IMTC Cascade Gateway Border Circulation Analysis
NEXUS Program Technical Report

1. Introduction

NEXUS is a pre-approved travel program jointly administered by U.S. and Canadian inspection agencies for low-risk travelers who frequently cross the international border.

NEXUS began as a pilot project at the Port Huron/Sarnia port-of-entry. Following the termination of previous pre-approved travel programs PACE, CANPASS and PORTPASS on September 11, 2001, NEXUS was established as a binational program for selected land ports-of-entry.

NEXUS policy objectives and intended benefits

The NEXUS program provides an optional pre-screening process for U.S. and Canadian citizens who, if determined to meet program criteria, are given a NEXUS card which provides access to a dedicated commuter lane (DCL) and primary booth.

Frequent, low-risk travelers can therefore bypass often-lengthy backups in general lanes. It can also benefit general traffic by removing a significant portion of travelers from the general lanes and thus speed the border crossing process for everyone.

The NEXUS program helps inspection agencies prioritize efforts and direct more resources to those travelers who the agencies know less about.

2. Process

Individuals fill out an application which is reviewed by U.S. Customs & Border Protection (CBP) and Canada Border Services Agency (CBSA). An applicant must be approved by both agencies before continuing on to an interview.

Interviews are conducted in person at a designated NEXUS Enrollment Center. In the Cascade Gateway there are three NEXUS Enrollment Centers (Blaine, WA at the Pacific Highway Port-of-Entry; downtown Vancouver, B.C.; and Boeing Field in Seattle, WA).

Following the interview, applicants receive a NEXUS photo identification card which links to biometric information (fingerprints and photo) stored in the NEXUS database. The card costs $50 (USD & CAD). For children under the age of 18 the fee is waived. The card is valid for five years assuming the participant has no violations or change in status.

Drivers use the NEXUS lane by holding up their NEXUS cards to a radio frequency (RF) reader which initiates a query of the driver profile for display to the officer in the booth. The officer can then determine whether to let the driver pass. The system also flags drivers whose status has changed or card has expired.

All passengers in a vehicle using the NEXUS lane must have valid NEXUS cards.

NEXUS is jointly administered by CBP and CBSA. Representatives from each agency work in the 22 NEXUS enrollment centers located in both nations.

3. Supply

Dedicated NEXUS clearance is available at 17 land border crossings, major Canadian airports with flights to the U.S., and at numerous marine ports-of-entry.

In the Cascade Gateway there are three ports-of-entry with dedicated NEXUS lanes: Peace Arch, Pacific Highway, and Point Roberts Ports-of-Entry. Hours of operation are as follows:

NEXUS Lane Hours of Operation

	Peace Arch	Pacific Highway
Northbound	7:00am – 12:00am	7:00am – 7:00pm
Southbound	6:00am – 9:00pm	7:00am – 6:00pm

In 2009, CBSA opened its new facility at Peace Arch/Douglas which includes two lanes equipped for NEXUS/RF processing.

Southbound at Peace Arch, the U.S. General Services Administration is constructing a new U.S. port-of-entry facility which will have the ability to designate any lane a NEXUS lane with common booth systems, RF readers in all lanes, and dynamic overhead signage. This too will allow for expanded NEXUS capacity as needed.

4. Demand

On April 30, 2010, the NEXUS program reached the 400,000 member mark.

The Peace Arch NEXUS lanes are the most used on the U.S. – Canada border, with 467,924 car trips using the lane southbound in 2009, making up 30 percent of southbound traffic there. [1] At Pacific Highway, 14 percent of southbound vehicles used the NEXUS lanes (196,031 car trips).

Northbound, 350,941 car trips used the Peace Arch NEXUS lane, representing 24 percent of overall traffic.

As of May, 2010, 173,483 NEXUS card holders live in the Pacific Northwest/B.C. Lower Mainland region, representing 43 percent of all NEXUS participants. 78 percent of participants in this region are from British Columbia.

Frequency of border crossing

Data on the use rates of NEXUS enrollees is unavailable.

Analysis of the 2008 IMTC Passenger Intercept Survey (which only surveyed those NEXUS users who crossed the border during the survey period) estimated that 63

[1] Numbers provided by CBP in April, 2010.

percent of NEXUS lane travelers at Peace Arch cross at least once a week or more (65 percent in summer, 61 percent in winter). Over 90 percent of those surveyed in the NEXUS lane cross at least once a month.

However this region as a whole has high crossing frequencies, with approximately 45 percent of non-NEXUS travelers crossing at least once a month. 18 percent of winter travelers cross at least once a week. [2]

Enrollment increases

In 2007 the Blaine NEXUS enrollment center processed 24,500 enrollees, and this number grew to 37,750 in 2008. During peak interview seasons the Blaine enrollment center conducted 140 interviews each day. [3]

Some of this increase can be attributed to large numbers of NEXUS cards expiring in 2008. As of May 2010, almost 87,000 participants have registered at the Blaine enrollment center.

Potential for additional NEXUS lanes

Four days of passenger vehicle intercept surveys were conducted at the Lynden/Aldergrove and Sumas/Huntingdon ports-of-entry in July, 2009 to collect user feedback about awareness of the NEXUS programs, interest in the program at these locations, and current levels of knowledge about eligibility.

573 records were collected between both ports-of-entry. Of those, four percent of Lynden/Aldergrove travelers interviewed and four percent of those at Sumas/Huntingdon already had NEXUS cards. However a larger percentage were aware of the program: 73 percent at Lynden/Aldergrove and 71 percent at Sumas/Huntingdon knew what NEXUS was, although knowledge of important program specifics was variable.

Of those who had heard of NEXUS:

- 52 percent knew the fee was ($50 USD & CAD) but
- 46 percent (88 percent of those who "knew" the price) were unaware that the fee covers five years.
- Only 18 percent knew that there is no fee for children.
- 58 percent knew NEXUS was WHTI-compliant (perhaps showing that CBP's aggressive WHTI advertising campaign was effective).

[2] IMTC 2008 Passenger Intercept Survey, Whatcom Council of Governments (http://resources.wcog.org/border/pis_2008finalreport.pdf)
[3] From U.S. Customs & Border Protection, March, 2009

Considering all Lynden-Aldergrove and Sumas-Huntingdon survey respondents (including those who did not know what NEXUS was):

- 40 percent would apply for NEXUS if a lane was available at those ports-of-entry
- 26 percent did not know what NEXUS was
- The remainder (34 percent) would not apply.

These summary results show that there is significant interest in NEXUS from travelers who use these lower-volume ports. The additional NEXUS lanes may also attract current enrollees to use those ports-of-entry as alternatives to Peace Arch and Pacific Highway. A next step would be to evaluate feasibility through simulation modeling and review options for dedicated access lanes.

5. Performance and alternatives

Benefits

NEXUS lanes at Peace Arch now process approximately 30 percent of border traffic. This impressive uptake suggests that NEXUS is delivering benefits to inspection agencies, NEXUS enrollees, and auto travelers as a whole. The fact that most drivers are renewing their enrollment suggests that the program is working.

In addition to the benefits reviewed above, NEXUS cards are now recognized as proof of citizenship under U.S. and Canadian regulations and compliant with the U.S. Western Hemisphere Travel Initiative.

NEXUS and other approved identification for entering the U.S.

Under the Western Hemisphere Travel Initiative (WHTI), four forms of identification have been approved as proper documentation for entering the United States at a land border port-of-entry: a U.S. passport, a U.S. passport card (issued through the State Department), a trusted traveler program card (NEXUS, SENTRI, or FAST), or an enhanced drivers license from one of the approved state or provincial licensing agencies.

Efforts to market these various forms of identification need to clarify the different costs and benefits. Different people will have different needs and travel patterns.

The chart below compares the various WHTI-compliant documents accepted for travel between the U.S. and Canada.

Identification document	Fee as charged	Annualized fee	Fee for children[4]	Dedicated lane	Proximity readable at border	Globally inter-operable
NEXUS[5]	$50/5 yrs	$10	Free	Yes	Yes	No
WA EDL[6]	$60/5 yrs	$12	$35/ 5 yrs (EID)	No	Yes	No
BC EDL[7]	$110/ 5 yrs	$22	$70/ 5 yrs (EIC)	No	Yes	No
US PASSCARD[8]	$55/ 10 yrs	$5.50	$40/ 5 yrs	No	Yes	No
US PASSPORT[9]	$135/10yrs	$13.50	$105/ 5yrs	No	No	Yes
CAN. PASSPORT[10]	$87/ 5 yrs	$17.40	Under 3 yrs: $22/ 3 years 3-15yrs old: $37/5 yrs	No	No	Yes

Issues

Technical problems

NEXUS travelers have noted past problems with antennas in the lane. However new "Gen 2" readers and cards installed in 2008 seem to have alleviated most of these issues.

Queues in the NEXUS lane

2009 was the first year that travelers experienced somewhat frequent queues in the southbound NEXUS lane. Until the new southbound U.S. port-of-entry is completed, one NEXUS booth will continue to serve high volumes during peak travel periods.

Strategies

Given the success of the NEXUS program in this region it makes sense to consider expansion and improvements to take full advantage of the regional interest.

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[4] Updated WHTI regulations state that U.S. & Canadian citizens under the age of 16 (or anyone under 19, if traveling with a school, religious, or other youth group) need only present a birth certificate, Consular Report of Birth Abroad, Canadian Citizenship Card, or a naturalization certificate. Birth Certificates can be an original, photocopy, or certified copy (source: US CBP form 0000-0807, June 2008).

[5] NEXUS application costs are $50 in both $US and $CAN. Children are 17 years old and under.

[6] A new EDL costs $60, but upgrading an existing license is $15. To renew an EDL costs $40 and to renew an Enhanced Identification (EID) costs $35. A child is under 18 years of age.

[7] All prices for BC cards are listed in Canadian Dollars. A 5-year original license or renewal costs $110. A 5-year original enhanced identification card (EIC) costs $70 and can be renewed for $50. Upgrading an existing license costs $52 and upgrading an identification card costs $50.

[8] A child is under 16 years of age. The fee for renewing a Passport Card is $30.

[9] A child is under 16 years of age. Children's passports are valid for 5 years. The fee for renewing a passport is $110.

[10] All prices for Canadian Passports are listed in Canadian Dollars. The prices listed are for a 24-page passport for a citizen who is living in Canada. Passport prices are higher if additional pages are ordered, or if the applicant is applying from outside of Canada.

Need for additional marketing

Given that 56 percent of non-NEXUS summer traffic and 61 percent of non-NEXUS winter traffic surveyed in 2008 cross the border at least six times a year, there is potential to expand the NEXUS user base in this region. Increasing the NEXUS portion of traffic would lead to greater times savings for both frequent travelers and less-frequent border crossers who will have shorter primary queues.

Many of those surveyed in the summer and winter of 2008 were unfamiliar with NEXUS, misunderstood program eligibility or cost, or found the application process inconvenient. And those surveyed in 2009 at Lynden/Aldergrove and Sumas/Huntingdon showed that a lot of misunderstanding persists about the program - even among those who are "familiar" with NEXUS.

Better marketing would clarify program benefits and costs, and could also advertise the online application process which many may find easier than the traditional mail-in process.

Surrey, B.C., Vancouver, B.C., and Bellingham, WA have the largest percentage of frequent border crossers (eight or more crossings a year) that are not enrolled in the NEXUS program. As shown in 2008 survey results, of those who cross six or more times per year and did not know of NEXUS at all, 19 percent live in Surrey, which is surprising given the proximity to the border. These cities should be the prime targets for advertising.

Expansion to additional crossings

60 percent of crossers at the Lynden/Aldergrove port-of-entry cross at least once every two months; and approximately 28 percent of crossers chose the Lynden/Aldergrove port-of-entry specifically to avoid congestion at other ports.[11]

This, and the fact that that 40 percent of those interviewed in 2009 at both Lynden/Aldergrove and Sumas/Huntingdon said they would get NEXUS cards if a lane opened at one or both of the ports makes a strong argument for adding a NEXUS lane in each direction at these smaller ports-of-entry.

The challenge of adding a NEXUS lane at these ports is the physical layout of property and connecting state routes/B.C. highways.

Hours of operation

One suggested program change would be to harmonize hours of operation in both directions, at both ports-of-entry.

[11] 2008 IMTC Passenger Intercept Survey

Interoperability

Acknowledging the general benefits of using information-technology to consolidate program requirements, it is worth considering the options that radio-frequency identification avails in this regard. On all of the generation-II RFID documents (NEXUS, EDL, PassCard, and FAST), data on individuals and their respective program status is not stored on the RFID itself. The RF number stored in the card itself allows a link to the databases accessible by the border inspection agencies. So, it should be possible for individuals to have one secure RF identification-card and more than one associated endorsement. So, for example, an EDL could also be upgraded with a NEXUS endorsement upon completing the additional application and interview process. The practical benefit of this kind of interoperability is the reduction of the number of cards an individual might have to carry with them.

6. Conclusions

The NEXUS program, having built on the preceding CANPASS and PACE trusted traveler programs in this region, has been a great success in the Cascade Gateway. But the profile of regional cross-border travelers indicates that enrollment could continue to grow along with program benefits for agencies and travelers..

With additional resources dedicated to marketing along with ongoing improvements to NEXUS operations, it is reasonable to expect that half of the recently-sampled cross-border travel flows in the Cascade Gateway could transit the border by way of NEXUS.

Introduction

The Whatcom Council of Governments (WCOG), on behalf of the International Mobility and Trade Corridor Project (IMTC), is evaluating regional NEXUS operations as part of IMTC's Cascade Gateway Cross-border Circulation Analysis.

To build on lane-specific traffic counts and data from passenger vehicle intercept surveys (completed at both NEXUS and non-NEXUS ports of entry in the region), a next step in evaluating regional NEXUS strategies is to analyze and assess the operational benefits of different NEXUS scenarios.

- Increased NEXUS enrollment rates.
- Addition of NEXUS lanes and/or booths at locations that already have a dedicated lane.
- Addition of NEXUS lanes and/or booths at ports that do not currently have NEXUS.

Initial attempts to conduct these analyses using the Border Wizard customized border micro-simulation have been unsatisfactory[1]. While WCOG still intends to further evaluate Border Wizard for this application, as well as other micro-simulation tools, this paper describes an interim approach using a more simple spreadsheet model to compare alternatives.

Building the Model

Source data

The primary source of data for model parameters and assumptions archived traffic arrival rates, departure rates, and calculations of service times from the BC Ministry of Transportation's border advanced traveler information system (ATIS). The data is archived and available at www.cascadegatewaydata.com.

Development steps

Create data sets

Data from two sample 24-hour periods of southbound traffic at Peace Arch was uploaded from the archive (Wednesday, August 13, 2008 and Wednesday, August 26, 2009). This data was uploaded from each lane of two vehicle detector stations (VDS); the first station crossed by cars entering the system (near Beach Road on BC Highway 99) and the last station (just prior to U.S. CBP inspection booths where there is loop-to-booth correspondence). In five-minute increments, this upload provided arrival rate per lane and departure rate per lane/booth.

Data checking

Analysis of the data showed discrepancy between the 24-hour vehicle count observed at the point of arrival and the count observed departing the system at the inspection booths. On August 13, 2008, loops in the standard lanes detected 13.5 percent more entering the system than were detected leaving. In the NEXUS lane, the difference was much lower – 5 percent more detected entering than leaving. On August 26, 2009 (following a recent recalibration of the ATIS by BC

[1] So far, WCOG has not been able to reconcile the output of Border Wizard with the wait-time profiles recorded from ATIS systems data stored at www.cascadegatewaydata.com.

MoT) a discrepancy was still observed but was smaller—nine percent more standard lane arrivals than departures and only two percent more detected NEXUS arrivals than departures.

One possible explanation of the discrepancy is that loops near the booths are more often occupied by cars are queued up and close together whereas the farthest back loop set, by design, is at a location that is usually free-flow, allowing more accurate distinction between (thus counting of) each vehicle.

If this difference is consistent, it can presumably be accounted for in the system (ATIS) calibration. But, for the purpose of using the data in the development of this spreadsheet model, the detected departure volumes were factored up to match the arrival volumes. Not doing this would cause calculated values for vehicle service times, and resulting estimates of wait time, to be too high.

Fitting to a smaller port ("Sumas") scenario

Since high-resolution arrival rate data is not currently available for Sumas (or Lynden), the first step taken was to factor down the observed Peace Arch arrival volumes to be in proportion to the lower arrival volumes at Sumas POE. Using the Aug. 26, 2009 sample day, each five minute arrival and (corrected) departure volume was factored down to 55 percent of its value (the annual volume difference for 2009 between southbound vehicle arrivals at Peace Arch and Sumas).

Booth staffing: The table below shows the observed booth schedule at Peace Arch on August 26, 2009 along with a factored translation to a "Sumas" booth schedule scenario. Peace Arch was using a total of four inspection booths on the subject day. US CBP's POE at Sumas currently has five available primary booths.

Time frame	Open booths at Peace Arch	"Sumas" open booths @ 55 percent (rounded up).
0:00 – 06:00	1	1
06:00 – 7:00	3 (including NEXUS)	2
7:00 – 20:00	4 (including NEXUS)	3
20:00 – 21:00	3 (including NEXUS)	2
21:00 – 23:30	2	1
23:30 – 0:00	1	1

Looking ahead to scenario evaluations later in this paper, it will be important to know that the share of NEXUS traffic at Peace Arch on the sampled day was 38 percent. This fact reduces the value of the observed booth schedule but it is a rough indicator of the times and frequency that inspection capacity is changed.

Vehicle service times: By evaluating Peace Arch data from hours of the day that there were standing lineups at inspection booths, the interval between loop-detector-departures (corrected to match arrivals as explained above) was used to measure **service times**—the full time in between vehicle arrivals at the inspection booth. This was estimated to be 66 seconds. A separate service rate was similarly developed for the NEXUS booth – estimated to be 25 seconds between vehicle arrivals at primary.

Setting up the spreadsheet

The goal of a spreadsheet model is to base iterative calculations on changeable inputs that represent the decisions being analyzed and generate scenario-based output that can be compared.

Unlike a simulation model that may be better at representing ranges of outcomes for a *single scenario*, this spreadsheet model, based on averages of values that are randomly distributed, should only be used to compare outcomes of two or more scenarios. Supporting analysis of *relative* performance is the goal here. Referencing the example work-sheet below (Figure 1), this section explains each field; the data source, calculation, and units; and the overall sequence of calculations that generates various outputs.

Figure 1. Components of the spreadsheet model and data-table.

Changeable parameters. *Arrival-factor* is a multiplier applied at the 5-minute level.

Changeable variables	
Linked or Calculated	
Std. Svc. Time Sec.	66
NEXUS Svc. Time	25.4
Arrival Factor	1.25
= 24 hr volume of	2,368
NEXUS share	25.0%

Hour 0-11	Std.	NEXUS	Hour 12-23	Std.	NEXUS
0:00	1	0	12:00	3	1
1:00	1	0	13:00	3	1
2:00	1	0	14:00	2	1
3:00	1	0	15:00	2	1
4:00	1	0	16:00	3	1
5:00	1	0	17:00	3	1
6:00	2	0	18:00	2	1
7:00	3	1	19:00	2	1
8:00	3	1	20:00	2	1
9:00	3	1	21:00	2	0
10:00	3	1	22:00	1	0
11:00	3	1	23:00	1	0

Hourly primary booth schedule for standard and NEXUS lanes.

HH:MM	Base case total arrivals	Factored total Non-NEXUS arrivals	Open Booths	Open NEXUS	Available Service Time (sec.)	Average Service Time (sec.)	Max. Cars per period	Cars added to queue	Queue at end of period	Est. wait time for next, non-NEXUS car
6:30	9	12	2	0	600	66.0	9.1	3	10	5.3
6:35	5	6	2	0	600	66.0	9.1	0	7	3.7
6:40	7	8	2	0	600	66.0	9.1	0	6	3.2
6:45	7	8	2	0	600	66.0	9.1	0	5	2.7
6:50	14	17	2	0	600	66.0	9.1	8	13	7.2
6:55	13	16	2	0	600	66.0	9.1	7	20	10.9
7:00	8	7	3	1	900	66.0	13.6	0	13	4.9
7:05	10	10	3	1	900	66.0	13.6	0	10	3.5
7:10	12	11	3	1	900	66.0	13.6	0	7	2.5
7:15	10	10	3	1	900	66.0	13.6	0	3	1.1
7:20	10	9	3	1	900	66.0	13.6	0	0	0.0
7:25	15	14	3	1	900	66.0	13.6	0	0	0.1
7:30	13	12	3	1	900	66.0	13.6	0	0	0.0

HH:MM: The five-minute periods of the day from 0:00 to 23:55. There are 288 records for each day.

Base case total arrivals: The raw arrival data—number of cars entering the border crossing system. The volumes and distribution of these volumes is based on the sample day from the Peace Arch border crossing and, in this worksheet, factored at 55 percent to represent a "Sumas" arrival volume.

Factored total arrivals: This field is the product of the record's "base case" volume, the "arrival factor" in the yellow cell above, and the *NEXUS share* if NEXUS lanes are designated in the

booth staffing schedule. This allows the user to change the daily volume but retain the arrival distribution at the five-minute resolution. In the Figure 1 example, a factor of 1.25 is used to increase the volume to that of a typical August 2009 volume of around 3,000 vehicles over 24 hours.

Open booths: The number of open, non-NEXUS booths is linked to the yellow cells of the booth schedule table in Figure 1. The value for each hour will populate the fields for the array of corresponding five minute periods.

Open NEXUS: Works the same as *Open booths*.

Available processing time: This field multiplies the number of open, standard booths by 300 seconds (the number of seconds in the five minute period) to provide a time-based measure of processing capacity. This total seconds of capacity is what is available for vehicles to "use" during the current five minutes.

Average service time: While this field is included as a data-table column, it is an artifact of earlier calculation methods. This is simply linked from the input parameter, *standard service time* in the top left corner of Figure 1.

Max cars per period: This is the mathematical upper bound of how many vehicles would be able to process through primary inspection given the parameters in place. The calculation is *available processing time* divided by the *average service time*.

Cars added to queue: This is a conditional calculation. If the *max cars per period* is equal to or greater than the period's *total arrivals*, then all arriving cars are assumed to have been moved through primary and no cars are added to the queue. If otherwise, the remainder of cars is considered *cars added to queue*.

Queue at end of period (cars)**:** This calculation takes the *queue at end of period* from the previous record, adds the *cars added to queue* from the current period, and then performs the same conditional arithmetic as above.

Estimated wait-time (minutes)**:** This field takes the *queue at end of period* and multiplies it by the quotient of *service time* divided by *open booths*. So, if two booths are open clearing at 66 seconds per car, the calculation assigns 33 seconds to each car currently waiting in the lineup. Lastly, the intermediate result is divided by 60 to convert the final result to minutes.

While a NEXUS lane will occasionally have some wait time, the current spreadsheet model, like current border-ATIS systems, does not calculate wait-times for NEXUS. This can be easily added to the model to investigate the optimal conditions for a second NEXUS booth.

Model outputs

Charts and metrics have been set up as outputs from the model.

Charts

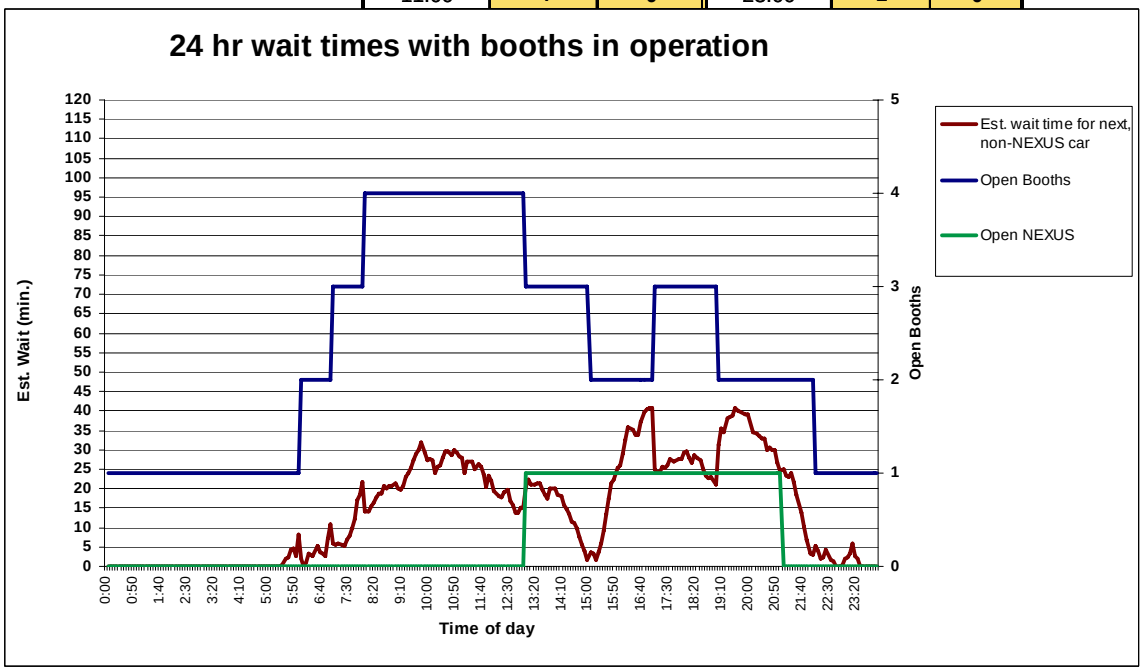
Chart 1 & 2 are inserted below. Chart 1, 24-hr. Wait Times with Booth Operations, plots the resulting wait-time (in minutes) for each five-minute period over the 24 hour modeled day. The designated booth-staffing levels are plotted against a second Y-axis on the right.

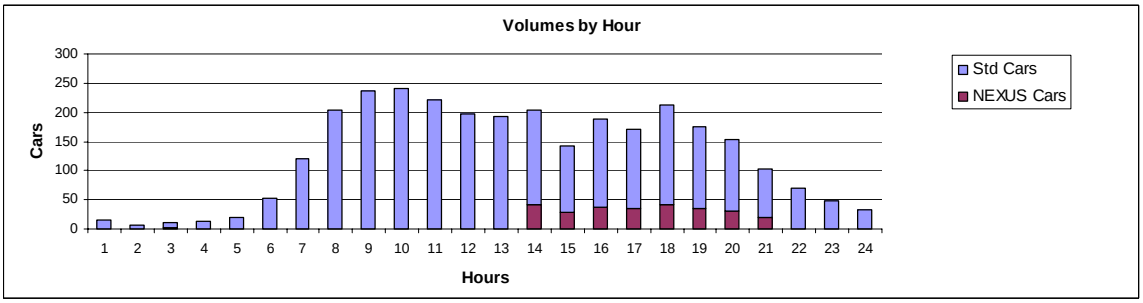
Chart 2 shows the corresponding car arrival volume – summarized by hour. The stacked bar-format is used to show a NEXUS share (depending on the designated *NEXUS share* and the opening of a NEXUS booth/lane.

The scenario shown in Charts 1 & 2 shows a heavy 24 hr. volume (3,038 cars) with a progression of booth-openings up to four by 8:00 AM. A NEXUS booth is opened at 1:00 and kept open until 10:00 PM (but the total booth count never goes above 4). In this scenario, NEXUS cars are assumed to be 20 percent of total traffic

Chart 1 & 2: Wait time, open booths, and corresponding arrival volume

Changeable variables		Hour 0-11	Std.	NEXUS	Hour 12-23	Std.	NEXUS
Linked or Calculated		0:00	1	0	12:00	4	0
		1:00	1	0	13:00	3	1
Std. Svc. Time Sec.	66	2:00	1	0	14:00	3	1
NEXUS Svc. Time	25.4	3:00	1	0	15:00	2	1
Arrival Factor	1.25	4:00	1	0	16:00	2	1
= 24 hr volume of	3,028	5:00	1	0	17:00	3	1
NEXUS share	20.0%	6:00	2	0	18:00	3	1
		7:00	3	0	19:00	2	1
		8:00	4	0	20:00	2	1
		9:00	4	0	21:00	2	0
		10:00	4	0	22:00	1	0
		11:00	4	0	23:00	1	0





Performance measures

To summarize system inputs and outputs and support the assessment of performance, some measures have been developed and illustrated here.

Table 2. Performance Measures(Based on Chart 1 above)

24-hr Measures			
Cumulative wait time		*min.*	*hrs.*
		55,369	**923**
No. of hours with a wait over	**60**	min.	**0**
Longest wait		**40.9**	min.
Total booth hours		**63**	

Cumulative wait time: The total wait time experienced by all cars (not individuals) over the subject 24 hours. Total wait time each 5-minute period is the *queue at end of period* multiplied by 300 seconds. That product is then summed over the entire day to generate this measure. It is separately listed in minutes and hours.

Number of hours with a wait time over *x* minutes: Inspection agencies are required to report hourly wait times to their headquarters and usually are required to file reports when wait times are over 1 hour. This measure is simply a count of each hour of the day that had any wait-time over the user-defined threshold (60 minutes in this example).

Longest wait: returns the maximum value for *estimated wait time* over the 24 hour day.

Total booth hours: The sum of staff hours directly associated with primary booth operation over the 24 hour period. This is intended only as a relative proxy measure since opening a booth has additional implications for staffing requirements.

Evaluating addition of NEXUS

The feasibility and success of a NEXUS lane is dependent on several things such as relatively high cross-border traffic volume, widespread awareness of the program's availability and basic workings, sufficient voluntary enrollment, willingness by both countries' inspection agencies to administer the program at a given border crossing, and dedicated infrastructure to support a queue bypass lane and a NEXUS inspection booth. The application of this spreadsheet model is limited to helping inspection and transportation agencies evaluate different traffic characteristics and determine when NEXUS would be an operationally advantageous addition to a port-of-entry.

This section steps through three scenarios constructed to identify an advantageous application of NEXUS in the modeled port environment. Observations about the sensitivity of specific variables and operational responses will be inserted along the way. The parameters and output of each scenario is attached as appendices.

Base case – no NEXUS.

Starting with a traffic volume, distribution of that volume (arrival rates), and vehicle service times developed as discussed above, creating Scenario 1, a no-NEXUS scenario, was done by changing the standard booth schedule with the goal of keeping wait-times below 30 minutes but, at the same time, avoiding over-staffing the port (resulting in no wait-time at all). This produced the parameters and output shown on the Scenario 1 Appendix.

Looking ahead to a comparison with the next scenario's inclusion of NEXUS, it is noted that the Cumulative Scenario 1 wait time is 682 hours and the total booth hours was 64.

NEXUS at 20 percent

The initial goal of developing a NEXUS scenario was to achieve measurable reductions in overall wait time while tallying up fewer booth hours. The conclusion is, with NEXUS at 20 percent of the traffic stream, this goal was not attainable[2]. A result was achieved that could be called break-even.

With a NEXUS booth open from 7 AM through 10 PM, but never having more than four total open booths, a schedule was found that reduced total wait time from 682 to 626 hours (an 8 percent reduction). Total booth hours went up two hours to 66 (a 3 percent increase). The day's highest wait time went up slightly to 34.5 minutes from 31.8 (an 8.5 percent increase).

NEXUS at 25 percent

Keeping the booth schedule the same from Scenario 2, this scenario, initially, made one change: increasing the portion of NEXUS cars to 25 percent. This resulted in a dramatic drop in cumulative wait time. Seeing opportunity (in this case in the mid afternoon) to reduce total booth hours, standard booths were reduced by one for three hours. Wait times were, for the most part kept under 20 minutes.

Under this scenario as finalized, the five percent increase in NEXUS share resulted in a 55 percent decrease in cumulative wait time (279 minutes down from 626). Total booth hours (63) did not go down nearly as much – only one hour less than the no-NEXUS scenario and three hours less than the 20 percent NEXUS scenario.

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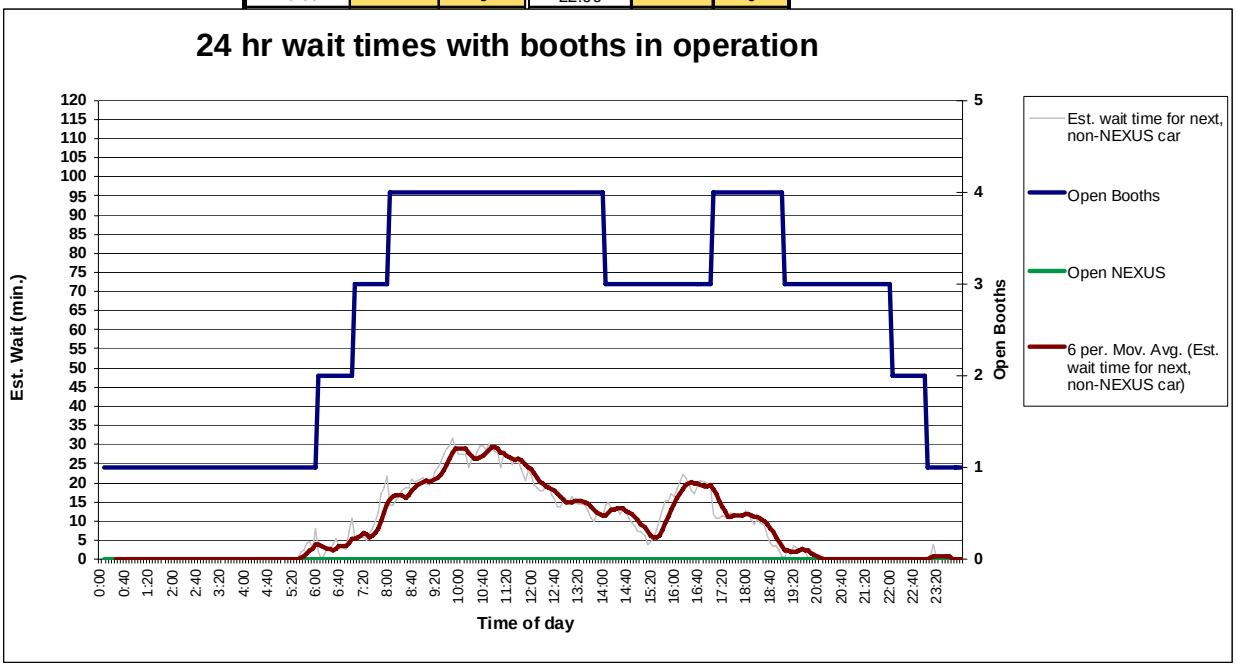
[2] It is possible that staffing parameters at increments of a half hour or less could be better optimized to achieve theoretical efficiency gains at 20 percent NEXUS share but the implications for frequent staffing level changes and on-and-off NEXUS lane hours are probably undesirable.

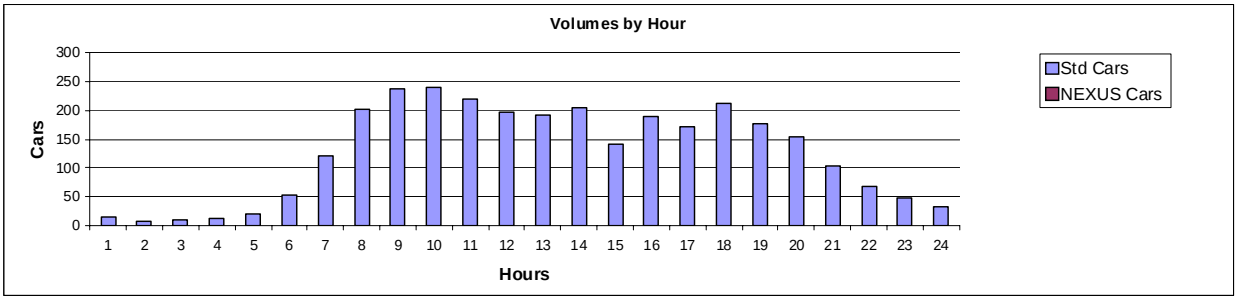
Appendix
Scenario 1 Base Case – no NEXUS
Never more than four lanes open

Changeable variables	
Linked or Calculated	
Std. Svc. Time Sec.	66
NEXUS Svc. Time	25.4
Arrival Factor	1.25
= 24 hr volume of	3,028
NEXUS share	20.0%

Hour 0-11	Std.	NEXUS	Hour 12-23	Std.	NEXUS
0:00	1	0	12:00	4	0
1:00	1	0	13:00	4	0
2:00	1	0	14:00	3	0
3:00	1	0	15:00	3	0
4:00	1	0	16:00	3	0
5:00	1	0	17:00	4	0
6:00	2	0	18:00	4	0
7:00	3	0	19:00	3	0
8:00	4	0	20:00	3	0
9:00	4	0	21:00	3	0
10:00	4	0	22:00	2	0

24-hr Measures		
Cummulative wait time	*min.*	*hrs.*
	40,919	682
No. of hours with a wait over	60 min.	0
Longest wait	31.8 min.	
Total booth hours	64	



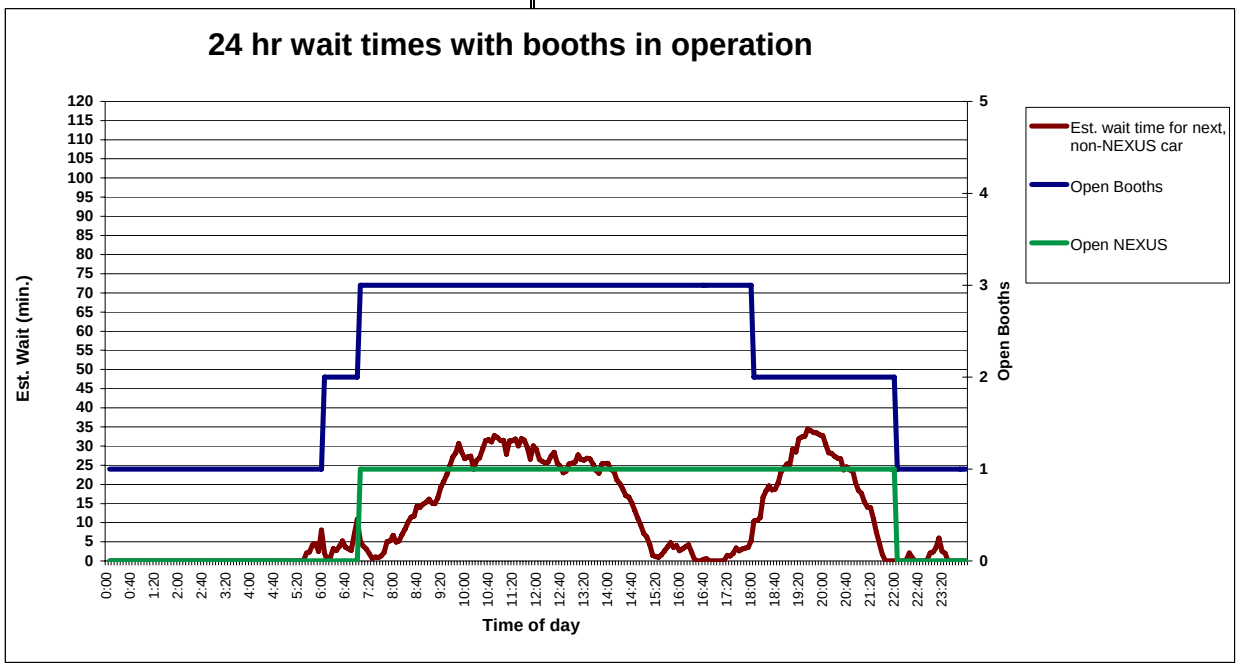


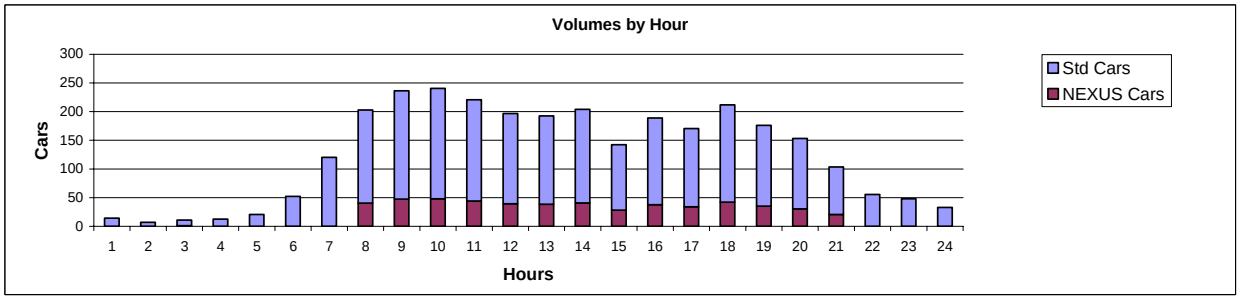
Appendix
Scenario 2 15 hours of a NEXUS lane
Never more than 4 lanes open
Nexus share of traffic is 20 percent

Changeable variables	
Linked or Calculated	
Std. Svc. Time Sec.	66
NEXUS Svc. Time	25.4
Arrival Factor	1.25
= 24 hr volume of	3,028
NEXUS share	20.0%

Hour 0-11	Std.	NEXUS	Hour 12-23	Std.	NEXUS
0:00	1	0	12:00	3	1
1:00	1	0	13:00	3	1
2:00	1	0	14:00	3	1
3:00	1	0	15:00	3	1
4:00	1	0	16:00	3	1
5:00	1	0	17:00	3	1
6:00	2	0	18:00	2	1
7:00	3	1	19:00	2	1
8:00	3	1	20:00	2	1
9:00	3	1	21:00	2	1
10:00	3	1	22:00	1	0
11:00	3	1	23:00	1	0

24-hr Measures			
Cumulative wait time		*min.*	*hrs.*
		37,577	626
No. of hours with a wait over	60	min.	0
Longest wait		34.5	min.
Total booth hours		66	





Appendix
Scenario 3 15 hours of a NEXUS lane
Never more than 4 lanes open
Nexus share of traffic is **25 percent**

Changeable variables		Hour 0-11	Std.	NEXUS	Hour 12-23	Std.	NEXUS
Linked or Calculated		0:00	1	0	12:00	3	1
		1:00	1	0	13:00	3	1
Std. Svc. Time Sec.	66	2:00	1	0	14:00	2	1
NEXUS Svc. Time	25.4	3:00	1	0	15:00	2	1
Arrival Factor	1.25	4:00	1	0	16:00	3	1
= 24 hr volume of	3,028	5:00	1	0	17:00	3	1
NEXUS share	25.0%	6:00	2	0	18:00	2	1
		7:00	3	1	19:00	2	1
		8:00	3	1	20:00	2	1
		9:00	3	1	21:00	2	1
		10:00	3	1	22:00	1	0
		11:00	3	1	23:00	1	0

24-hr Measures			
Cumulative wait time		*min.*	*hrs.*
		16,703	278
No. of hours with a wait over	60	min.	0
Longest wait		21.8	min.
Total booth hours		64