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An Update on Congestion Pricing Options for Southbound Freight at the Pacific Highway Crossing

Mark (Mark Christopher) Springer
Western Washington University

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Mark Springer, Ph.D.
College of Business and Economics
Western Washington University

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Border Policy Research Institute
Western Washington University
516 High Street
Bellingham, WA 98225-9110
(360)650-3728

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Introduction

As discussed in detail in Roelofs and Springer (2007), "congestion pricing" involves charging users a variable price for the use of transportation facilities: increased congestion leads to a higher price, while the price of the facilities declines when overall usage decreases. In the broadest sense, the rationale behind such an approach is to best allocate the scarce resource of transportation capacity. Congestion pricing therefore treats transportation capacity as simply another type of "good" to be purchased by the individual. As with oranges or lumber, an increase in demand or a decrease in supply results in rising prices, while a decrease in demand or increase in supply yields lower prices. With many congestion pricing applications, the supply of transportation capacity is fixed, so prices change primarily in response to changing demand. For example, the toll on a roadway that utilized congestion pricing would be greatest during morning and evening rush hours and much lower at 2:00 AM.

Most existing applications of congestion pricing in transportation are with regards to roadways and, to a lesser extent, bridges. A classic and early example of applying congestion pricing to manage roadway traffic is California's I-15 Value Pricing Project, in which underutilized HOV (high-occupancy vehicle) lanes were opened to single-occupancy vehicles (SOV) for a congestion-based fee. Traffic counts in the newly-renamed "HOT" (high occupancy/toll) lanes on I-15 were calculated for every six minute interval, and per-trip prices were adjusted based on this demand information. Prices were changed to maintain a "level of service" (LOS) of C or better, which implies busy but relatively free flowing traffic (Wilbur Smith Associates, 2005).

A more recent example may be found in Washington State, which transformed the HOV lanes on a section of State Route 167 to HOT lanes in the Spring of 2008. On SR 167, tolls are updated every five minutes to control the flow of traffic into the HOT lanes. As with I-15 in California, the goal is to allocate the excess capacity in the former HOV lanes without causing a lessening of service for traditional HOV and newly-enrolled HOT lane users: the enabling legislation for the SR 167 HOT lanes requires that average traffic speeds during the peak hours match or exceed forty-five mph ninety per cent of the time. Since the pricing scheme "sold" excess capacity in the HOT lanes to SOV users who would have otherwise used the general purpose (GP) lanes, congestion pricing helped increase the average lane speeds in *both* the HOT lanes and the GP lanes (WSDOT, 2009).

Close comparison of the HOT lane concept and the commercial freight situation at the Southbound Pacific Highway Crossing (PHC) led Roelofs and Springer (2007) to conclude that the crossing could benefit from the application of congestion pricing. A key reason for this tentative conclusion was the existence of an under-utilized inspection lane at the Southbound PHC. This lane was restricted to enrollees in the FAST, or Free and Secure Trade, program (USCBP, 2005). As with HOV programs for commuters, the FAST program was designed to encourage drivers to engage in socially-desirable behavior by rewarding them with shorter travel times. To qualify for FAST, carriers, drivers, and shippers need to follow certain security procedures which enhance the safety and security of the border. Trucks enrolled in FAST are then allowed to use a dedicated lane and inspection booth, thereby bypassing the potentially long queues in the general-purpose commercial freight lanes. While there had been no formal study of FAST utilization before 2006, anecdotal information seemed to indicate that the FAST lane and FAST inspection booth were grossly underutilized.

Roelofs and Springer (2007) consequently conducted a study that examined the potential costs and benefits of introducing congestion pricing to the Southbound PHC and allowing trucks not satisfying the FAST criteria to utilize the supposed excess capacity in the FAST lane. The current

project updates these results using more recently collected data. As discussed below, there were critical limitations to the data used to generate the results presented in Roelofs and Springer (2007). The current study therefore uses more recent data collected under more carefully controlled conditions to investigate the impact of adopting a congestion pricing scheme to allow toll-paying but non-FAST-qualified (NFQ) trucks to access the excess capacity in the FAST lane. As shown below, congestion pricing can indeed decrease overall waiting times at the Southbound PHC, but the likelihood of success depends on key external factors not entirely under the control of the U.S. Customs and Border Protection (USCBP) service.

Congestion Pricing in Practice: From Roads to Borders

Much like its more recent counterpart SR 167, the I-15 project possessed four key attributes of a successful congestion pricing application (SANDAG, 1999). First, there was congestion in the general-purpose lanes open to SOV traffic, creating a willingness on the part of some drivers to pay a toll to reduce travel time. Second, there was a restricted HOV lane, not open to general traffic, which possessed excess capacity. Therefore, it was possible to allow some SOV traffic into the HOV lane (now called the HOT lane) and ensure that no driver's travel time significantly increased: average travel time in the GP lanes would decrease since there would be fewer vehicles in those lanes, while the excess capacity in the HOT lane could absorb some SOV drivers without lengthening travel times.

The third element was the use of the dynamic toll to determine how many and which SOV drivers were to be allowed to join the HOT lane. As the HOT lane approached capacity, the toll would increase rapidly, effectively shutting off new SOV entrants as drivers became unwilling to pay the higher price. Maintaining rapid travel times in the HOT lane was critical not only to give paying SOV drivers a sense of value, but also to ensure that HOV drivers, who were helping the state fulfill a policy objective, did not feel that their sacrifices (the possible inconvenience of car-pooling) were being insufficiently rewarded. In addition, at each level the toll would select for entrance into the HOT lane those SOV drivers who placed the appropriate value on the reduced travel time of the HOT lane, i.e. who were willing to pay the toll.

The fourth attribute, which was important from a political standpoint, was the continued existence of an un-tolled alternative. The general purpose lanes were to remain open to SOV traffic free of charge, and therefore no one would be coerced into paying a toll. While economic theory shows that leaving an un-tolled option yields a "second-best" solution compared to a situation in which all drivers are tolled (Verhoef, Nijkamp, & Rietveld, 1996), it has been considered easier to muster the political will for congestion-based pricing if a free alternative remains available.

In 2006, the border crossing for commercial freight into the U.S. at Pacific Highway (SR 543) seemed to possess the first two attributes discussed above, thereby warranting an investigation into congestion pricing as a way to reduce overall border congestion. A 2003 study found the average waiting time per southbound truck over a four-day period in the summer of 2002 to be about half an hour (USDOT, 2003). Despite subsequent facility enhancements and a decrease in southbound commercial freight at the crossing, however, by the summer of 2006 security-oriented changes had increased overall processing times and doubled the waiting times for many trucks at the border (WCOG, 2007).

In addition, the primary facility enhancement at the Southbound PHC between 2002 and 2006 was the construction of a lane dedicated to trucks enrolled in the FAST, or Free and Secure Trade, program (USCBP, 2005). As mentioned in the introduction, carriers, drivers, and shippers could

qualify for FAST enrollment by following certain security procedures which enhance the safety and security of the border. Trucks enrolled in FAST are then allowed to use a dedicated lane and inspection booth, which due to limited FAST enrollment was expected to have a much shorter queue length and waiting time than the GP lanes used by all remaining trucks. Many people familiar with the Southbound PHC agreed that the FAST lane was grossly underutilized, thereby providing a potential source of capacity to "sell" to non-FAST-qualified trucks.

The 2006 Data Survey and Congestion Pricing Study

The Southbound PHC for freight therefore appeared to possess two key elements of a successful congestion pricing application: congested general-purpose lanes and an underutilized restricted lane. Allowing non-FAST-qualified (NFQ) vehicles to access the FAST lane for a dynamically-set toll could therefore help reduce overall congestion at the border. As noted by Roelofs and Springer (2007), the analogy between the FAST lane and an HOV lane is not perfect: it is possible to add SOV vehicles to an HOV lane without slowing down existing HOV traffic, while adding a single NFQ truck to the FAST lane will increase the wait time of arriving FAST-qualified vehicles. However, a maximum wait time could be specified, and the toll adjusted to ensure that the likely wait time of an arriving truck would not exceed this level. This would come close to satisfying the third element of a successful congestion pricing application. Finally, if at least one of the existing general-purpose lanes was left un-tolled, implementation of the toll would be easier politically.

Roelofs and Springer (2007) set out to examine congestion pricing alternatives using a simulation model of the Southbound PHC for commercial vehicles. In order to set the necessary parameters for arrival rates and inspection booth processing times, they used data gathered by a third party over a four day period in June 2006 (WCOG, 2007). During the preliminary data analysis and simulation experiments, both authors were surprised to discover that during each of the four days of data collection, approximately thirty-five per cent of the arriving trucks used the FAST inspection booth and were, therefore, apparently enrolled in the FAST program. The authors were aware that on one of the four days in question the FAST booth had been open all day to NFQ enrolled trucks due to extreme queue lengths in the general-purpose lanes, but the proportion of trucks using the FAST booth seemed to be roughly the same (thirty-five per cent) for each of the four days.

However, while the FAST booth was open all day to NFQ trucks on only one of the four survey days, for each of the remaining three days CBP personnel had been selectively admitting NFQ trucks into the FAST lane when the FAST lane seemed underutilized. Since these instances were not recorded, there was no record of the actual demand for FAST processing by FAST-qualified trucks at the crossing. This made it difficult to determine how much FAST lane capacity was actually available and what the expected costs and benefits would be of the different congestion pricing options examined in the study.

The 2009 Data Survey

The shortcomings of the 2006 data survey were rectified by a new data survey of the Southbound PHC in the summer of 2009 (IMTC, 2009). Specifically, when NFQ trucks were admitted into the FAST lane and FAST inspection booth, a distinction was to be maintained in the records between the FAST and NFQ trucks. This would allow an accurate count of the number of FAST trucks using the crossing, which is critical for estimating the capacity available for a successful congestion pricing application. Other problems with the 2006 data, such as an inability to match the

license plates of arrivals with those of departures for nearly one third of the trucks, were also somewhat rectified with more accurate data collection in 2009.

One new difficulty experienced with the 2009 survey data was the impact of observers on the inspection or service times for trucks in both the GP and FAST lanes. Over the four days of initial data collection for the Southbound PHC, observers were stationed in each of the inspection booths to aid in recording freight details for each vehicle. When inspection times collected over this period were compared to those collected on two separate days when observers were not present in the booths, they were consistently larger: the presence of the observers seemed to result in the inspectors taking additional time to do their tasks. Consequently, inspection times for the initial four-day period of observation were adjusted in an attempt to remove the effect of the observers. These adjusted inspection times were used in this study.

A quick summary comparison of the 2009 data with similar data collected in 2006 (WCOG, 2007) and 2002 (USDOT, 2003) shows two clear trends over the past several years: fewer trucks are heading south across the border at the PHC, and inspection times, which bumped up significantly following increased security procedures after 2002, have declined somewhat but remain above their earlier 2002 levels.

	2002	2006	2009
% FAST	NA	35%	23%
Arrivals/Hour	78	65	51
Inspect Time-FAST (Sec)	NA	86	75
Inspect Time-GP (Sec)	57	120	98

Table 1. Summary Data from Three Studies of Southbound PHC Freight

In addition, usage of the FAST lane in 2009 was much lower than that recorded in 2006, when both FAST and NFQ trucks were allowed access to the FAST lane. In 2009, although data observers were prepared to record instances of NFQ trucks using the FAST lane, very few (twenty-five trucks over four days) such instances occurred. The 2009 figure of 22.5% (rounded to 23% for Table 1) is therefore the first reliable estimate of FAST enrollees using the Southbound PHC.

The lower level of FAST enrollment than was erroneously recorded in 2006 is important, since this lower enrollment makes it more likely that the Southbound PHC would possess the second attribute of a successful congestion pricing scheme: excess capacity in the FAST lane available for sale to NFQ vehicles. Furthermore, the decline in overall arrivals per hour would also free up FAST capacity, since a constant fraction of that demand constituted FAST demand. However, the dramatic drop in demand could also lower overall congestion in the GP lanes, lessening the need for NFQ trucks to pay to access the FAST lane. This drop in demand, a cause of both economic and security conditions, can be clearly seen in the annual truck volumes recorded over the past ten years, as shown in Figure 1. Since border traffic can be expected to recover along with the economy, however, a key focus of our study is the impact of potential future changes in FAST enrollment and overall traffic volumes on the desirability of congestion pricing at the border. In order for the first two attributes of a successful congestion pricing application to be satisfied, traffic must be high enough to generate congestion in the GP lanes, but not so high as to leave no excess capacity in the FAST lanes.
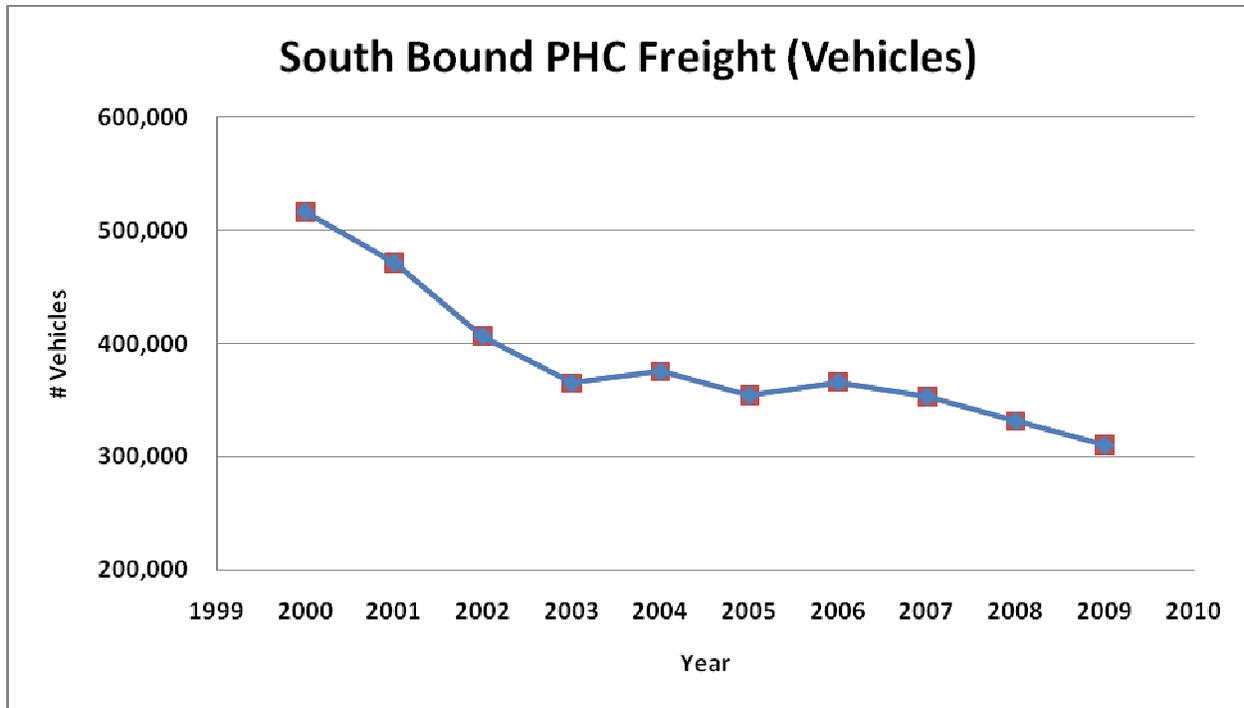
**Figure 1. Annual Number of Southbound Commercial Vehicles
at the Pacific Highway Crossing**

Current Border Operations

At the time of the 2009 study, the Southbound PHC border configuration was essentially unchanged from 2006, when the previous study was conducted (Springer and Roelofs, 2007).   As in 2006, we are concerned with the stretch of road beginning sixteen hundred linear meters north of the border. For twelve hundred meters of this approach, NFQ trucks are restricted to the curb lane; during the remaining four-hundred-meter approach, these same trucks are routed through a series of lane splitting and re-merging before being directed into two lanes approaching the GP booths. In the initial twelve hundred meter segment, FAST traffic bypasses any waiting NFQ trucks in a passing lane open to FAST trucks and all non-truck traffic; four hundred meters from the border, the remaining non-truck traffic splits off to a separate lane and FAST trucks continue on a lane to a booth dedicated for their use. Finally, at each of the FAST and GP booths, the truck immediately behind the one currently being inspected must wait several meters upstream of the booth. When the truck being inspected leaves, there is a short transition time required for the next truck to pull up to the booth.

While the border operation and therefore the essential structure of the simulation model did not change from the study of 2006, key system parameters did change and were incorporated into the simulation model. The arrival time distribution, the distribution of vehicle types, the inspection and transition time distributions for each vehicle type, and the percentage of FAST enrollees were all estimated based on the 2009 data.

Future Border Operations

Our key interest is in evaluating the performance of a Southbound PHC configuration which converts the existing FAST lane to a combined FAST/toll lane; this would leave two GP "free" lanes for all other freight traffic. Trucks unable or unwilling to enroll in FAST would therefore have the option to pay for a shorter wait time. All Southbound PHC trucks would therefore see continuously-updated information boards on the approach to the border stations listing the following information: the expected wait time for each type of lane, and the current price per vehicle for joining the FAST/toll lane. This information board should be available to trucks no later than the beginning of the sixteen-hundred-meter approach to the border. NFQ trucks that opted to pay the toll would then follow the route now taken by the FAST trucks. The information board would display two wait times – one for the two "free" booths and one for the FAST/toll booth – and one toll price. The driver's (or dispatcher's) decision on whether or not to pay the toll would depend on the expected difference in waiting time and the value he or she placed on time.

In addition to this possible tolling configuration, we will also examine two other scenarios which do not involve congestion pricing. First, we will consider the current scenario: two GP booths, and a single booth reserved for FAST enrollees. Second, we will consider a scenario which opens the FAST booth to all traffic, i.e. creates three booths served by a single truck lane. Our primary performance measures for each of these systems will be the expected and maximum waiting times for FAST-qualified and NFQ vehicles.

For each of these configurations, we will assume that the distributions of vehicle types, service times, and transition times remain at the levels observed during the 2009 data survey. Our key concern, therefore is how possible future changes in traffic volume and FAST enrollment could impact the relative performance of each of the three scenarios under consideration.

Results: Current Border Operations

It is reasonable to consider 2009, during the midst of the "great recession," as a low point in cross-border freight traffic. We will first consider, as a baseline scenario, what would happen if overall freight traffic increases towards the levels recorded in 2001 and all other system parameters remain unchanged. The results are presented below in Figures 2, 3 and 4. All reported results are based on a fourteen hour day starting at 7:00 AM and ending at 9:00 PM, and all waiting times are expressed in minutes.

It is clear that under the current traffic levels, there is not only relatively little waiting in the FAST lane (0.99 minutes average), but that the average waiting time in the GP lane is also relatively low (7.59 minutes average). Of course, these are averages: the maximum waits over a single simulated day are much larger (8.32 for FAST, 31.02 for GP). In addition, the traffic volume from day to day does vary, and a small ten per cent increase in traffic can increase the average and maximum waits in the GP lane to roughly fifteen and fifty minutes, respectively. However, the general conclusion is that while at current levels there is certainly capacity available in the FAST lane, there might not be much need for NFQ trucks to pay to avoid the GP lane.

If traffic volumes were to increase towards year 2000 levels (2000 traffic volumes are 66% higher than those of 2009), however, the current configuration would become overwhelmed without additional capacity or a shortening of inspection times. While FAST waiting times stay within reason, waiting times for trucks in the GP lanes average as high as two and a half hours, with maximum waits of five hours. As demand increases from its current level, therefore, there would likely be strong demand for tolled access to the FAST lane if it were available.
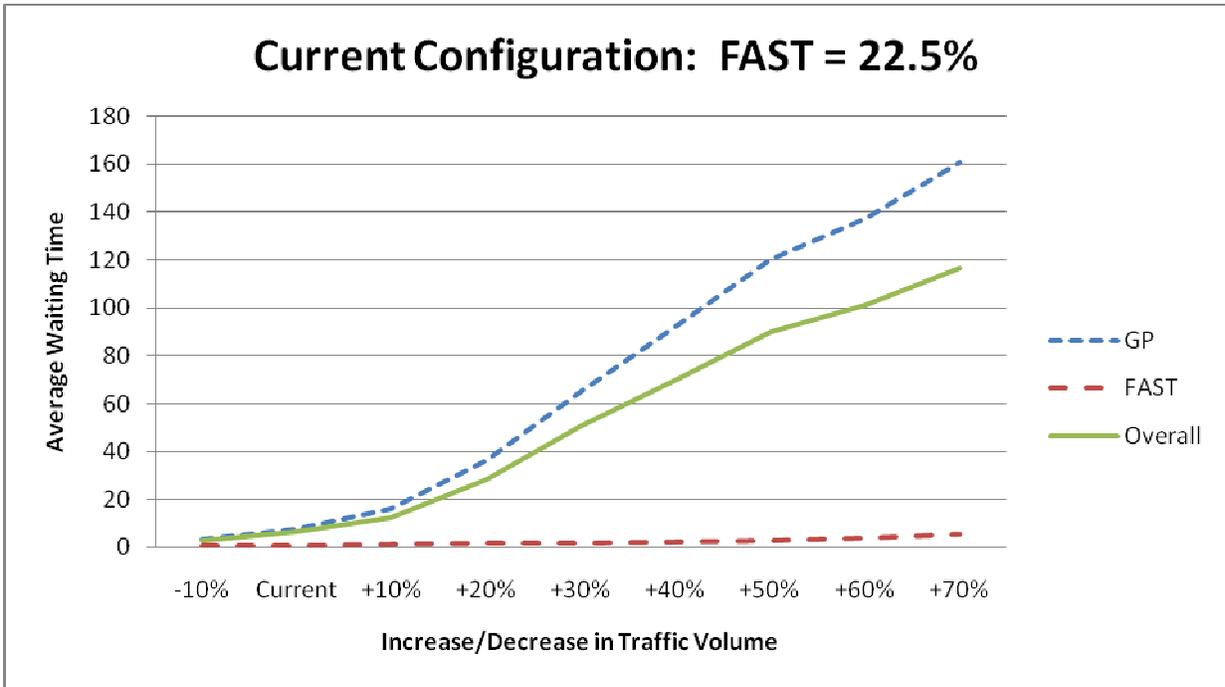
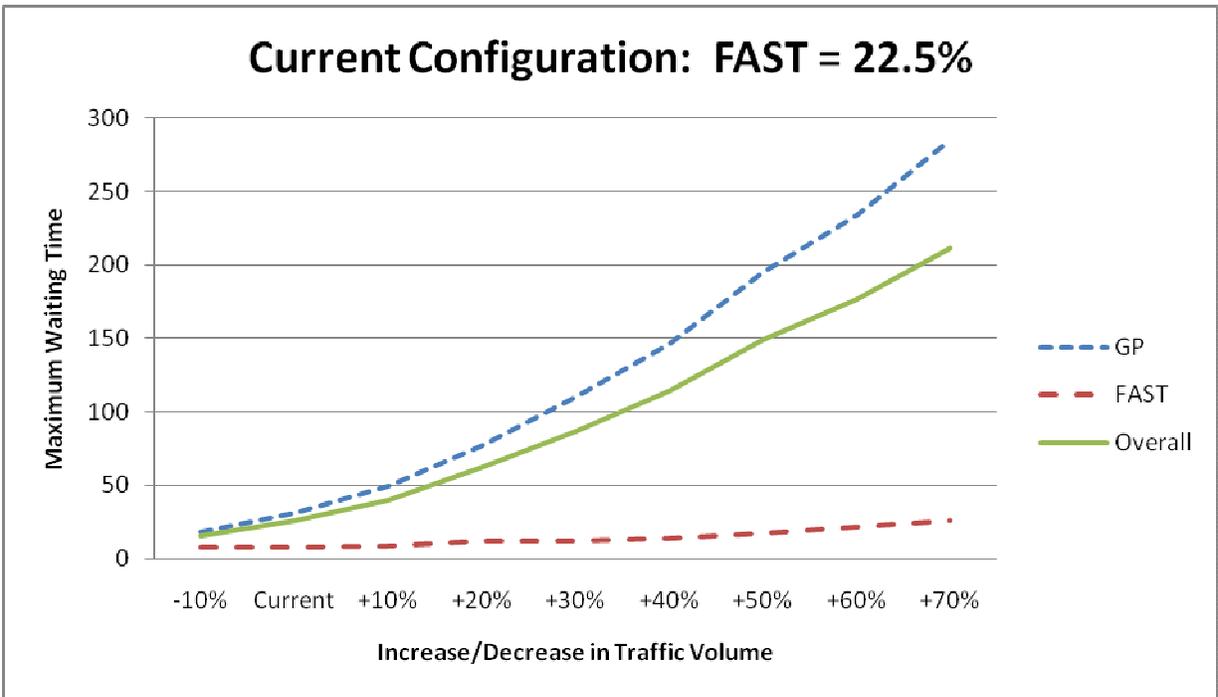**Figure 2: Impact of Traffic Volume on Average Waiting Time for Current Border Configuration**

Figure 3: Impact of Traffic Volume on Maximum Waiting Time for Current Border Configuration
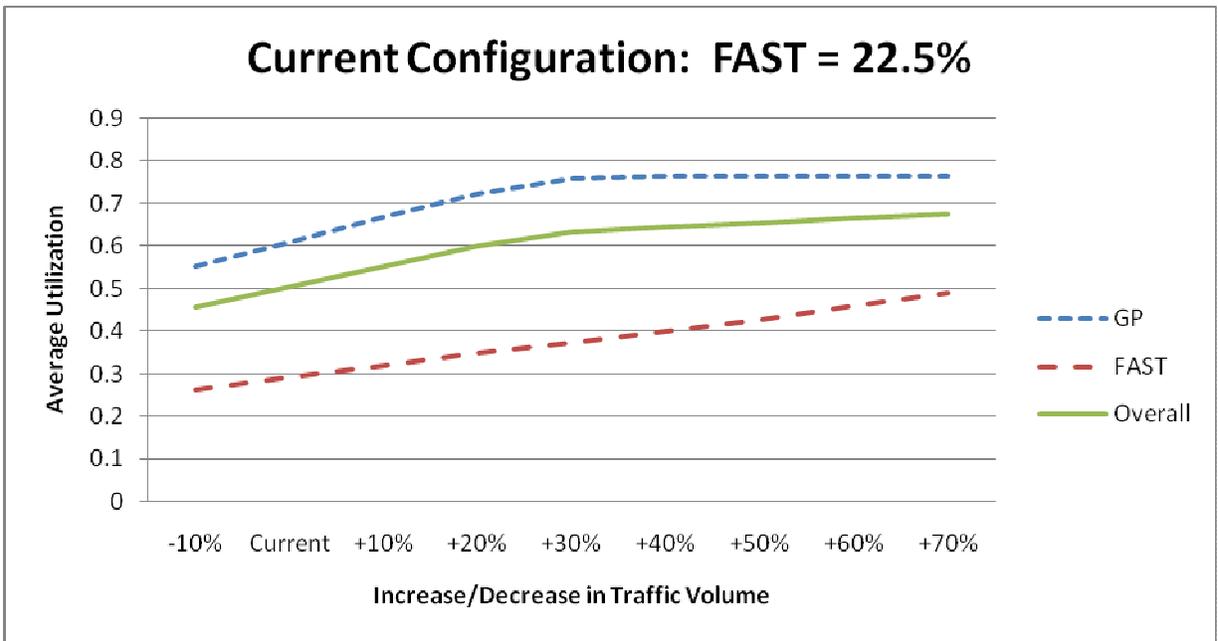
**Figure 4: Impact of Traffic Volume on Booth Utilization
for Current Border Configuration**

Finally, as a side issue, the utilization rates shown in Figure 4 illustrate the impact of transition times on congestion. Recall that the transition time is the time required by each truck to pull into the booth after it is cleared of the previous occupant. While this may seem to be a minimal item (less than thirty seconds, on average for GP trucks), it occupies a significant portion of the inspector's time and causes the booth utilization to reach a maximum of less than eighty percent. That is, for over twenty percent of his or her time, the inspector is waiting for the previous truck to leave and the next truck to pull into place.

Also of interest, in addition to the likelihood of an increase in border traffic, is the possibility of changing enrollment in FAST. Figure 5 shows, at current traffic levels, what the anticipated change in average wait times would be for the FAST and GP lanes if FAST enrollment changed by various percentages. Presumably, policy makers would like to see FAST enrollment increase, since according to the program design this would enhance border security. Clearly, however, since only one of the three southbound lanes is dedicated to FAST, as FAST enrollment approaches one third of all border traffic, the benefit of FAST enrollment for carriers declines.

As figure 6 shows, the same phenomenon occurs at higher traffic levels, although the increased traffic ensures that the gap between the FAST and GP average waits remains relatively large until the crossover point is reached. At roughly 2006 traffic levels, a twenty per cent increase in FAST enrollment still yields a twenty minute difference in average waiting time between the FAST and GP lanes.
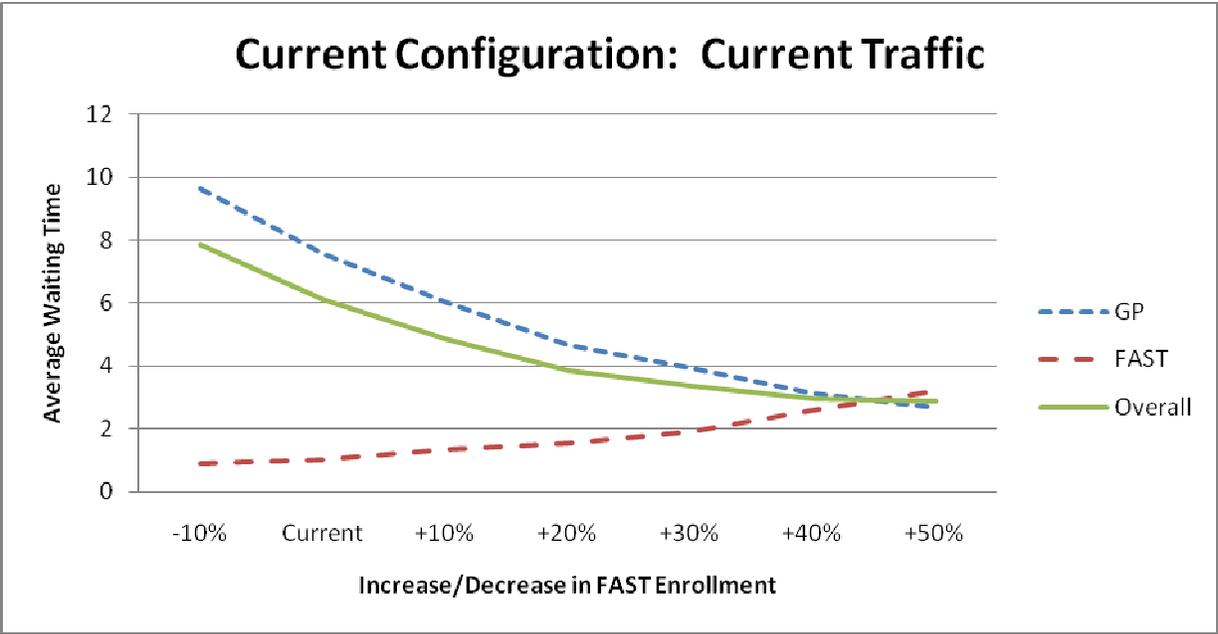
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Figure 5: Impact of FAST Enrollment on Average Wait Times for Current Border Configuration
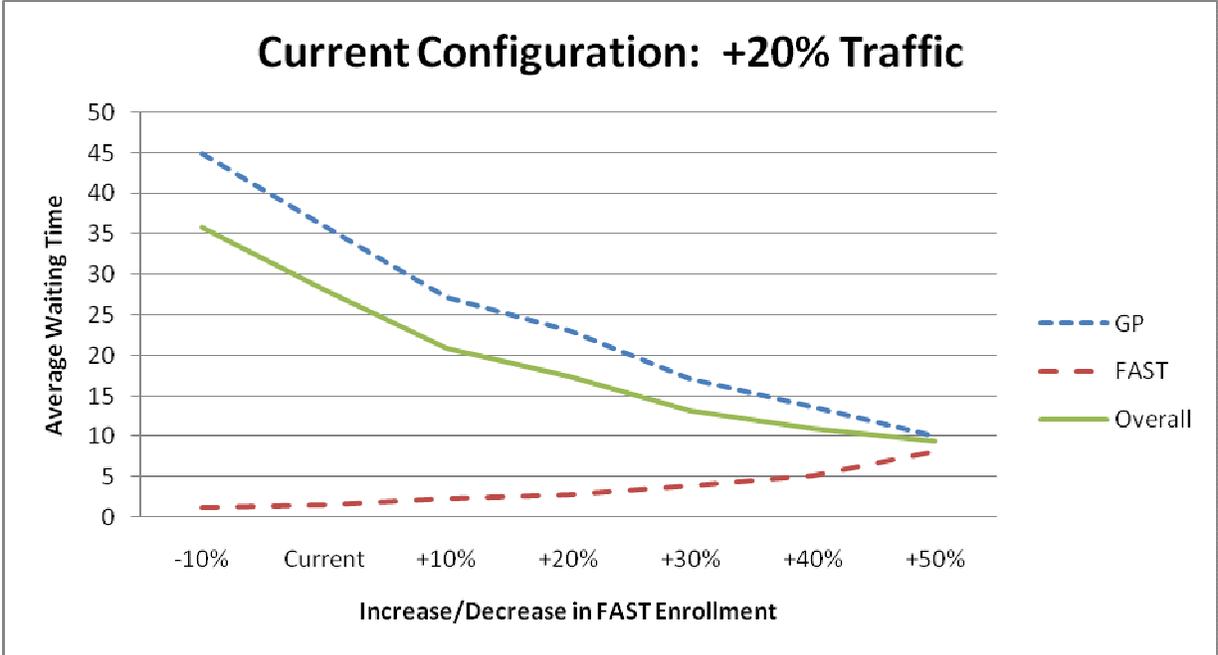

Figure 6: Impact of FAST Enrollment on Average Wait Times for Current Border Configuration Combined with Added Traffic

In short, the performance of the current border configuration is extremely susceptible to both traffic volumes and FAST enrollment levels. Currently, southbound traffic at PHC is at very low levels, resulting in low wait times for the GP lanes as well as for the FAST lane. At current traffic volume, therefore, there might not be much demand among NFQ trucks to pay a toll to access the FAST lane. That situation would likely change, however, if traffic increased to pre-recession levels. Furthermore, to ensure that there is excess capacity in the FAST lane to "sell" to NFQ toll-paying trucks, it is necessary for FAST enrollment to not exceed some amount, which somewhat contradicts the presumed goal of increasing FAST enrollment.

Results: Changing the GP Lane to a FAST Lane

For comparison, before examining the results of the tolling scenario, we will consider the situation where the FAST lane is eliminated and all three existing lanes are dedicated to GP traffic. The current low level of utilization of the FAST lane has led to discussion of this alternative, although as one can probably guess from the preceding discussion, the efficacy of this decision depends heavily on traffic levels. Figure 7 shows how the average and expected waiting times of all vehicles could be expected to change as traffic volume increased. Of course, opening all three lanes to GP traffic decreases average waiting times across all vehicles below average waiting times of the current configuration for all levels of traffic volume. At higher traffic levels the difference is significant: at 2000 traffic levels, changing the FAST lane to a GP lane would decrease average waiting time by more than fifty minutes. However, the enhanced security benefits of FAST would be lost as the 22.5% of trucks currently using the FAST program would no longer have any incentive to remain in the program.
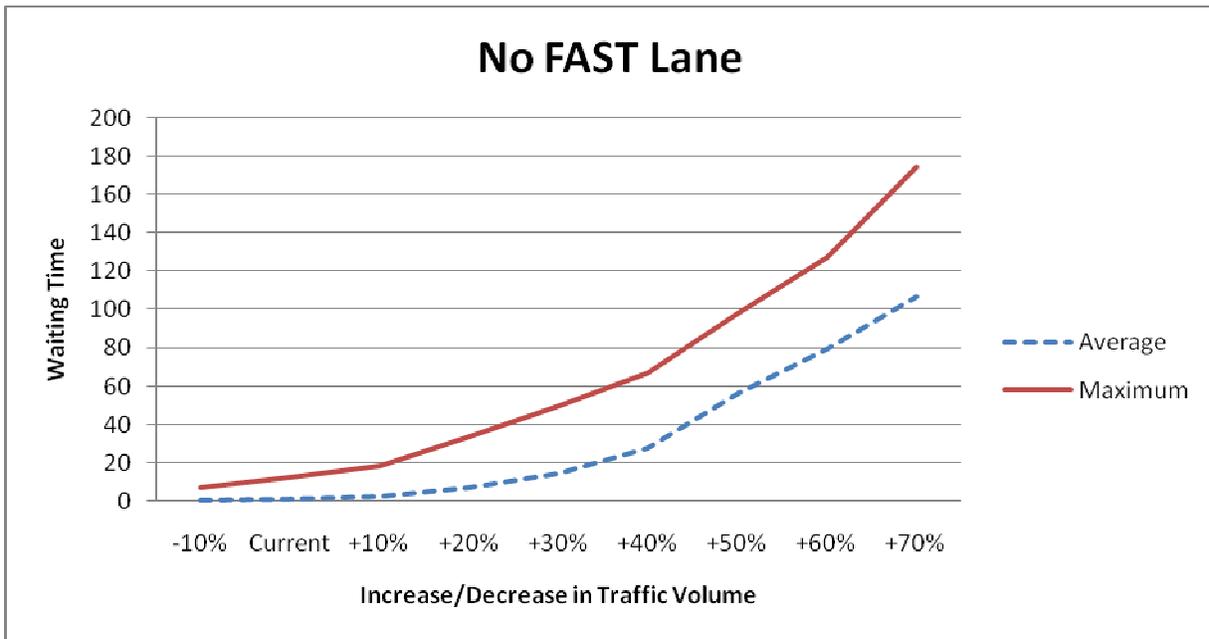

Figure 7: Impact of Traffic Volume on Average and Max Wait Times for No FAST Lane Configuration

Results: Congestion Pricing

We now consider a congestion pricing scenario, where the FAST lane is open not only to FAST-qualified trucks but also to NFQ trucks willing to pay a dynamic toll. As mentioned above, NFQ trucks approaching the border would receive information on the expected waiting times for both the FAST/toll and GP lanes, as well as the current price for joining the FAST/toll lane. While toll-paying vehicles are processed in the same booth as FAST-qualified vehicles, their inspection times are longer since they are subject to a more rigorous inspection process (their inspection times are drawn from the same distribution used for trucks passing through the GP lane).

The algorithm for dynamically adjusting the toll, and the parameters used to adjust its performance, are discussed more fully in Roelofs and Springer (2007). Relying on the experiments described in the aforementioned work, parameter values for this study were chosen based on practicality, fairly conservative policy goals, and performance. For example, as a practical matter the toll was set to be updated every five minutes, and to be changed in increments of five dollars. From a conservative policy standpoint, the parameters were set to ensure, if possible, that users of the FAST lane had a ninety-eight per cent chance of waiting less than thirty minutes. Other, technical algorithmic parameters, such as the smoothing parameter, were set based on their ability to yield consistent results.

In addition, two changes were made to the algorithm to enhance its performance. First, a shut-down capability of the tolling option was introduced based on the experience of certain HOT lanes. If border congestion becomes extremely high, some NFQ drivers may become willing to pay exorbitant prices to access the FAST lane, thus causing its performance to deteriorate well below its goal. In these situations, the current model shuts down tolled access to the FAST lane until the situation improves. Second, a restricted variable step size was introduced to allow the dynamic toll to change more quickly in the face of rapidly changing conditions. While a continuously variable step size, such as that advocated by the authors of a study of Washington's SR 167 (Wang and Zhang, 2009), is more algorithmically efficient, drivers approaching the border with an insufficient appreciation of queueing theory will be resistant to dramatic price swings. Most practical algorithms therefore limit the extent to which the price can change in a single update interval; this simulation has adopted five possible step sizes as a compromise between the theoretically optimal and the politically feasible.

As with the current and "no FAST" configurations examined above, we are interested in the impact of traffic volume and FAST enrollment on the viability and desirability of adopting a congestion pricing scheme at the southbound PHC. Another key factor which impacts success is the value that drivers and carriers place on time: the higher the hourly Value of Travel Time (VOTT), the more likely that NFQ trucks will opt to pay a toll to join the FAST lane. As mentioned in Roelofs and Springer (2007), there have been various studies to determine this hourly amount, and in this project we use the conservative value of fifty dollars per hour as our base assumption on the VOTT.

Figures 8 and 9 show the average and maximum wait times for the congestion pricing scenario as traffic volume varies from ten per cent below its current level up to seventy per cent above 2009 levels. The level of FAST enrollment is assumed to remain at its current level, i.e. 22.5%, and the VOTT averages fifty dollars. Note that the waiting times of the FAST-enrolled trucks is shown separately from that of the NFQ toll-paying trucks that access the FAST lane; the latter tends to be smaller than the former, since the toll-paying trucks are more likely to enter the FAST lane when the FAST line is shorter. Furthermore, comparing these results to Figures 2 and 3, which show the
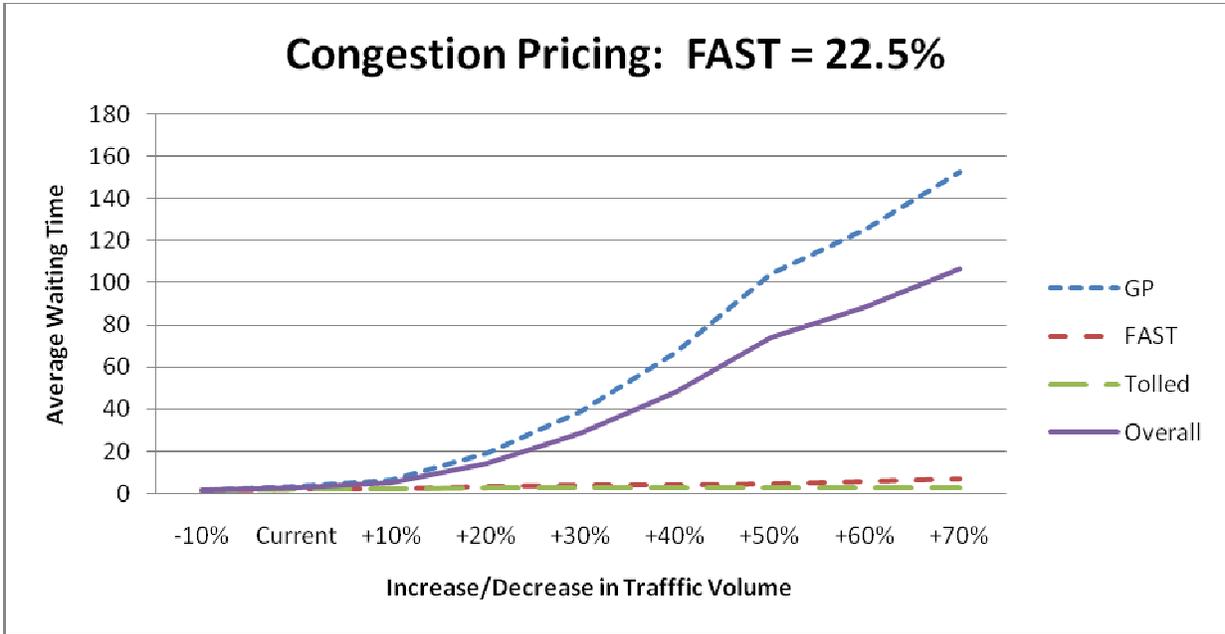
Figure 8: Impact of Traffic Volume on Average Wait Times for Congestion Pricing Option
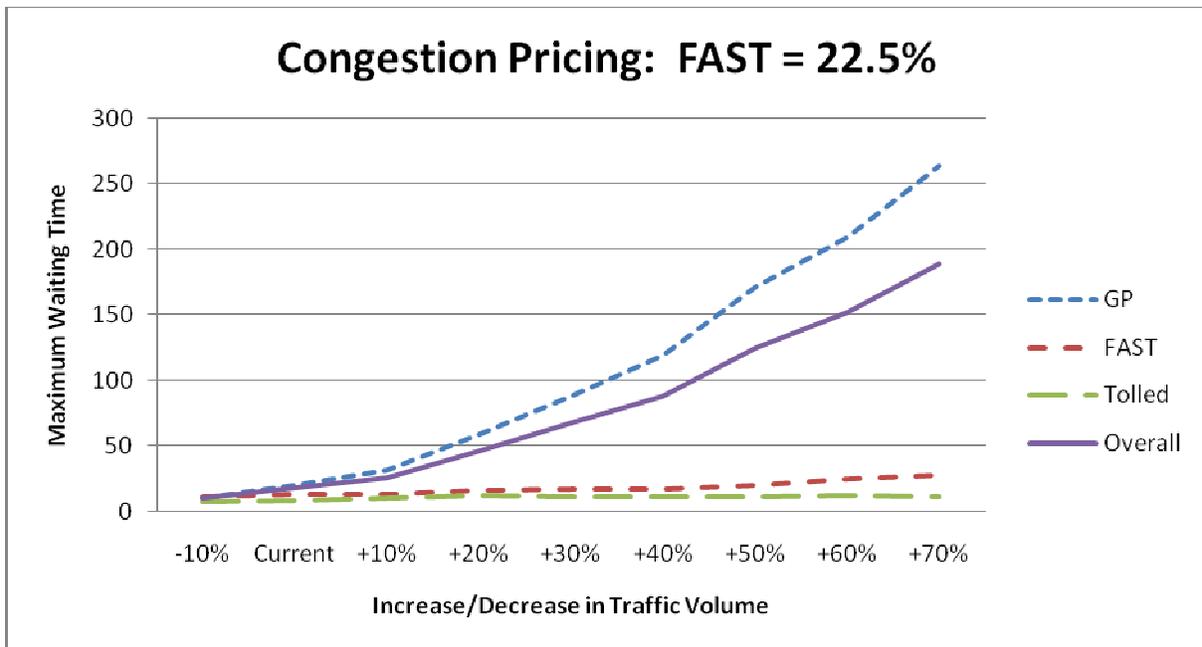
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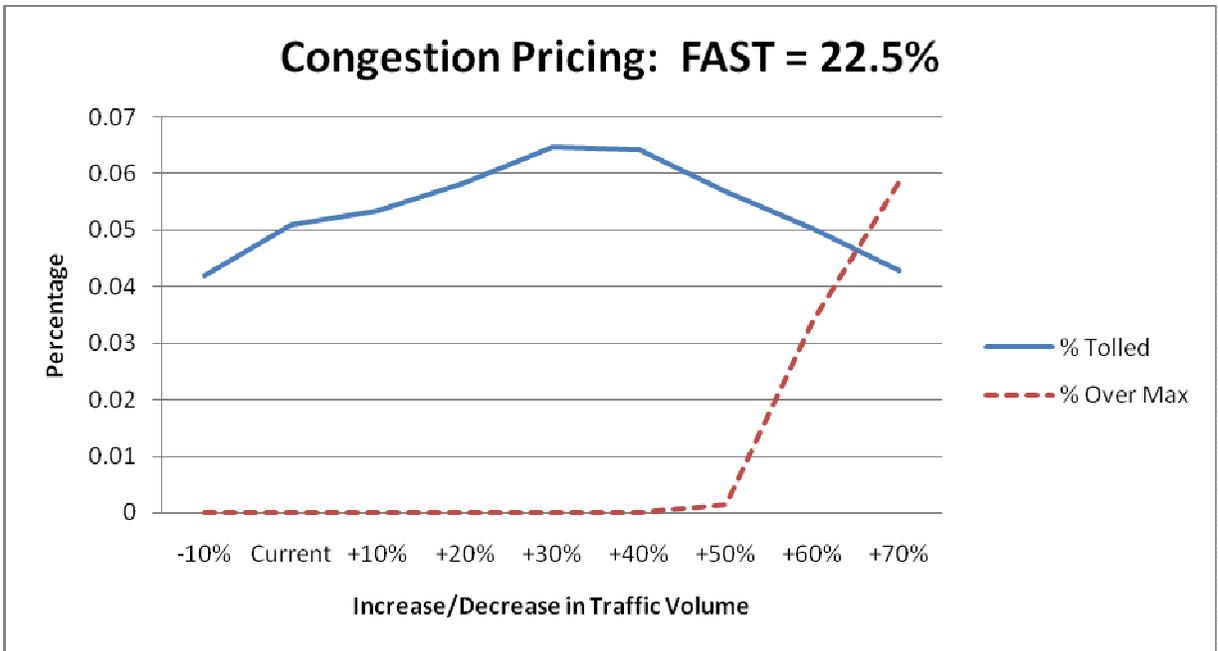**Figure 9: Impact of Traffic Volume on Maximum Wait Times for Congestion Pricing Option**

**Figure 10: Percentage of All Vehicles Paying Toll & Percentage of all
FAST Lane Vehicles Exceeding 30 Minutes of Wait Time**

same quantities for the current border configuration, one can see that waiting times for FAST trucks are only slightly higher after tolling is introduced, while the waiting times in the GP lanes have improved by a larger margin. This is due to a small fraction of the GP traffic paying to access the excess capacity in the FAST lane

Figure 10 shows what fraction of the total traffic is paying the toll. At low levels of traffic, where the waiting-time differential between the FAST and GP lanes is small, only four per cent of the trucks are paying to access the FAST lane. As traffic and congestion increase, this percentage increases to a maximum of nearly six and half per cent when the traffic is thirty per cent over 2009 levels. As traffic volume increases beyond that, however, the ability of the FAST lane to provide excess capacity declines, as can be seen by the increase in the percentage of FAST lane users (FAST-enrolled and NFQ toll-paying) that are exceeding the target maximum waiting time of thirty minutes. These larger waits are mostly the result of increased FAST traffic; the declining number of toll-paying trucks that are able and willing to enter the FAST lane are admitted only during the few short periods of relative slack. These trucks do pay an increasingly steep toll, however, as can be seen in Figure 11.
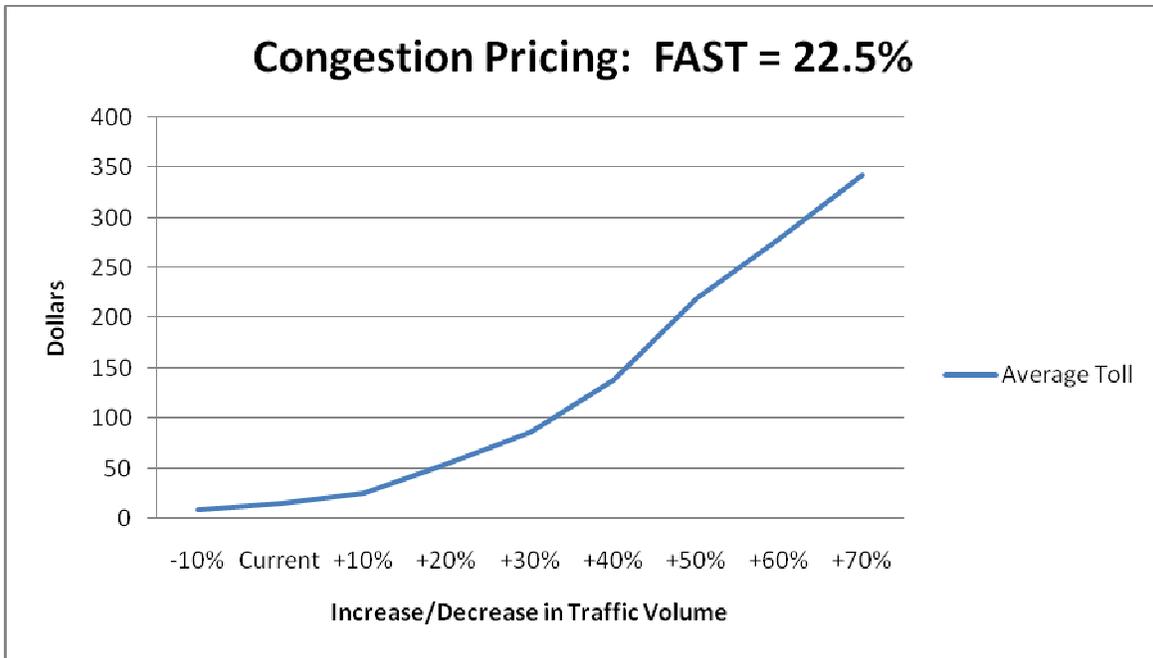
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Figure 11: Average Toll Paid to Enter FAST Lane.

Figures 12 and 13 show the impact of changing FAST enrollment on the average waiting time and participation in the tolling option. The results are shown for a scenario where traffic volume has increased to twenty per cent above its 2009 level. In Figure 12, the pattern of a declining gap between GP and FAST performance as FAST enrollment increases is similar to that seen in Figure 6 under the current configuration. This is not a surprise: more FAST enrollment means longer waits in the FAST lane, and fewer trucks and smaller waits in the GP lane. However, the drop in average waiting times for trucks in the GP lane as FAST enrollment increases is less steep under a congestion pricing scheme, primarily since the average waiting times for trucks remaining in the GP lane will be less for lower levels of FAST enrollment in a congestion pricing scenario. Congestion pricing at this level of traffic will therefore tend to lower GP lane waiting times at levels of FAST enrollment up to twenty or thirty percent higher than current levels, but an increase in enrollment beyond that will yield GP waiting times similar to the current border configuration. At these higher levels of FAST enrollment, the FAST lane has little excess capacity and few NFQ toll-paying vehicles can be admitted from the GP lane (see Figure 13).

Finally, consider the impact of the third key external factor: the value of travel time. We once again assume that FAST enrollment is at its current level, 22.5%. However, suppose that the hourly VOTT is one hundred dollars, rather than fifty dollars. By comparing Figure 14 with Figure 11, we can see that if trucks place a higher value on VOTT, the average toll paid increases. However, the main impact this has on the non-monetary aspects of the system is to increase use of the FAST lane at lower levels of traffic volume. Comparing Figure 15 with Figure 10, we see that with the higher VOTT, more trucks are likely to opt for the toll when traffic volume is low. At higher traffic volumes, however, the greater value placed on time cannot create additional capacity in the busy FAST lane, and the fraction of toll-paying trucks remains similar to what it was with the lower value of VOTT. The waiting time profile at the higher VOTT, shown in Figure 16, is also similar to that corresponding to the lower VOTT value (Figure 8).
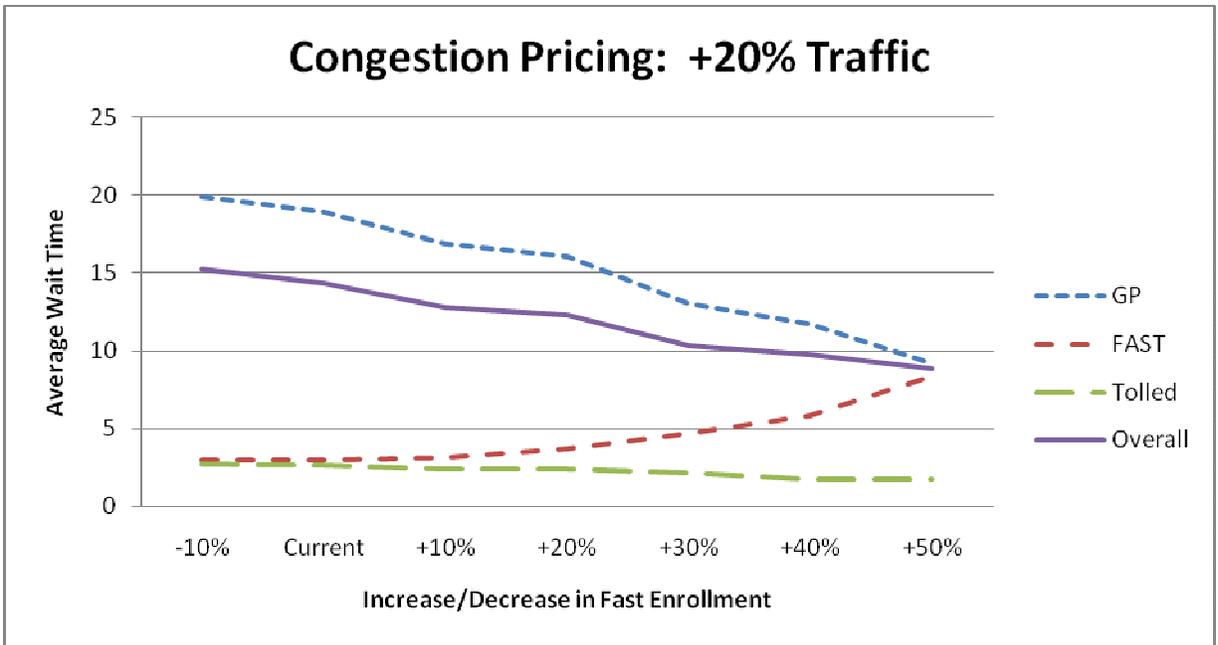
Figure 12: Impact of FAST Enrollment on Average Wait Times for Congestion Pricing Option
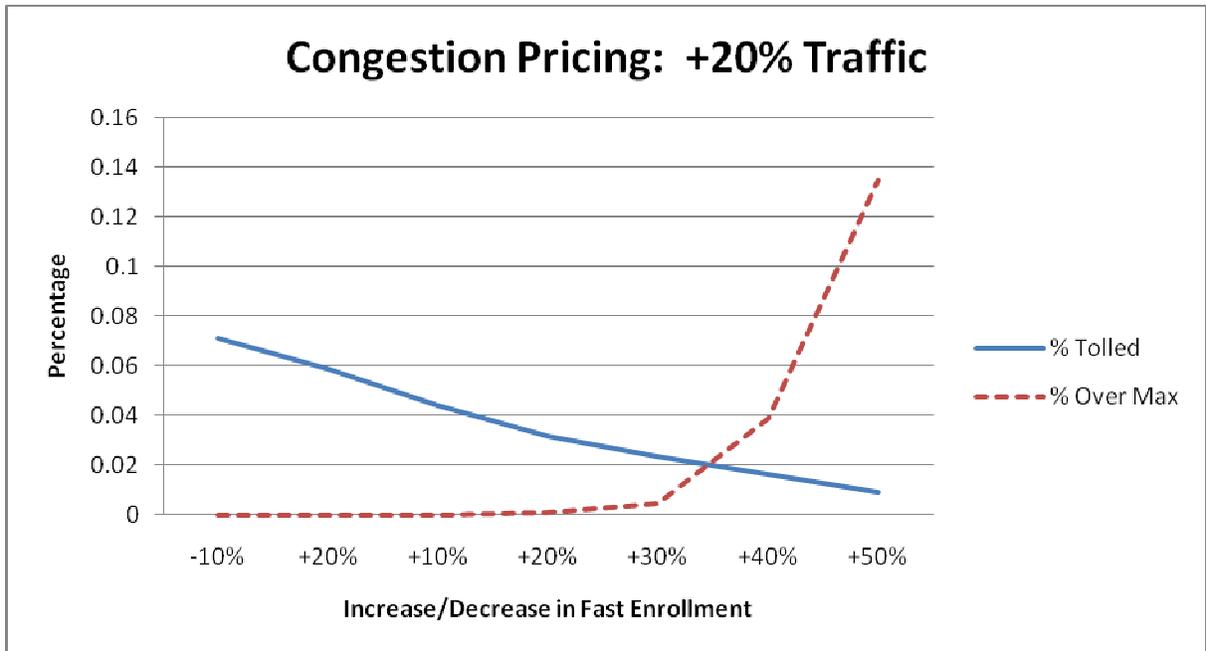

Figure 13: Impact of FAST Enrollment on Percentage of All Vehicles Paying Toll & Percentage of all FAST Lane Vehicles Exceeding 30 Minutes of Wait Time
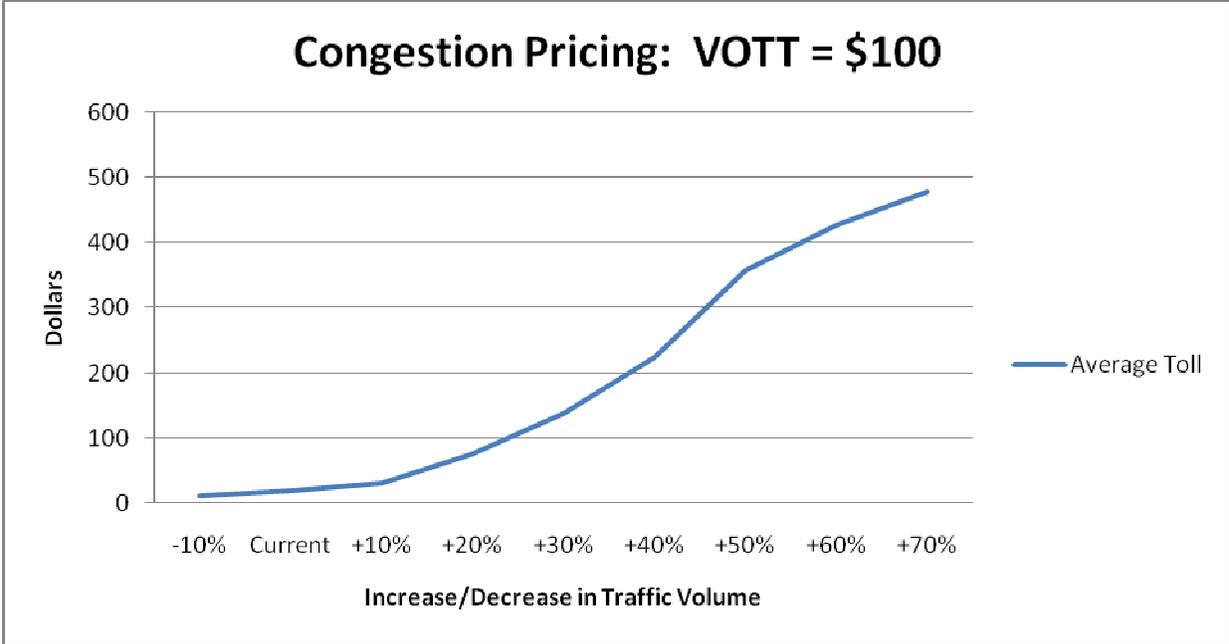
Figure 14: Impact of Traffic Volume on Average Daily Toll.
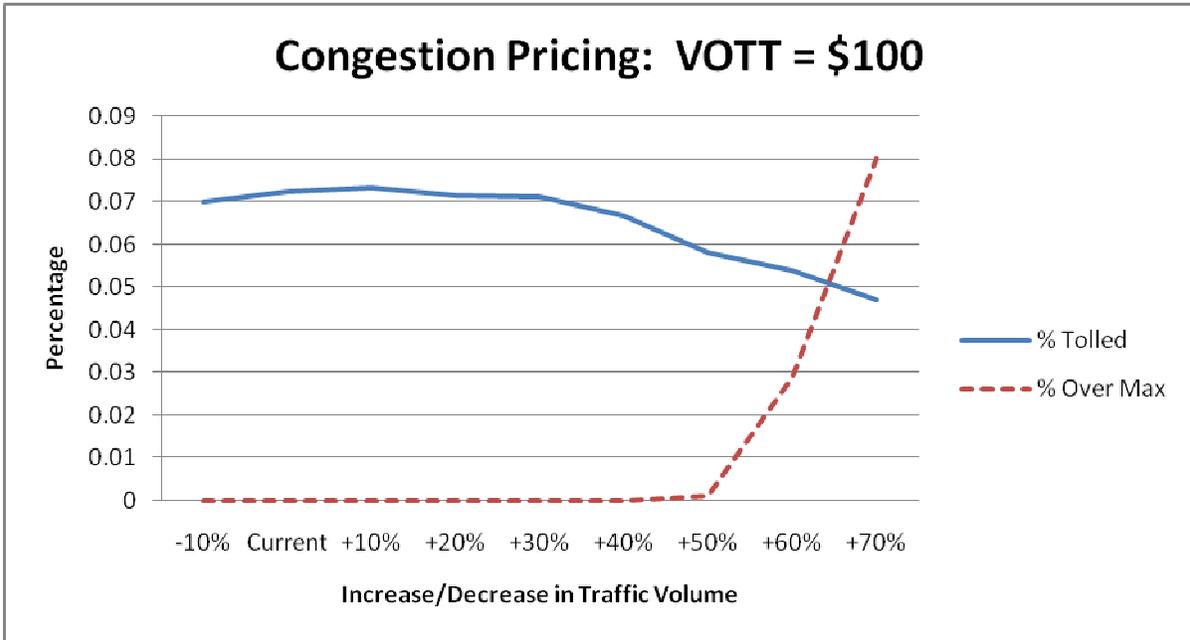

**Figure 15: Impact of Traffic Volume on Percentage of All Vehicles Paying Toll &
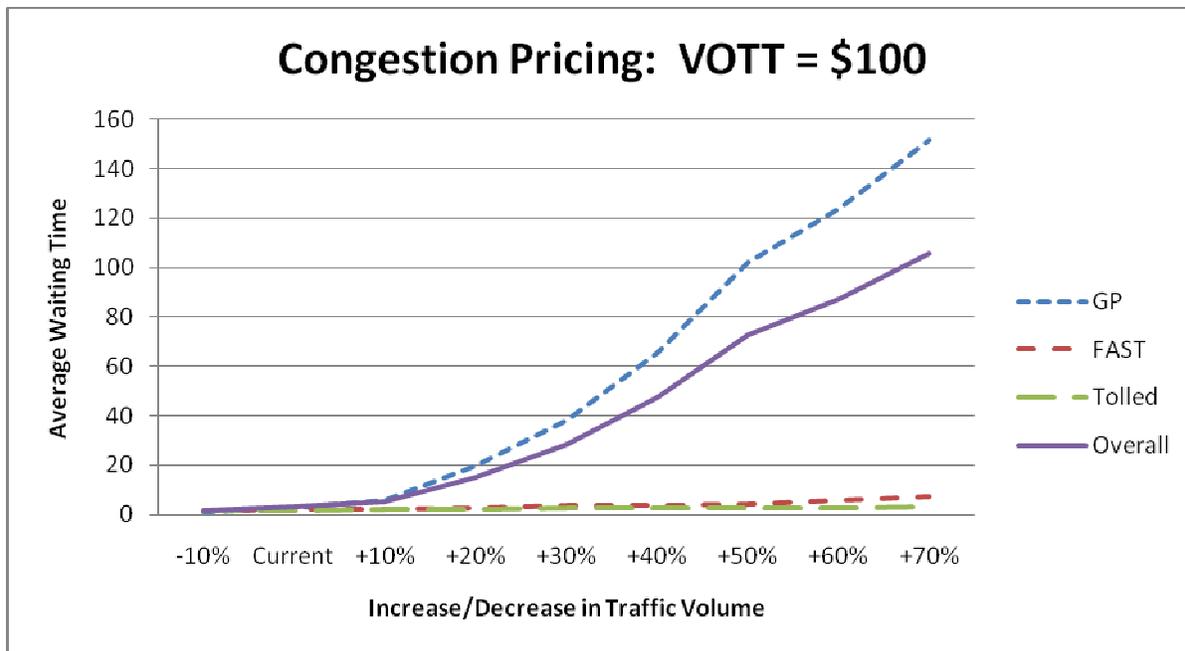Percentage of all FAST Lane Vehicles Exceeding 30 Minutes of Wait Time**

**Figure 16: Impact of Traffic Volume on Average Wait Times
for Congestion Pricing Option**

Conclusion

For a congestion pricing implementation to be successful, two key elements are the presence of congestion in the existing general purpose lanes, and excess capacity in a previously "restricted" lane that can be "sold" to users of the general purpose lanes to selectively increase overall system throughput. At the Southbound Pacific Highway Crossing for freight, there are two general purpose inspection booths open to all freight traffic, and a lane and booth restricted to serving FAST-qualified vehicles. Under favorable conditions, therefore, opening the FAST lane and booth to toll-paying non-FAST-qualified vehicles could lower waiting times for vehicles in the general purpose lanes without appreciably increasing waiting times for FAST-enrolled vehicles. Two of the factors determining these conditions are beyond the control of U.S. Customs: overall traffic volume and the value of travel time (VOTT) experienced by carriers and their drivers. The general performance of a potential congestion pricing implementation does not seem to be drastically impacted by possible changes in the VOTT over the likely range of possible values. A higher VOTT means higher tolls (and greater revenue) and greater toll utilization at lower traffic volumes, but these differences are not overly dramatic.

Changing traffic volumes, however, can have a dramatic effect on the viability of a congestion pricing implementation. To a much greater extent than commuter traffic between suburbs and the urban center, cross-border freight traffic is extremely sensitive to economic conditions. Traffic levels were approximately sixty-six per cent higher in 2000 than in 2009. If traffic levels were to increase toward year-2000 levels, and inspection times were to stay at their current level, the result would be monumental backups at the border. At 2000 traffic levels, without additional system capacity, the benefit of a congestion pricing implementation would be limited: there would be less capacity in the FAST lane to sell to NFQ trucks in the GP lane. Conversely, there is also less benefit in a congestion pricing implementation at current or lower traffic levels, as there is simply not

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enough of a waiting time differential between the FAST and GP lanes to generate sufficient interest in paying a toll. It should be noted, however, that a higher VOTT would make a difference here, making congestion pricing a desirable option at lower traffic levels.

Given the three-booth configuration at the border, the "best" level of traffic volume for a congestion pricing implementation would seem to be at traffic volumes twenty to fifty per cent higher than those found in 2009. At this level of traffic, and assuming a rather conservative VOTT, the waiting time differential between the GP and FAST lanes would likely encourage many NFQ trucks to pay a toll to access the FAST lane. While the percentage of all vehicles choosing to pay a toll would not be large, it would result in dramatic time savings for the toll-paying vehicles and modestly reduce average waiting times for all vehicles that remain in the GP lane.

Finally, the remaining key external variable is one over which U.S. Customs has some control, namely the fraction of trucks qualified for FAST. The current level of FAST usage, 22.5%, provides for some excess capacity to be sold to NFQ trucks without significantly increasing FAST waiting times. However, if FAST enrollment were to increase significantly, there would be less capacity available for NFQ toll-paying trucks and less likelihood of a successful congestion pricing implementation. Presumably, system designers did not anticipate FAST enrollment surpassing thirty-three per cent, as with only one of three booths reserved for FAST trucks, FAST enrollments higher than thirty-three per cent would result in FAST waits longer than GP waits (at this point FAST vehicles would simply use the GP lanes). However, if the goal was to dramatically increase FAST enrollment for security reasons, congestion pricing would not be beneficial unless additional (FAST) lane capacity was to be added to the system.

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