Whatcom Council of Governments

Commercial Vehicle Border Crossing Choice Model

Border Choice Model Assessment - Phase 1

Final Report

January 2010

Halcrow Consulting Inc

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Contents

1 Introduction

1.1 Background

The IMTC Bi-national Truck Models developed back in 2004 were designed to serve bi-national and regional planning applications related to evaluating the impacts of future truck demand at the US/Canada border crossings. As the Bi-National Models were developed prior to recent improvements at the border, it is important to assess the functionality of the models to determine whether any refinements may be necessary prior to their application for upcoming projects.

1.2 Key Tasks

Phase I of the Bi-national Truck Models assessment is to focus on the Border Crossing Choice model and whether it can adequately predict crossing locations under current conditions as well as handle future changes to commercial vehicle border operations. The purpose of this report is to examine, through use of the most recent IMTC Commercial Vehicle Operations Survey data (2009 CVO Survey), the adequacy of the Border Crossing Choice model and identify whether any refinements are required at this time. The contents of the report are as follows:

- Chapter 2 – Overview of the Bi-national Truck Border Choice model
- Chapter 3 - Preparation of the 2009 IMTC CVO Survey data and other data
- Chapter 4 – Results of the assessment
- Chapter 5 – Select link preparation
- Chapter 6 – Potential next steps

2 Overview of the Bi-National Truck Border Choice Model

2.1 Introduction

The purpose of the Bi-National Truck Border Choice model is to estimate truck demand at each of the US/Canada border crossings located in the Cascade region. This chapter sets out an overview of the existing Bi-national Truck Border Choice model including a description of the model structure and formulation.

2.2 Existing Bi-national Truck Border Choice Model

2.2.1 External Truck Traffic

In the existing Bi-national Truck Border Choice model, external truck traffic[1] (truck traffic that cross the border but have origins or destinations outside of the model area) are not feed into the border choice model. Based on the 2000 IMTC Survey, external truck traffic contributes approximately 34% of all bi-national truck traffic in a summer weekday and 40% in a fall weekday. External truck trip tables derived from the 2000 IMTC Survey are imported into the Bi-national Truck model as fixed trip tables by time of day and border crossing following the border choice model, as displayed in **Figure 2-1**. As such, to forecast external truck demand for future years, growth factor(s) need to be estimated based on external sources and applied in future year models. Note that external truck traffic is subject to many of the same factors as internal trucks when selecting a crossing location and consideration should be given to including this market segment in the border choice algorithm.

2.2.2 Internal Truck Traffic

The Bi-national truck border crossing choice model was developed to estimate the internal truck traffic using each of the U.S./Canada border crossing: Pacific Highway, Lynden, and Sumas border crossings, as shown in **Figure 2-1**. The choice among these three locations is made by the decision-maker or truck driver based on a variety of reasons such as travel time or distance of the whole trip, waiting time and/or queue lengths at the border-crossing, daily trade flows across the border, location of paper work, presence of customs broker, number of crossings across the border per day, etc. The truck border crossing choice mode uses a set of multinomial logit models to determine the border crossing split for internal truck trips. The logit model estimates the probability of one alternative being chosen over another given the utility of each option. For instance, the

[1] In the current version of the model, external truck trips are directly allocated to each crossing and not subject to the border crossing choice model. External truck trips include external to external, internal to external and external to internal.

probability of choosing Pacific Highway border crossing over Lynden and Sumas border crossings is given by:

$$P_{Pac} = \frac{\exp(U_{Pac})}{\exp(U_{Pac}) + \exp(U_{Lynden}) + \exp(U_{Sumas})}$$

Where:

U_{Pac} = Utility function for using Pacific border crossing

U_{Lynden} = Utility function for using Lynden border crossing

U_{Sumas} = Utility function for using Sumas border crossing

The utility function consists of key factors that influence the border-crossing choice which includes travel time, travel distance of the entire trip, wait time at border crossing location and trade flows in U.S. dollars. The number of variables included in the utility function is different by border crossing, time of day, day of week, and seasons. The following presents the utility functions used in the summer weekday model:

<u>AM Peak period</u>

Pac utility = *f* (trade flow data)

Lynden utility = *f* (cross border bias, border wait time, trade flow data)

Sumas utility = *f* (cross border bias, congested time)

<u>PM Peak period</u>

Pac utility = *f* (trade flow data, congested time)

Lynden utility = *f* (cross border bias, trade flow data, congested time, border wait time)

Sumas utility = *f* (cross border bias, border wait time)

<u>Off Peak period</u>

Pac utility = *f* (trade flow data, congested time)

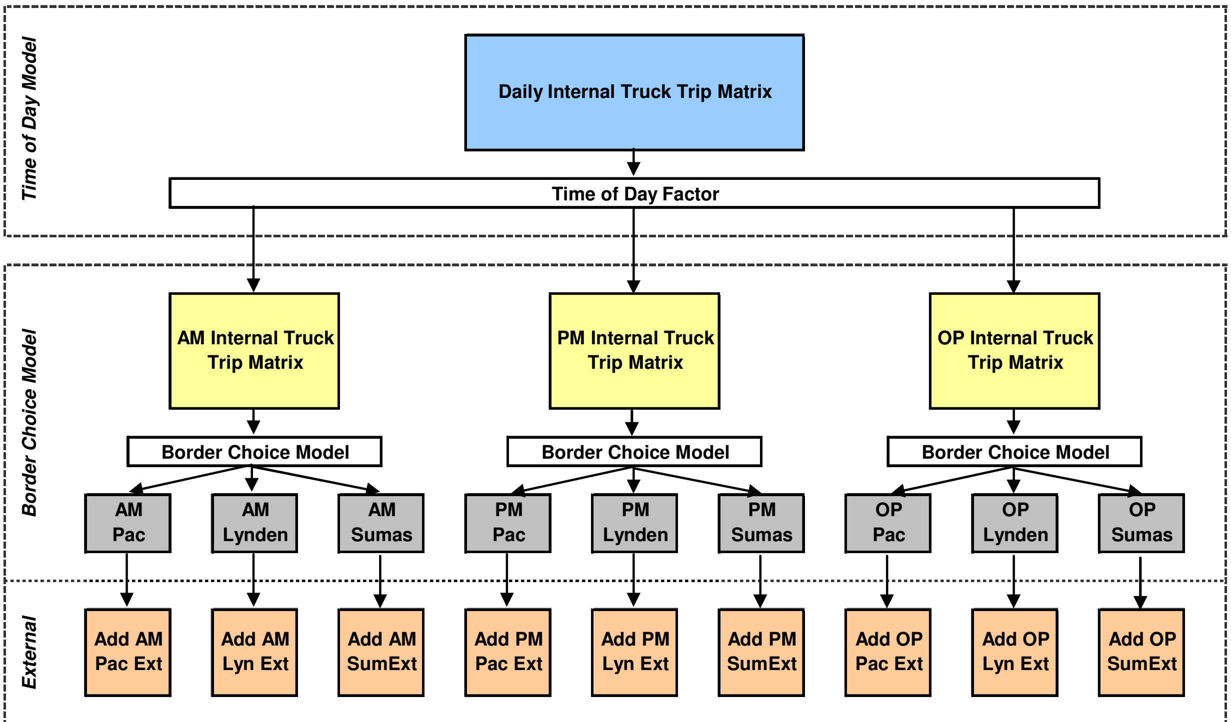
Lynden utility = *f* (cross border bias, trade flow data, border wait time)

Sumas utility = *f* (cross border bias, border wait time)

Based on the 2000 IMTC survey information, one would expect utility variables such as congested travel time, border wait time and possibly some variable to reflect the location of the customs broker along with a crossing bias (which reflects the influence of other factors that are not explicitly defined by the model). What is unusual is that the utility functions do not include all of the same variables, which could seriously impact the forecasting capabilities of the model. It is our view that the utility function formulation should be standardized to include the same variables and recalibrated to observed crossing behaviour.

Another issue that may need to be considered within the truck border crossing choice model is the treatment of southbound truck traffic using the Lynden border crossing as it is a permit port-of-entry. However, it should be noted that empty trucks or trucks with low value shipment may still cross without a permit.

Figure 2-1 Truck Border Crossing Choice Model Structure



As shown in **Figure 2-1** above, the key input to the border choice model is the internal truck trip tables by three time periods: a.m. peak (8 a.m. to 11 a.m.), p.m. peak (2 p.m. to 5 p.m.) and off-peak (remaining hours). Other model input requirements that feed into the border crossing choice model include congested time and distance between origins and destinations, border wait time, and trade flow data in U.S. dollars. To undertake the assessment, observed data were extracted from the 2009 IMTC CVO survey database and other available data sources, which are discussed in the following chapter.

3 Preparation of the 2009 IMTC CVO Survey Data and Other Data

3.1 Introduction

IMTC conducted a Commercial Vehicle Operations Survey (2009 IMTC CVO Survey) in the summer of 2009 which collected information on origin-destination, delay, commodity, status (FAST, permit, other), etc. The 2009 IMTC CVO survey provides an excellent basis for assessing the predictive capabilities of the Bi-National Truck Models. In order to prepare the necessary 2009 truck trip tables, traffic zone numbers defined in the bi-national model were assigned to all origins and destinations within the 2009 IMTC CVO survey database. This chapter of the report summarizes the traffic zone mapping and survey data extraction used to undertake the assessment of the truck border choice model.

3.2 Traffic Zone Mapping

The survey database has a total of approximately 4,700 observations. Upon closer examination, the majority of the origins and destinations identified in the database contain generic city names that do not provide sufficient detail (e.g., cross street information) to map to the traffic zone system defined in the bi-national model. For example, the survey contains broad municipality names such as “Seattle” in which multiple traffic zones related to “Seattle” can be found within the model. To facilitate the traffic zone mapping exercise, origin and destination (OD) information from the bi-national model was used to estimate more refined OD locations. The OD locations were mapped independently based on the OD distribution extracted from the model.

The database contains about 9,400 origins and destinations, and of these, approximately 82% were able to be mapped with a traffic zone. The remaining 18% were irreconcilable due to incomplete information and were excluded from this analysis. Since the objective of this assignment is to assess the border choice model, expanding the IMTC survey database to reflect the actual truck population crossing the US/Canada is not required at this stage but will be required in the assessment of the forecasting capability of the model.

3.3 Data Extraction from the IMTC Survey Database

3.3.1 Observed Internal Truck Demand

Table 3-1 shows the observed internal border crossing truck trips that use Pacific Highway, Lynden, and Sumas border crossings for a.m. peak, p.m. peak and off peak periods. Based on the unexpanded IMTC database, it can be seen that the most heavily used border crossing is Pacific Highway, followed by Sumas and Lynden. It is worth reiterating that the observed border crossing split can not be treated as final without expanding the IMTC database to the observed control totals.

Table 3-1 Observed Internal Truck Demand at Each Border Crossing

Internal Truck Trips		AM 08:00 to 11:00	PM 14:00 to 17:00	Off Peak	Total
Northbound	Pacific Hwy	161	191	374	726
	Lynden	36	35	88	159
	Sumas	80	86	109	275
Northbound Total		**277**	**312**	**571**	**1160**
Southbound	Pacific Hwy	204	119	347	670
	Lynden	57	39	83	179
	Sumas	163	91	200	454
Southbound Total		**424**	**249**	**630**	**1303**
Total		**701**	**561**	**1201**	**2463**

3.3.2 *Observed External Truck Demand*

As described in Chapter 2, external truck trips are not feed into the Border Choice model; they are imported as fixed trip tables by time of day and border crossing. The observed 2009 external truck trips with unknowns removed are shown in **Table 3-2** below. It is observed that external truck trips contribute approximately 30% to 40% of the overall total border crossing truck trips, which is fairly substantial. Again, this statistics could change slightly once the 2009 IMTC survey database has been expanded.

Table 3-2 Observed External Truck Demand at Each Border Crossing

External Truck	AM 08:00 to 11:00	PM 14:00 to 17:00	Off Peak	Total
Pacific Hwy	171	239	493	903
Lynden	32	31	50	113
Sumas	64	106	187	357
Total	**267**	**376**	**730**	**1373**

3.3.3 *Border Wait Times*

Table 3-3 outlines the 2009 border wait times (includes queue time and booth inspection time) for truck traffic at each border crossing. The 2009 border wait time at Pacific Highway represents an average of both GP and FAST lane wait times because the current Bi-national Truck models do not distinguish between FAST and GP. The year 2000 border wait times[2] used in the border choice model are also included for comparison. Note that in year 2000, it was assumed that the border wait times at Lynden were similar to Sumas.

[2] The 2000/2002 border wait time data were provided by a combination of the US Customs and Border Protection (CBP), Canada Border Service Agency (CBSA) and the Washington State Department of Transportation (WSDoT). It was assumed that the truck border wait time data at Lynden were similar to Sumas border crossing during the 2002 truck model calibration.

In general, the average border wait times at Pacific Highway in the a.m. peak have decreased slightly for both directions but have increased in both the p.m. and off peak periods. Border wait times at both Sumas and Lynden also show increase since year 2000.

In most cases, the 2009 southbound border wait time is longer than the northbound by approximately 5 minutes. The overall average border wait time is longer for the p.m. than the a.m. by about 11 minutes. Note that these border wait times were extracted from the 2009 IMTC CVO survey database. To confirm these border wait times, they will need to be verified against other data source such as the Washington State Department of Transportation during the model refinement stage.

Table 3-3 Border Wait Time (in Minutes)

AM 08:00 to 11:00			Year 2000 Avg Border Time (mins)	Year 2009 Avg Border Time (mins)	2009 vs. 2000 (min)
AM	Northbound	Pacific Hwy	12	10	-2
		Sumas	2	5	3
		Lynden	2	7	5
	Northbound Average			**9**	
	Southbound	Pacific Hwy	23	18	-5
		Sumas	6	14	8
		Lynden	6	11	5
	Southbound Average			**16**	
AM Average				**13**	
PM 14:00 to 17:00			**Year 2000 Avg Border Time (mins)**	**Year 2009 Avg Border Time (mins)**	**2009 vs. 2000 (min)**
PM	Northbound	Pacific Hwy	15	24	9
		Sumas	1	23	22
		Lynden	1	6	5
	Northbound Average			**21**	
	Southbound	Pacific Hwy	24	38	14
		Sumas	21	13	-8
		Lynden	21	16	-5
	Southbound Average			**27**	
PM Average				**24**	
Rest of Hours			**Year 2000 Avg Border Time (mins)**	**Year 2009 Avg Border Time (mins)**	**2009 vs. 2000 (min)**
OP	Northbound	Pacific Hwy	13	20	7
		Sumas	1	10	9
		Lynden	1	8	7
	Northbound Average			**17**	
	Southbound	Pacific Hwy	20	26	6
		Sumas	7	15	8
		Lynden	7	26	19
	Southbound Average			**22**	
OP Average				**20**	

3.4 Trade Flow Estimates Update for Border Choice Model Testing

According to the model calibration report and consultation with Cambridge Systematics, the trade flow estimates used in the Bi-national truck model were derived from the BTS North America Transborder Freight Database3. Unfortunately, we were not able to track down how exactly the trade flow estimates were derived from the BTS database. To update the trade flow estimates used in the model, annual growth factors based on 2002 and 2008 BTS trade flow for each border crossing were applied to the model inputs, as shown in **Table 3-4** below.

Figure 3-1 displays the annual exports and imports between U.S. and Canada for different border crossings between years 2002 and 2008. All exports experienced double digits percentage annual growth from years 2002 to 2008. The greatest increase is Lynden at 43% increase per year since 2002 – $58 Million in 2002 to $497Million in 2008. Pacific Highway and Sumas border crossings also experienced annual export growth of 15% and 20% respectively. On the other hand, imports are stagnant at an average annual growth of 2% per year. Lynden border crossing actually experienced a negative 3% annual growth since year 2002. One possible reason for this decline could be related to the U.S./Canada exchange rate.

In our opinion the use of the trade flow variable in the crossing choice model should be reviewed. First, this variable would be difficult to forecast accurately by individual crossing and is heavily dependent on the value of the goods being shipped. Furthermore, if these forecasts were accurate the truck volumes at each crossing could be determined by applying factors to the trade flows, thereby eliminating the need for a logit choice model.

Table 3-4 Total Annual Exports and Imports between U.S. and Canada (All Land Modes and Commodities)

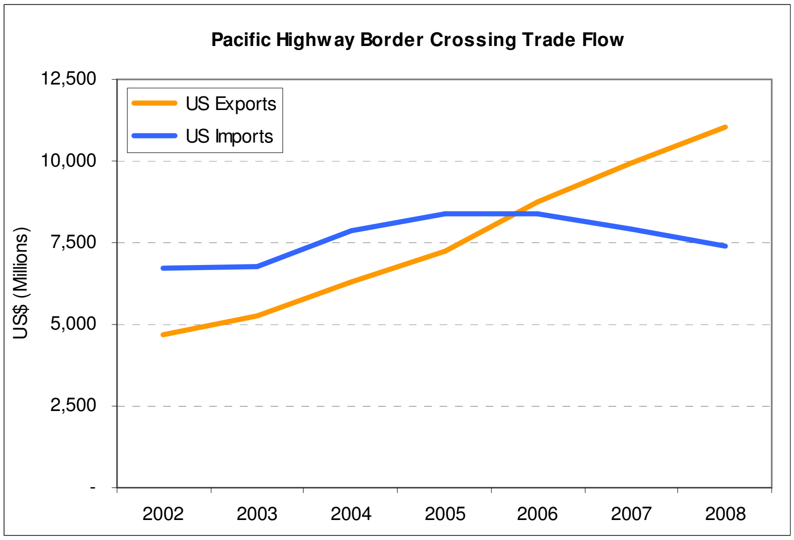
		Annual Trade Flows (U.S. $)		Annual Growth
		2002	2008	
Exports	Pacific Hwy	4,662,011,468	11,035,445,385	15%
	Lynden	57,658,341	497,078,210	43%
	Sumas	393,579,217	1,171,505,760	20%
	Export Total	5,113,249,026	12,704,029,355	
Imports	Pacific Hwy	6,732,470,451	7,383,704,741	2%
	Lynden	45,260,461	37,654,207	-3%
	Sumas	1,004,791,614	1,497,987,671	7%
	Import Total	7,782,522,526	8,919,346,619	

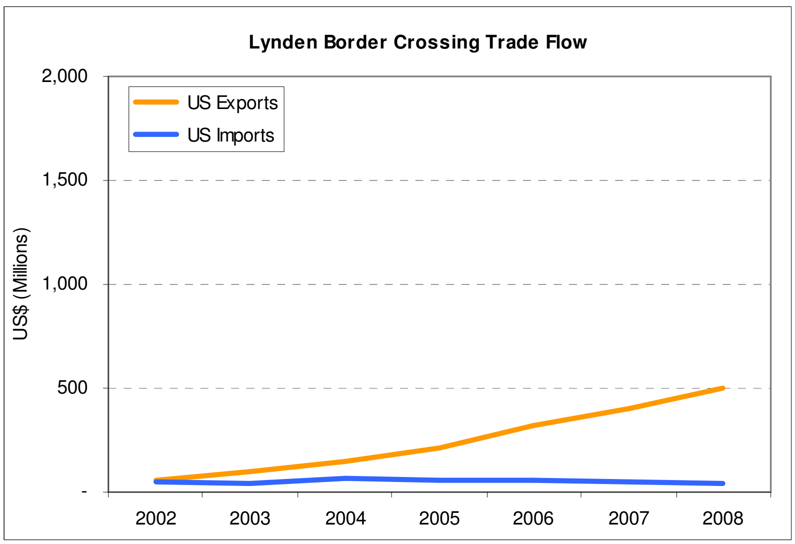
* BTS Data Source: http://www.bts.gov/programs/international/transborder/TBDR_QA.html

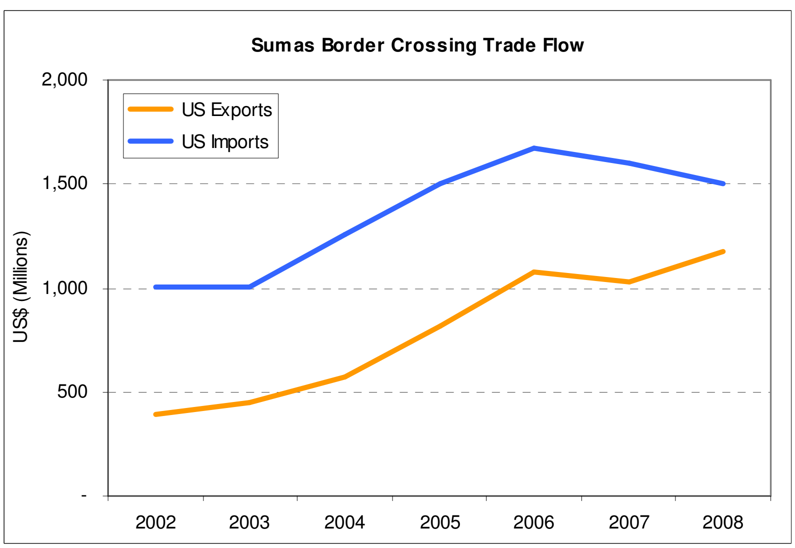
Trade Flows Data Extraction Assumptions: 1) US State - All US State; 2) Trading Partner - Canada; 3) Month - annual summary; 4) Mode - all land modes with exclusion of pipeline

[3] BTS Data Source: http://www.bts.gov/programs/international/transborder/TBDR_QA.html

Figure 3-1 Border Crossing Trade Flow (Years 2000 to 2008)







4 Results of Assessment

4.1 Introduction

As noted in Chapter 2 of the report, the key model factors employed in the Truck Border Choice model include congested time, distance, border wait time and trade flow data, which are all currently in year 2000/2002. Since the observed data represents cross-border truck travel characteristics in the summer of year 2009, it is essential to update some of the key factors identified in the Border Choice model to reflect a more representative border operation condition prior to undertaking the assessment. The purpose of this chapter is to discuss the assessment procedures and results.

4.2 Assessment Procedure

In order to streamline the analysis, we have assumed that both the congested time and distance have not experienced significant changes that would alter the results of the Border Choice model. As such, the update of the key model factors is focussed on border wait time and trade flow data which were extracted from the 2009 IMTC CVO survey and the BTS database as discussed in the previous chapter. The following section provides a brief description of the assessment procedure follow by the results. **Figure 4-1** illustrates the assessment procedure for the a.m. peak. First, the observed 2009 internal truck trip tables by time of day and border crossing are imported into the Border Choice model followed by adjusting key model factors and running the model to obtain the border choice outcome, which is then compared against the 2009 observed data. For instance, a 2009 observed AM internal truck trip table using Pacific Highway border crossing can be imported into the Border Choice model. After conducting the Border Choice model run, the outputs will show how many truck trips are allocated to Pacific Highway border crossing, or the capture rate. Due to the nature of a logit model, a certain percentage will always be allocated to the other crossings. However, if the Border Choice model is properly estimated, a high percentage of the observed matrix should be assigned to the crossing where the survey was conducted.

To better understand the border choice impact as a result of changes to key input factors within the Border Choice model, the assessment was undertaken using a staged evaluation process as identified by the four test scenarios shown in **Table 4-1**. Test 1 represents a model run of the Truck Border Choice model based on the original input factors such as year 2000 border wait time. An update of 2002 border wait times to 2009 is included in Test 2 and an update of trade flow data is incorporated in Test 3. Finally, Test 4 consists of updating both border wait times and trade flow data concurrently.

Figure 4-1 Border Choice Model Assessment Procedure

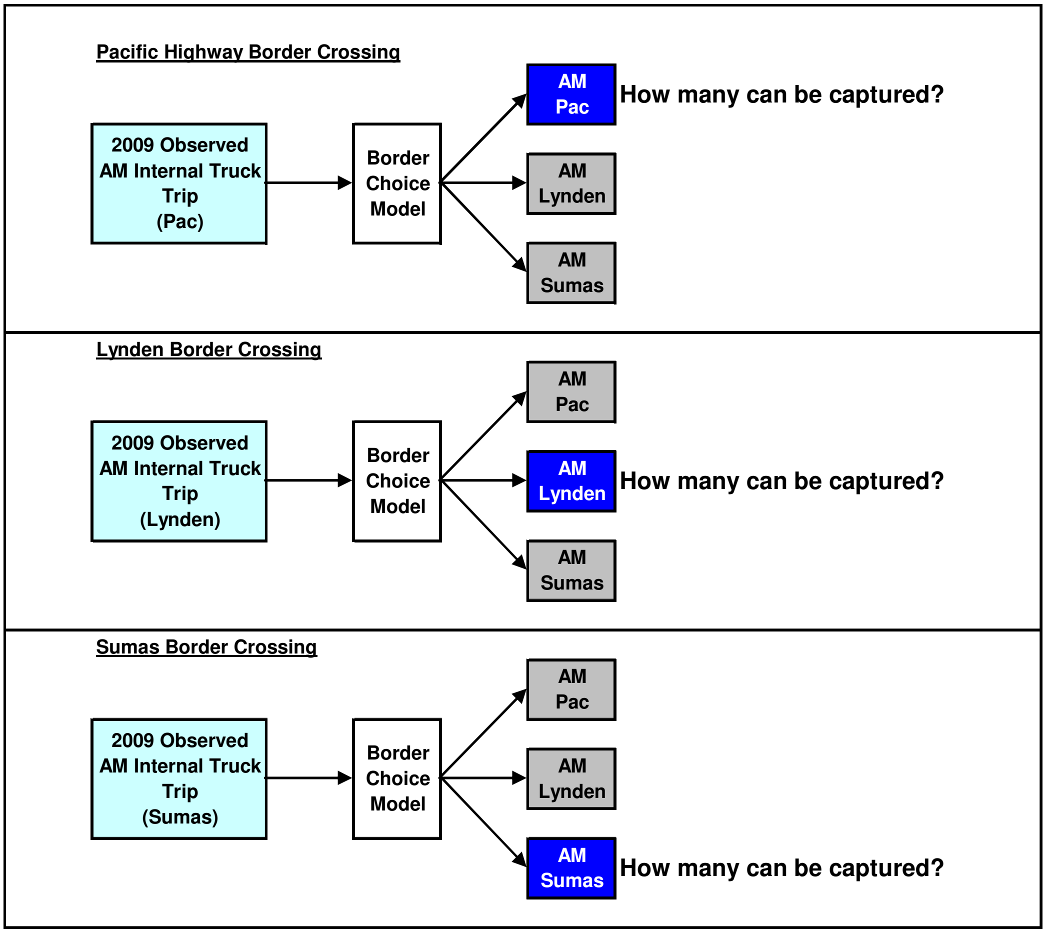


Table 4-1 Model Test Scenarios

Test Scenario	Variables in the Truck Border Choice Model			
	Congested Time	Distance	Border Wait Time	Trade Flow
Test 1	2000	2000	2000	2002
Test 2	2000	2000	2009	2002
Test 3	2000	2000	2000	2008
Test 4	2000	2000	2009	2008

4.3 Assessment Results

4.3.1 Internal Truck Trips

Table 4-2 to **Table 4-4** show the border crossing choice results for the four test scenarios using the EMME software platform. The red highlighted column represents the number of 2009 observed internal truck trips by various crossings. The model results generated from each test scenario are then compared against the column with observed data. Key observations include:

- Test 1: Without updating any existing variables within the cross border choice model, the resulting capture rate for Pacific Highway is about 50% to 60% for northbound and 85% to 90% for southbound. The capture rates for both Lynden and Sumas crossings are in a low range of 2% to 30%.
- Test 2: By simply updating the border wait time from 2002 to 2009, the capture rates for all three border crossings are similar to Test 1,
- Test 3: By updating the trade flow estimates from 2002 to 2008, the capture rates for Pacific Highway show a significant improvement from 50%-60% range to approximately 90% for both directions. On the other hand, the capture rates for Lynden and Sumas decline even further.
- Test 4: By updating both the border wait time and the trade flow estimates, the resulting capture rates are similar to those found in Test 3.

Table 4-2 Results of Assessment (AM)

AM 08:00 to 11:00			Observed	Test 1		Test 2		Test 3		Test 4	
				Modelled Trips	Capture Rate	Modelled Trips	Capture Rate	Modelled Trips	Capture Rate	Modelled Trips	Capture Rate
AM	NB	Pacific Hwy	161	100	62%	101	63%	151	94%	151	94%
	SB	Pacific Hwy	204	171	84%	172	84%	179	88%	180	88%
	Total NB + SB		365	271	74%	273	75%	330	90%	331	91%
	NB	Lynden	36	5	14%	5	13%	1	2%	1	1%
	SB	Lynden	57	3	6%	3	5%	3	4%	2	4%
	Total NB + SB		93	8	9%	8	8%	3	3%	3	3%
	NB	Sumas	80	20	25%	20	25%	1	2%	1	2%
	SB	Sumas	163	17	11%	17	11%	13	8%	13	8%
	Total NB + SB		243	37	15%	37	15%	14	6%	14	6%

Table 4-3 Results of Assessment (PM)

PM 14:00 to 17:00			Observed	Test 1		Test 2		Test 3		Test 4	
				Modelled Trips	Capture Rate	Modelled Trips	Capture Rate	Modelled Trips	Capture Rate	Modelled Trips	Capture Rate
PM	NB	Pacific Hwy	191	100	52%	113	59%	181	95%	181	95%
	SB	Pacific Hwy	119	103	86%	102	86%	105	88%	105	88%
	Total NB + SB		310	203	65%	215	69%	286	92%	286	92%
	NB	Lynden	35	5	14%	5	15%	0	0%	0	0%
	SB	Lynden	39	1	2%	1	2%	1	2%	1	2%
	Total NB + SB		74	6	8%	6	8%	1	1%	1	1%
	NB	Sumas	86	26	30%	20	23%	1	1%	1	1%
	SB	Sumas	91	6	7%	7	7%	5	6%	5	6%
	Total NB + SB		177	33	18%	27	15%	6	3%	6	4%

Table 4-4 Results of Assessment (OP)

Rest of Hours			Observed	Test 1		Test 2		Test 3		Test 4	
				Modelled Trips	Capture Rate	Modelled Trips	Capture Rate	Modelled Trips	Capture Rate	Modelled Trips	Capture Rate
OP	NB	Pacific Hwy	374	216	58%	221	59%	335	90%	335	90%
	SB	Pacific Hwy	347	324	93%	324	93%	329	95%	329	95%
	Total NB + SB		**721**	**540**	**75%**	**545**	**76%**	**664**	**92%**	**664**	**92%**
	NB	Lynden	88	14	16%	14	16%	5	6%	5	6%
	SB	Lynden	83	2	2%	2	2%	1	1%	1	1%
	Total NB + SB		**171**	**16**	**9%**	**16**	**9%**	**6**	**4%**	**6**	**4%**
	NB	Sumas	109	24	22%	23	21%	1	1%	1	1%
	SB	Sumas	200	6	3%	6	3%	4	2%	4	2%
	Total NB + SB		**309**	**30**	**10%**	**29**	**9%**	**5**	**2%**	**5**	**2%**

4.3.2 External Truck Trips

As external truck trips are treated as fixed trip tables by time of day and border crossing in the existing Bi-national model. To forecast the base year 2000 to 2009 condition, growth factor(s) need to be estimated. As the focus of this study is to assess the Border Choice model, a simple growth factor of 0.80 obtained from the 2000 and 2008 cross-border truck volumes[4] was applied to all external truck trip tables. The results are presented in **Table 4-5**. Since the growth factor was derived from the actual cross-border truck volumes as opposed to forecasting, additional research and analysis will be required to establish a methodology to forecast external truck trips and whether it can be part of the Border Choice model.

Table 4-5 Results of External Truck Trips

External Truck	Observed	Factored	Diff %
AM 08:00 to 11:00			
Pacific Hwy	171	134	-22%
Lynden	32	23	-28%
Sumas	64	45	-30%
Total	**267**	**202**	**-24%**
PM 14:00 to 17:00			
Pacific Hwy	239	125	-48%
Lynden	31	26	-17%
Sumas	106	25	-76%
Total	**376**	**176**	**-53%**
Off Peak			
Pacific Hwy	493	664	35%
Lynden	50	36	-28%
Sumas	187	123	-34%
Total	**730**	**822**	**13%**

[4] Cross-Border Truck Volumes at Pacific Highway, Lynden and Sumas (1998 – 2008) were obtained from www.wcog.org/imtc

The assessment results illustrate that the existing Bi-national Truck Border Choice model considerably underestimates internal truck trips at Lynden and Sumas border crossings – the capture rates at both border crossings are less than 5% after updating the key variables in Test 4. To explore this further, it is worthwhile to examine the relationship between the observed truck OD patterns and those selected by the border choice model, as discussed in the next section.

4.4 2009 Observed and Modelled OD Patterns

4.4.1 2009 AM Observed OD Patterns by Crossing Location

Table 4-6 to **Table 4-8** show the a.m. peak period OD trip tables (as a percentage of the total trips) for Pacific Highway, Lynden and Sumas border crossings. For example, the 8% provided in **Table 4-6** represents the percentage of a.m. peak trucks at Pacific Highway border travelling from Richmond/Delta/Surrey to the US externals. These OD tables were extracted from the 2009 IMTC survey. The OD pattern tables are tabulated according to 11 sub-areas, including one external which represents externals in both U.S. and Canada. The red outlined cells correspond to northbound cross border truck traffic whereas the blue outlined cells refer to cross border truck trips going southbound. We have also identified OD pairs (in yellow) with higher percentages of truck traffic.

According to **Table 4-6**, approximately 70% of truck trips using the Pacific Highway border have origins or destinations in Blaine/Ferndale, PSRC and the West Lower Mainland such as Burrard Peninsula and Richmond/Delta etc. At the Lynden border crossing, it is observed that a substantial fraction of truck trips have origins or destinations in Lynden, Sumas, Langley, Fraser Valley and Surrey as illustrated in **Table 4-7**. It is also not surprising to observe that a significant portion of truck trips (more than 50%) at Sumas border crossing have origins or destinations in the Lynden, Sumas, and the East Lower Mainland such as Fraser Valley and Langley because of their proximity to the crossing. This analysis shows the relationship between the truck OD patterns and border crossing location choice which should be more or less reflected by the Border Choice model.

Table 4-6 2009 Observed AM OD Trip Table (Pacific Highway)

	Ext	BurrPen	Rich/Del/ Sur	Maple Ridge	Langley	Fraser V.	Blaine	Bellingham	Lynden /Sumas	Skagit	PSRC	sum
Ext	2%	5%	6%	0%	2%	1%	0%	0%	0%	0%	1%	18%
BurrPen	3%						5%	0%	0%	0%	5%	14%
Rich/Del/Sur	8%						7%	1%	1%	2%	11%	29%
Maple Ridge	0%						0%	0%	0%	0%	0%	0%
Langley	1%						2%	0%	0%	0%	2%	5%
Fraser V.	0%						0%	0%	0%	0%	0%	1%
Blaine	0%	4%	7%	0%	1%	0%						14%
Bellingham	0%	2%	1%	0%	0%	0%						3%
Lynden/Sumas	0%	0%	1%	0%	0%	0%						1%
Skagit	1%	0%	2%	0%	0%	0%						3%
PSRC	1%	3%	7%	0%	0%	0%						11%
sum	16%	14%	23%	0%	4%	2%	17%	1%	1%	3%	19%	100%

Table 4-7 2009 Observed AM OD Trip Table (Lynden)

	Ext	BurrPen	Rich/Del/ Sur	Maple Ridge	Langley	Fraser V.	Blaine	Bellingham	Lynden /Sumas	Skagit	PSRC	sum
Ext	3%	1%	2%	1%	2%	0%	0%	0%	1%	0%	1%	10%
BurrPen	2%						1%	2%	0%	6%	2%	11%
Rich/Del/Sur	3%						3%	2%	2%	0%	2%	13%
Maple Ridge	0%						2%	1%	0%	0%	2%	4%
Langley	9%						3%	5%	3%	1%	2%	23%
Fraser V.	1%						2%	2%	2%	0%	2%	8%
Blaine	1%	0%	1%	0%	2%	0%						4%
Bellingham	1%	0%	0%	0%	1%	0%						2%
Lynden/Sumas	0%	2%	3%	0%	3%	3%						11%
Skagit	0%	2%	0%	0%	0%	0%						2%
PSRC	0%	3%	2%	0%	4%	4%						13%
sum	19%	7%	7%	1%	11%	7%	11%	12%	7%	6%	10%	100%

Table 4-8 2009 Observed AM OD Trip Table (Sumas)

	Ext	BurrPen	Rich/Del/ Sur	Maple Ridge	Langley	Fraser V.	Blaine	Bellingham	Lynden /Sumas	Skagit	PSRC	sum
Ext	1%	0%	0%	0%	0%	1%	0%	1%	3%	0%	3%	10%
BurrPen	0%						0%	0%	1%	1%	2%	4%
Rich/Del/Sur	1%						0%	0%	4%	0%	2%	8%
Maple Ridge	0%						0%	0%	0%	0%	1%	1%
Langley	1%						1%	0%	2%	1%	5%	10%
Fraser V.	6%						3%	0%	16%	3%	9%	38%
Blaine	0%	0%	0%	0%	0%	1%						1%
Bellingham	0%	0%	1%	0%	0%	1%						2%
Lynden/Sumas	1%	1%	2%	0%	2%	14%						21%
Skagit	1%	0%	0%	0%	0%	0%						1%
PSRC	0%	0%	0%	0%	1%	3%						4%
sum	12%	2%	3%	1%	3%	21%	4%	2%	26%	5%	22%	100%

4.4.2 2009 AM Observed vs. Choice Model OD Patterns by Crossing Location

This section shows how the truck trips surveyed at the Sumas crossing (observed Sumas trip table) are allocated between the individual crossings according to the current Border Choice model. Note that a logit model will always allocate a percentage to other crossings, but this should be minimal if the model is properly specified. **Table 4-9** shows the 2009 observed a.m. peak truck matrix for the Sumas crossing. For the northbound truck traffic, approximately 95% have origins or destinations in Lynden/Sumas, North Fraser Valley and Langley because of their proximity to the Sumas crossing (as highlighted in orange). Similarly over 85% is observed for the southbound truck traffic.

Tables 4-10 to **4-12** show how the observed Sumas trips are allocated by the border choice model. One would expect a high percentage of the trips to be assigned to the Sumas crossing. However, the Border Choice model estimated that 91% of the 243 truck trips would use Pacific Highway border, 3% use Lynden and 6% Sumas. In general, the model tends to assign most of the border crossing truck trips to Pacific Highway border. Even for trips that have origins or destinations near the Sumas crossing (i.e. from Fraser Valley to Lynden/Suma), the model only assigned 9% to the Sumas crossing. We believe this is related to the non-standard formulation of the utility functions as discussed in Chapter 2.

Table 4-9 2009 Observed AM Truck OD Trip Table at Sumas Border

	BurrPen	Rich/Del / Sur	Maple Ridge	Langley	Fraser V.	Blaine	Bellingham	Lynden/ Sumas	Skagit	PSRC	sum
BurrPen						0	0	4	2	7	13
Rich/Del/Sur						0	1	13	0	7	21
Maple Ridge						0	0	0	0	4	4
Langley						3	1	6	3	14	27
Fraser V.						9	1	50	10	28	98
Blaine	0	0	0	0	3						3
Bellingham	0	2	1	0	2						5
Lynden/Suma	4	5	0	6	44						59
Skagit	0	0	0	0	0						0
PSRC	0	0	1	2	10						13
sum	4	7	2	8	59	12	3	73	15	60	243

Table 4-10 2009 Modelled AM OD Trip Table (Pacific Highway)

	BurrPen	Rich/Del / Sur	Maple Ridge	Langley	Fraser V.	Blaine	Bellingham	Lynden/ Sumas	Skagit	PSRC	sum
BurrPen						0%	0%	90%	86%	90%	90%
Rich/Del/Sur						0%	90%	88%	0%	89%	88%
Maple Ridge						0%	0%	0%	0%	90%	90%
Langley						90%	90%	88%	90%	89%	89%
Fraser V.						89%	90%	88%	88%	90%	88%
Blaine	0%	0%	0%	0%	100%						100%
Bellingham	0%	100%	100%	0%	100%						96%
Lynden/Suma	100%	96%	0%	97%	97%						97%
Skagit	0%	0%	0%	0%	0%						0%
PSRC	0%	0%	100%	100%	98%						97%
sum	100%	97%	100%	98%	97%	88%	90%	88%	89%	89%	91%

Table 4-11 2009 Modelled AM OD Trip Table (Lynden)

	BurrPen	Rich/Del / Sur	Maple Ridge	Langley	Fraser V.	Blaine	Bellingham	Lynden/ Sumas	Skagit	PSRC	sum
BurrPen						0%	0%	3%	5%	4%	3%
Rich/Del/Sur						0%	0%	4%	0%	4%	4%
Maple Ridge						0%	0%	0%	0%	3%	3%
Langley						3%	0%	3%	3%	4%	4%
Fraser V.						3%	0%	4%	4%	4%	4%
Blaine	0%	0%	0%	0%	0%						0%
Bellingham	0%	0%	0%	0%	0%						2%
Lynden/Suma	0%	2%	0%	2%	1%						1%
Skagit	0%	0%	0%	0%	0%						0%
PSRC	0%	0%	0%	0%	1%						2%
sum	0%	1%	0%	1%	1%	3%	3%	4%	3%	4%	3%

Table 4-12 2009 Modelled AM OD Trip Table (Sumas)

	BurrPen	Rich/Del / Sur	Maple Ridge	Langley	Fraser V.	Blaine	Bellingham	Lynden/ Sumas	Skagit	PSRC	sum
BurrPen						0%	0%	8%	10%	6%	7%
Rich/Del/Sur						0%	10%	8%	0%	7%	8%
Maple Ridge						0%	0%	0%	0%	8%	8%
Langley						7%	10%	8%	7%	7%	8%
Fraser V.						8%	10%	9%	8%	7%	8%
Blaine	0%	0%	0%	0%	0%						0%
Bellingham	0%	0%	0%	0%	0%						2%
Lynden/Suma	0%	2%	0%	2%	2%						2%
Skagit	0%	0%	0%	0%	0%						0%
PSRC	0%	0%	0%	0%	1%						2%
sum	0%	1%	0%	1%	2%	8%	7%	8%	8%	7%	6%

5 Select Link Preparation

5.1 Introduction

Following the above analysis, the EMME trip assignment model was run to highlight the key routes used by trucks at each of the crossings (this is based on the observed matrices assigned to their respective crossing and not the results of the border choice model which significantly underestimates trips at Lynden and Sumas). The resulting route assignment for each crossing (or select link) is stored in specific link attributes and plots can be prepared showing the spatial distribution of truck traffic using each border crossing. **Figure 5-1** to **Figure 5-3** provide a select link plot for each border crossing during the a.m. peak.

For the Pacific Highway crossing, the key route south of the border is I-5 while north of the border are primarily Highway 99, Highway 91 and Highway 15. The majority of the origins and destinations appear to be in the western Lower Mainland and PSRC. The key route for trucks using the Lynden crossing immediate south of the border is Route 539. North of the border is Highway 13 serving the north south corridor. It can be seen that key origins and destinations are located in Lynden, Sumas, Langley and Fraser Valley. As for the Sumas crossing, the key route south of the border is Route 9 and to the north is Highway 11. Key origins and destinations for Sumas border crossing users are located in Lynden, Sumas, Fraser Valley and Langley.

Figure 5-1 Select Link Plot for 2009 AM Unexpanded Internal Truck at Pacific Hwy

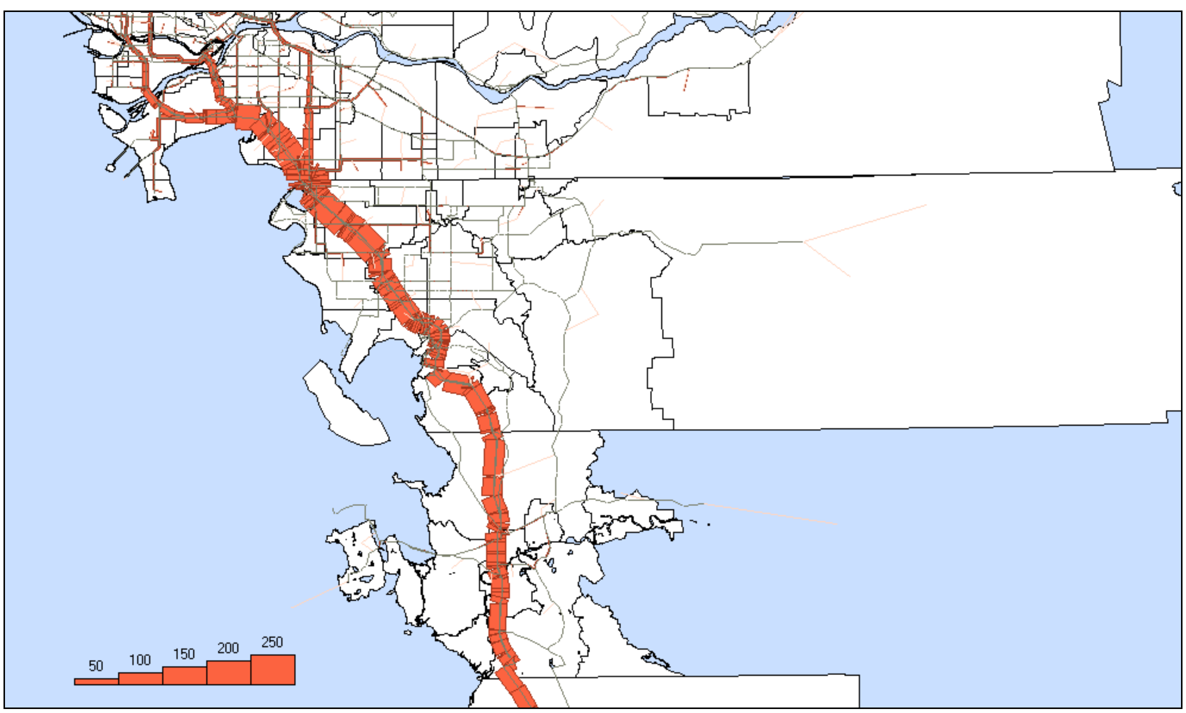


Figure 5-2 Select Link Plot for 2009 AM Unexpanded Internal Truck at Lynden

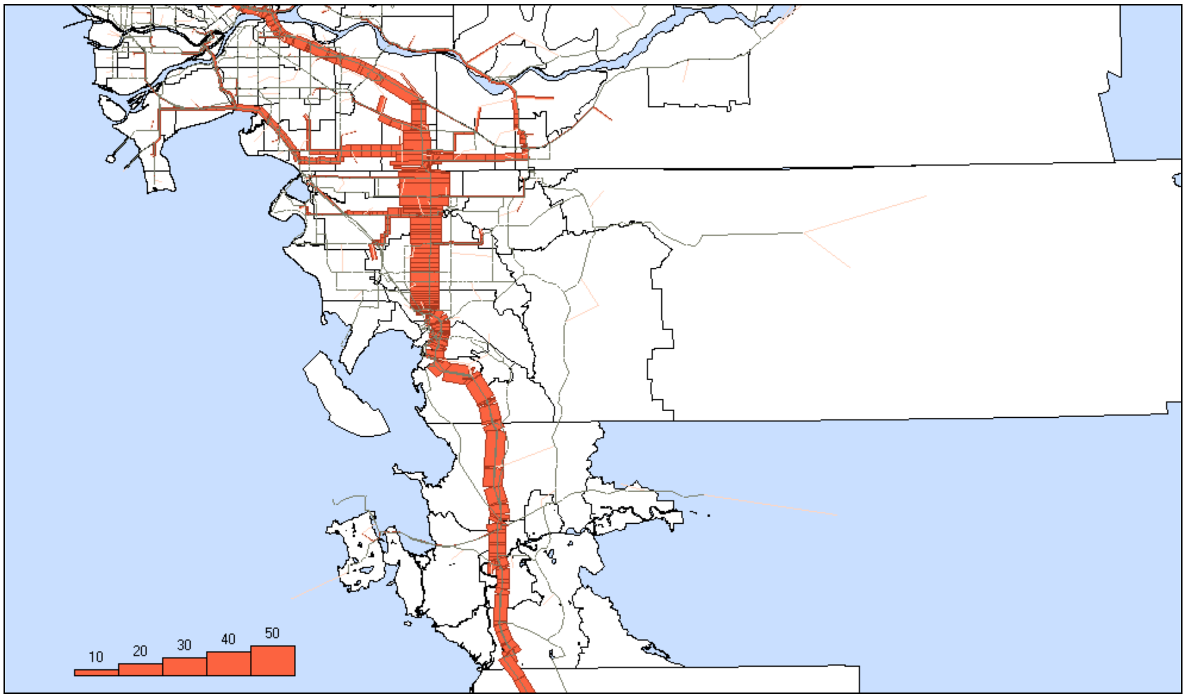
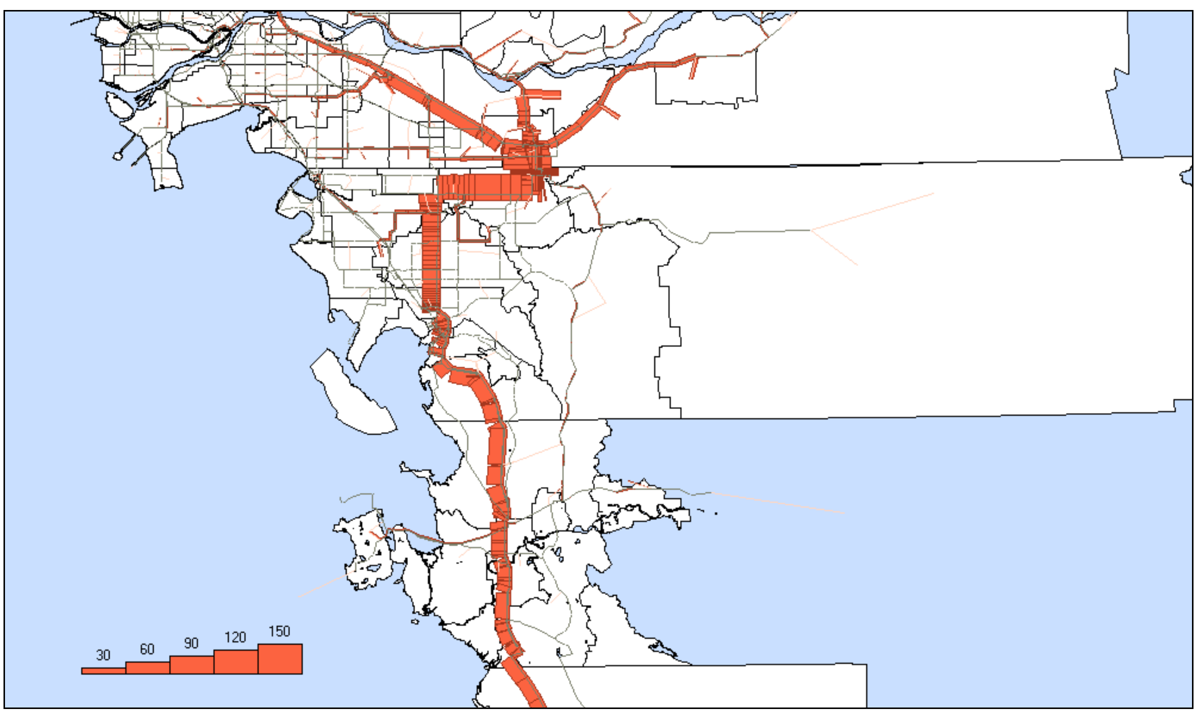


Figure 5-3 Select Link Plot for 2009 AM Unexpanded Internal Truck at Sumas



6 Potential Next Steps

6.1 Introduction

The objective of Phase 1 of this study is to assess the Bi-national Truck Border Crossing Choice model and determine whether it can adequately predict crossing locations under current conditions as well as handle future changes to commercial vehicle border operations such as different operation hours or the introduction of FAST at another border crossing.

The structure of the Border Choice model is highly dependent on its upcoming needs. The existing Border Choice model has not been set up to model changes to different operating hours and the introduction of FAST at other border crossings. This chapter summarizes the potential next steps to refine the existing Truck Border Choice model.

6.2 Potential Model Refinements

Based on this assessment, the existing Bi-national Truck Border Choice model considerably underestimates internal truck trips choosing Lynden and Sumas border crossings. These results appear to be primarily related to how the model was specified and less so on the operational changes between 2002 and 2009. However, as the model was developed prior to recent operational improvements at the border (e.g., FAST lane, southbound permit port at Lynden), road improvements on either side of the border and the latest economic downturn it would be important to address these factors as part of any in the model recalibration effort. The following provides a list of potential actions:

- Re-specify the model structure and utility functions to include a consistent set of variables that reflect both current and future key decision factors. Additionally, efforts should be made to include only those variables that can be readily estimated for current and future years;
- Re-calibrate the Border Choice model using data from both the 2000 and 2009 truck OD surveys. Model validation should include details on truck volumes by crossing and direction as well as OD patterns; and,
- Examine the feasibility of incorporating the external truck trips into the Border Crossing choice model.

6.3 Preliminary Model Structure

For a loaded truck to qualify as a FAST user, the truck driver, the carrier, and the shipper need to be enrolled in the FAST program. If a truck is empty, the FAST program only requires driver and carrier enrolment. This suggests that forecasting the potential FAST demand, which may well be part of the trip generation stage, is essential particularly when testing the introduction of FAST at another border crossing. Even under current operations, the FAST lane provides significant time savings to registered users that will influence their choice of border crossing.

Assuming the upcoming needs of the border choice model are primarily to address the changes to border operating hours and the introduction of FAST at another border crossing, a preliminary model structure is shown in **Figure 6-1**. FAST demand would need to be explicitly forecast as part of the trip generation and distribution stage. Another key component to the border crossing choice model is the time of day factoring which may require subdividing the daily truck matrix into more refined time intervals such as the inclusion of midday, evening and night time. At this stage we believe this would be a relatively straight-forward factoring process (expand the 3 time period factors to 5 time period factors).

Prior to proceeding with any re-specification or recalibration effort, we would discuss with the client to ensure that the resulting model is able to effectively address key analytical issues.

Figure 6-1 Potential Truck Border Crossing Choice Model Structure