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Field Observations of Northbound Truck Traffic at Pacific Highway

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About the Border Policy Research Institute

The BPRI focuses on research that informs policy-makers on matters related to the Canada-U.S. border. Policy areas of importance include transportation and mobility, security, immigration, energy, environment, economics and trade.

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Introduction

This report pertains to a field project designed to collect data suitable for development of a simulation model of commercial vehicle operations (CVO) in the *northbound* direction at the Pacific Highway border crossing in Blaine, Washington. The project complements a recently completed effort that generated similar data for trucks moving southbound at Pacific Highway. The southbound field effort took place in February-April of 2011 in partnership with the Whatcom Council of Governments (WCOG), and the results of that effort are documented in a separate report titled "2011 Pacific Highway Southbound FAST Lane Study: Final Report," accessible online at: http://www.wwu.edu/bpri/files/2011_Jun_BPRI-WCOG_FAST_Report.pdf. The northbound field effort, the subject of this report, took place in July-August of 2011, and was conducted solely by BPRI researchers.

This pair of 2011 projects is the most recent iteration of regional CVO data-gathering efforts completed over the last nine years. Stakeholders in the Blaine region have worked to enhance freight mobility at Pacific Highway, which is the main commercial crossing serving the I-5 corridor, and CVO data is crucial to the measurement of mobility through the port-of-entry. Paired CVO studies were undertaken in 2006 and 2009, retrievable from the WCOG website at: http://www.wcog.org/Border/IMTC-Projects/CVO-Border-Evaluation-Study/288.aspx.

This report skips discussion of the regional and national context surrounding cross-border freight mobility. To gain a greater understanding of such topics, the reader is referred to the above-cited 2011 report co-authored with WCOG, and to earlier reports posted at the WCOG website. We instead focus on the methodology and results of the summer 2011 northbound field effort.

Project Logistics

The project took place in coordination with local officials of the Canada Border Services Agency (CBSA) and U.S. Customs and Border Protection (USCBP). Planning began in June 2011 and proceeded in a rapid manner, due to the existing framework of relationships and processes developed to support the southbound field effort undertaken three months earlier. Logistical details follow:

- <u>Staffing and funding</u>. A field team of five students from Western Washington University was recruited, and team members were vetted by CBSA and USCBP. David Davidson, Associate Director of the BPRI, served as the team supervisor. The BPRI hired the students and paid the cost of the project from internal funds.
- <u>Schedule</u>. Field work took place on four days:
  - Monday, July 25, 8:00 a.m. to 5:00 p.m.
  - Tuesday, July 26, 8:00 a.m. to 5:00 p.m.
  - Wednesday, August 3, 10:00 a.m. to 7:00 p.m.
  - Thursday, August 4, 10:00 a.m. to 7:00 p.m.

  The schedule was developed in consultation with CBSA. The heaviest traffic exists in the Monday-Thursday period, and traffic is significant from early morning through early evening. This set of days and hours allowed us to collect large uninterrupted sequences of CVO data that are representative of high-traffic conditions at the port.

- Methodology. We used Palm Tungsten E2 personal digital assistants (PDAs) running a set of custom data-collection windows created with Pendragon Forms 5.1 software. The internal clocks of the PDAs were synchronized to within two seconds, such that a timestamp collected at one station could be accurately compared to a timestamp collected elsewhere with a different PDA. There were four stations, as follows:
    - *Queue-end.* At this station, a student recorded the time that a given truck joined the queue of trucks waiting to reach the standard booths (i.e., the non-FAST booths). Because queue length changes constantly, this was a roving station.
    - *Standard booths.* At this station, a student recorded activities occurring at the two booths used to process standard truck traffic. We refer to these as booths 1 and 2, and they are the eastern two, closest to the CBSA commercial building. For a given truck, a timestamp was captured when the truck came to a stop adjacent to a booth, and a second timestamp was captured when the truck began to move away from the booth. The difference between the two timestamps pertaining to a single truck represents the amount of time spent in the inspection process. Subtracting the departure time of one truck from the arrival time of the subsequent truck allows for computation of the "transition time" needed between trucks. The inspection time combined with the transition time yields the total amount of time—i.e., the "service time"—involved in moving a truck through the at-booth process. Subtracting the queue-end timestamp of a given truck from its booth-arrival timestamp allows computation of the time the truck spent waiting in the queue.
    - *Parking lot.* If a truck joined the queue upstream of the parking lot and then parked (i.e., to visit a broker or the duty-free store), a simple subtraction of queue-end timestamp from booth-arrival timestamp would overstate the time actually spent in the queue. At this station, a student recorded which trucks left the queue to park, so that wait-times of such trucks could be omitted from later calculations.
    - *FAST booth.* This booth is the one most distant from the CBSA commercial building, and we refer to it as booth 3. As at the standard booths, the student at this station captured a timestamp when a truck came to a stop at the booth and a second timestamp when the truck began moving again. The FAST booth is very lightly used compared to the standard booths. A typical FAST truck moves continuously north on a dedicated FAST highway lane until it reaches the booth. Such a truck spends no time in a queue. At no time did we observe a queue of more than two trucks waiting to reach the booth. Because of these conditions, we chose not to separately capture the queue-end times associated with FAST traffic.

  License plates were used as the means to tie together the timestamps associated with a given truck. At the end of each field day, the data from all PDAs was uploaded automatically by the Pendragon application, with all data placed into an MS Access database. Data was then exported to an MS Excel spreadsheet to perform post-processing, which included the steps necessary to bundle the information relative to a specific truck into a single record, and to compute the various statistics presented later in this report.

Results

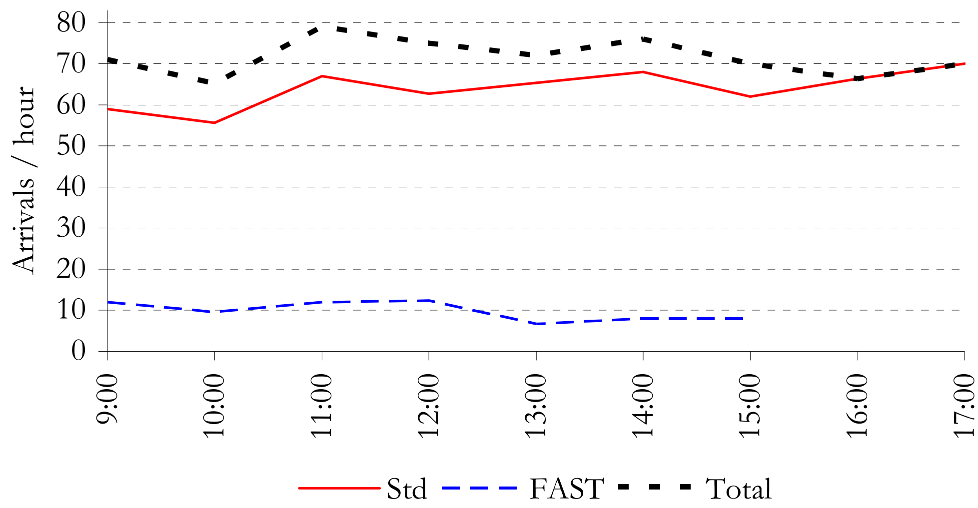
Excel spreadsheet. The main product of the project is an MS Excel spreadsheet containing 2,544 rows, with each row containing the data describing "sightings" of a single truck as it progressed through the port. Not all rows contain a *complete* record of a truck's progress, due to aspects of the methodology. For instance, upon arrival at the port in the morning, the student at the booths would begin logging data at essentially the same time as the student at the queue-end. But the trucks logged at the queue-end would not arrive at the booths for several minutes, so the first records collected at the booths would have no matching queue-end entry, and would thus result in incomplete rows of data within the spreadsheet. Errors in recording license-plate values likewise resulted in a number of incomplete records, as no matching booth record could be found for a truck logged into the queue. Some incomplete records are due to the design of the CBSA facility, as oversize vehicles are diverted out of the queue upstream of the booths. For such trucks, we would record an entry into the queue, but no matching booth entry would exist. Finally, some vehicles had no license plates, making it difficult to accurately log their progress. Despite all such issues, the Excel spreadsheet contains a very robust set of data with which to populate a simulation model and from which to derive statistics pertaining to wait-times and duration of inspections. The spreadsheet contains:

- 2,388 records of arrival of trucks at the queue-end. Whether or not it is matched to a booth record, each arrival record is useful in the construction of an arrival-rate profile, which is a crucial component of a simulation model.
- 2,422 records of inspection durations. Again, every such record is used in the construction of a service-rate profile, another crucial modeling factor.
- 2,249 records of wait-times within the queue.

Operational irregularities. In normal operations CBSA opens three booths, with FAST trucks making use of booth 3 and standard trucks using booths 1 and 2. On Monday, July 25, normal operations were suspended at two points during the day. For more than an hour at a time, one standard booth was closed, and booth 3, together with its associated highway approach lane, was made accessible to all trucks. During these episodes of irregular operations, our methodology could not produce valid records of wait-times within the queue. We did not have enough crew to monitor the queue-end of two separate queues, and we had no way of knowing which trucks clearing through booth 3 were FAST trucks. For this reason, some of the results presented below are confined to the data collected on the other three days.

Profile of arrivals. Figure 1 shows a profile of arrival rate over the course of the day. The FAST booth closes each day at 16:00, resulting in truncation of the associated plot line. For both FAST and standard trucks, the rate of arrival is relatively constant throughout the day. A slightly greater arrival rate is evident in the midday period from 11:00 a.m. through 14:59 p.m., but the midday peaking is far less marked than that observed in the southbound direction (see above-cited southbound report).

Figure 1: Rate of Arrival vs. Time of Day
(n = 1,784, all data from 7/25 excluded)



Profile of wait-times. Figure 2 shows the variation in wait-times for standard trucks over the course of the day. A midday peak is also evident in this graph, with average waits climbing to over 12 minutes at noon, and a mid-day maximum wait of over 40 minutes observed on one field day. There is a logical correspondence between the profiles of arrival-rates and of wait-times. As arrival-rates increase in late morning, the service capacity at the booths is exceeded and a queue builds. The queue dissipates later in the day, as arrival-rates fall from their peak. The overall average wait-time is 7 min. 4 sec. in the northbound direction, which is much less than the average "baseline" wait-time of about 50 min. in the southbound direction, as measured last February (see above-cited report). We did not capture wait-times for FAST trucks, because there was essentially no queue.

Figure 2: Wait-time vs. Time of Day, Standard Trucks
(n = 1,849, irregular data from 7/25 excluded)

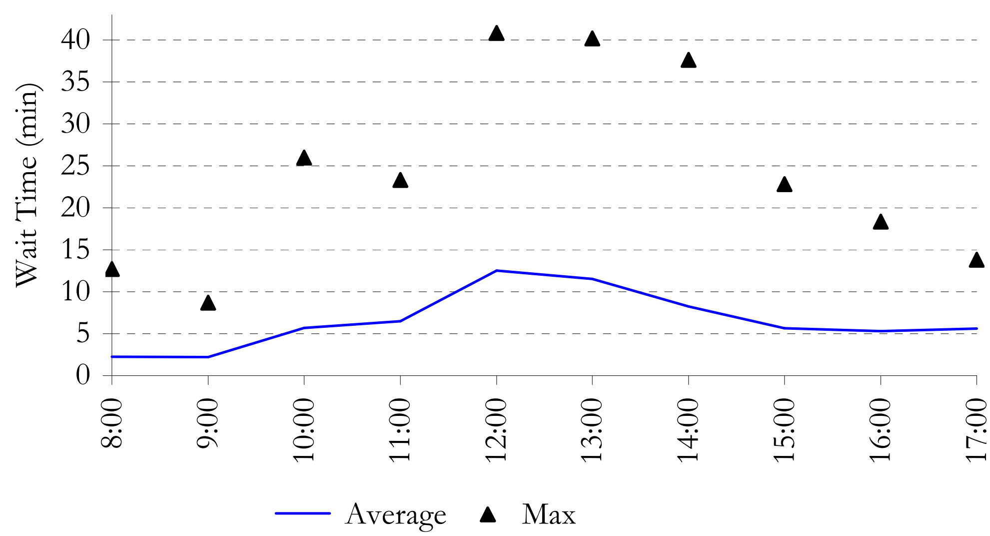


Figure 3: Frequency Distribution of Wait-time, Standard Trucks
(n = 1,849, irregular data from 7/25 excluded)

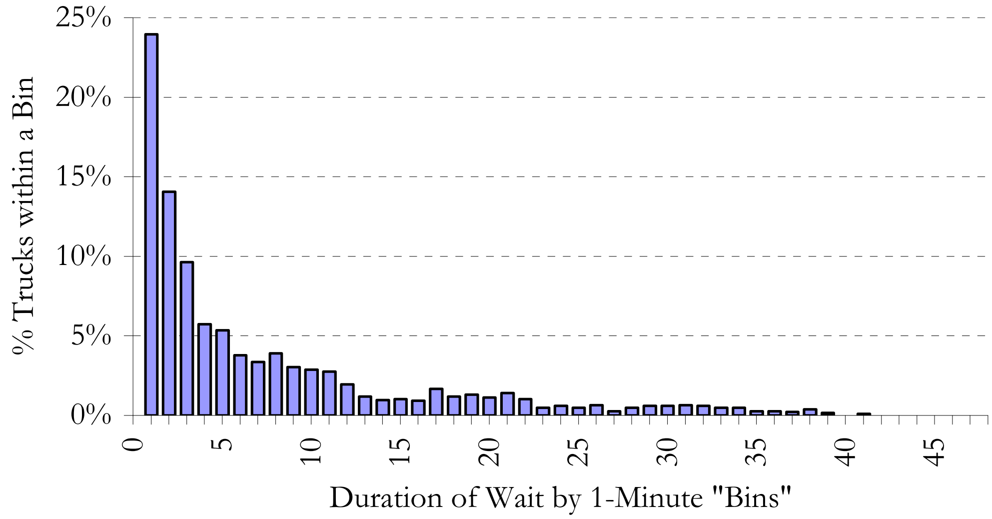


Figure 3 provides a better understanding of the wait-time experienced by individual trucks. The modal value is a wait of 1 min. or less, experienced by 24 percent of trucks. The median value is 3.5 min., and 66 percent of trucks experience wait-times less than or equal to the average of 7 min. 4 sec. It is the long waits experienced by a small fraction of the trucks that yield an overall average value so much higher than a typical truck's experience.

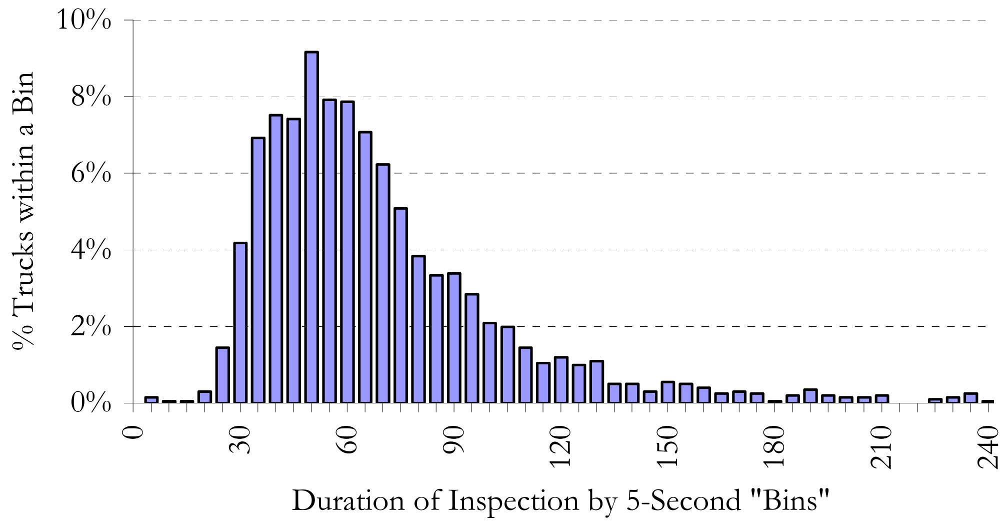
Inspection duration. Table 1 shows the average duration of an inspection at the booth, from the moment a truck comes to a halt until the moment it resumes travel. The table shows values for both FAST and standard trucks and includes comparable values collected in earlier CVO studies. The values for 2011 are significantly less than those for 2009, particularly for FAST trucks. The 2011 data is based upon a sample of 218 FAST trucks and 2,022 standard trucks. Because FAST did not exist in the northbound direction at Pacific Highway until 2008, two cells in the table are vacant.

Table 1: Inspection Duration (sec.)
(irregular data from 7/25 excluded)

	2002	2006	2009	**2011**
FAST booth	n/a	n/a	69	**37**
Standard booths	49	63	76	**67**

Figure 4 provides a more detailed understanding of inspection duration. As seen above, the average duration for a standard truck is 67 seconds. Figure 4 shows that the modal value is about 48 seconds (i.e., within the "bin" that spans the interval of 46 – 50 seconds). The median value is 58 seconds, and about two-thirds of trucks experience inspections lasting less than the average of 67 seconds. A cut-off of 240 seconds was applied to Figure 4, but there were 14 additional trucks in our sample that experienced inspections of a greater duration. The worst-case truck was 373 seconds (6 min. 13 sec.).

Figure 4: Frequency Distribution of Inspection Duration, Standard Trucks
(n = 2,008, irregular data from 7/25 excluded)



<u>Summary of hourly data</u>. On the next page is a table summarizing each hour's data throughout the course of the four field days. Some comments about the table:

- The pink-shaded rows contain wait-time data gathered for *standard* trucks (i.e., non-FAST trucks), whereas the remainder of each day's data pertains to *all* trucks moving through the port. As noted earlier, wait-time data was not gathered for FAST trucks because the FAST queue was virtually nonexistent.
- The stippled columns of data on Monday, July 25, represent the portions of that day in which CBSA operated the booths in an irregular manner, as discussed earlier.
- CBSA provided a count of the total number of trucks cleared through the port per hour, according to its records. The top three rows of each day's data are designed to show what fraction of that total we were able to capture. Our value for "# Captured" represents the number of wait-time records we gathered per hour, based upon the time at which a truck arrived at the booth. Included are standard trucks, each of which is represented by a field-measured value, as well as FAST trucks, which have each been assigned a wait-time of zero. Our expectation was that we would routinely capture most, but not all, of the trucks clearing the port. We understood that at times of heavy traffic we would be unable to capture each truck. We also knew that in the first and last hour of each day our capture-rate would be lower, because of the time-lag inherent in the startup process (as discussed earlier in the section titled "Excel spreadsheet"). However, in many hours we captured values for *more* trucks than CBSA counted, which is not a reasonable result. To determine whether our counts reconcile with CBSA's when averaged over a number of hours, we computed cumulative capture ratios for the "core" set of hours each day (as identified in **bold blue** font), and those values are shown in the right-most column. Even these cumulative values are unreasonably high (i.e., a 101 percent capture ratio on August 4). As a future work task we will discuss this inconsistency with CBSA, and one outcome of that discussion might be a revised version of the table below. Note that this inconsistency does not affect the overall validity and usefulness of the data—wait-times and service rates are still very accurate.

		8 to 9	9 to 10	10 to 11	11 to 12	12 to 13	13 to 14	14 to 15	15 to 16	16 to 17	17 to 18	18 to 19	Day
Mon 25-Jul	CBSA hourly #	57	76	95	41	55	53	70	54	78			522
	% Captured	46%	91%	65%	154%	109%	100%	91%	98%	83%			94%
	# Captured	26	69	62	63	60	53	64	53	65			489
STD Trucks	Min Wait	00:09	00:04	00:26	00:14	00:14	00:04	00:07	00:12	01:05			
	Avg Wait	00:55	01:15	03:46	03:02	07:48	04:47	07:50	02:26	08:46			
	Std. Dev.	01:06	01:15	02:36	02:48	03:56	02:40	05:43	01:51	04:37			
	Max Wait	04:35	05:00	10:02	08:30	13:27	09:25	18:35	07:16	18:22			
	# Arrivals	30	67	64	61	60	62	56	56	63			
Tue 26-Jul	CBSA hourly #	84	75	63	48	102	79	77	81	60			585
	% Captured	58%	93%	94%	131%	82%	103%	112%	93%	105%			99%
	# Captured	49	70	59	63	84	81	86	75	63			581
STD Trucks	Min Wait	00:10	00:14	00:00	00:06	03:17	00:07	00:11	00:03	00:04			
	Avg Wait	02:59	03:12	02:00	01:35	11:29	02:18	01:36	03:51	02:00			
	Std. Dev.	02:56	02:08	01:44	01:45	04:09	01:54	01:07	03:03	01:43			
	Max Wait	12:43	08:41	06:46	08:25	20:06	08:07	05:38	14:07	07:16			
	# Arrivals	49	71	62	72	78	79	84	75	62			
Wed 3-Aug	CBSA hourly #			66	82	65	94	91	92	60	78	55	562
	% Captured			55%	82%	108%	72%	77%	85%	98%	91%	67%	86%
	# Captured			36	67	70	68	70	78	59	71	37	483
STD Trucks	Min Wait			14:19	14:34	13:56	25:46	13:44	00:12	03:57	04:47	00:11	
	Avg Wait			19:59	18:19	25:47	31:22	24:57	09:45	08:31	09:17	09:20	
	Std. Dev.			03:12	02:08	04:38	03:37	07:30	06:48	02:07	01:46	04:51	
	Max Wait			25:58	23:19	40:49	40:11	37:37	22:48	13:37	13:48	16:51	
	# Arrivals			52	92	76	73	68	69	62	81	26	
Thur 4-Aug	CBSA hourly #			67	74	74	68	65	61	68	66	57	476
	% Captured			67%	96%	100%	88%	120%	108%	103%	97%	35%	101%
	# Captured			45	71	74	60	78	66	70	64	20	483
STD Trucks	Min Wait			00:04	00:13	00:02	00:03	00:13	00:07	00:09	00:00	00:00	
	Avg Wait			00:45	02:09	02:28	02:43	02:15	05:35	02:15	01:30	01:41	
	Std. Dev.			00:37	01:21	02:19	02:27	01:27	03:34	02:00	02:02	02:03	
	Max Wait			02:48	05:35	10:16	07:09	06:30	11:42	08:53	08:47	06:36	
	# Arrivals			49	73	71	64	76	66	75	59	19	

- In the earlier discussion regarding wait-times, mention was made of how a relatively small number of trucks experiencing long waits can raise an overall average to a value that is quite high in comparison to the experiences of most trucks. This phenomenon is evident when looking at the detailed hourly data. For example, the average wait of 12 minutes in the hour from 13:00 to 14:00 (as plotted in Figure 2) is heavily influenced by the lengthy delays evident on Wednesday, August 3. On none of the other days did the average wait reach 5 minutes during that hour. As another example, on the three days other than August 3, a wait of as long as 20 minutes was only evident once, at the noon hour on July 26. This means that the entire "tail" of longer waits in Figure 3, as well as almost every "max" value graphed in Figure 2, are products of the heavy traffic on August 3.

Conclusion

Several items are worth mentioning in conclusion:

- The project is a tremendous testament to the cooperative relationship between CBSA and regional stakeholders. The project was mounted in an amazingly short time—from conception to conclusion of the field effort in just 9 weeks.
- A robust data set was gathered and development of a simulation model of northbound truck traffic is now feasible, should such a task be desired by the BC/WA working group that reports to the Governor and Premier.
- Even absent the construction of a model, the data represents a new snapshot of CVO activities at northbound Pacific Highway. Comparing 2011 to earlier years, we see:
  - The duration of the at-booth inspection process is substantially faster now than in 2009, particularly so at the FAST booth.
  - A larger percentage of trucks use the FAST booth than did in 2009. This is due either to a modification of the rules governing eligibility of use of the booth, or to a larger group of users choosing to establish eligibility under an unchanged set of rules.
- We anticipate completing some minor follow-up work on this project. We will approach CBSA to investigate the issue of why our count of vehicles clearing the port was at times in excess of theirs. We also will seek to clarify any changes to the rules governing eligibility for use of the FAST booth.