)
- 2009 City of Bellevue turning movement counts entering/exiting driveways (15 minutes for each block)
- 2008 Signal Phasing/Timing
- 2008 Bellevue Downtown Network Geometry and Intersection Channelization

<u>Vehicular Travel Time Data Sources</u>

- Peak hour travel time survey was conducted in 2009 using floating car method with routes as shown in the adjacent map.
- Seven Routes
  - Bellevue Way
  - 108th Avenue NE
  - 110th Avenue NE
  - 112th Avenue NE
  - Main Street
  - NE 4th Street
  - NE 8th Street
- Six to ten+ runs for each direction
- 2008 PM Peak Hour Existing Condition
- One hour simulation with another half hour network loading
- Results averaged over ten simulation runs

Vehicle Travel Time Routes and Check Points