Report on Border Queuing Times, September 1999

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For

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Introduction

This report presents estimated queuing delays for passenger vehicles at the San Ysidro and Otay Mesa border crossings for September 1999. It is part of a series of monthly reports sponsored by San Diego Dialogue. The major purpose of these reports is to track changes in waiting times at the border crossings. Wait time estimates are based on data supplied by Metro Networks and the U. S. Customs Service. Methodology for estimating waiting times is explained in the Methodological Note at the end of this report.

Queuing Delays for Monitored Hours

The reporting system tracks delays for three time periods. On weekdays, the hours tracked are 6 a.m., 7 a.m., 8 a.m., 12 noon, 1 p.m., and 2 p.m. On weekends, the hours tracked are 2 p.m., 3 p.m., and 4 p.m. These represent the morning commute peak, an early-afternoon peak on weekdays which has emerged as a major source of delay over the past several months, and the mid-afternoon peak on weekends. For current conditions, these time periods are believed to be the most likely to experience delays. The primary statistic reported is the percentage of hours for which the estimated wait time exceeds the standard of 20 minutes.

Figures 1 and 2 show trends in delay for the weekday time periods since October 1998 and for the weekend mid-afternoon peak since January 1999. Wait time distributions were not calculated for weekends prior to January 1999 because data on line lengths was insufficient.

Figures 1 and 2 show a dramatic reversal of recent trends in delay on weekdays, in which delays in the early afternoon exceeded morning peak delays at both border crossings. In September, the percentage of early afternoon hours with delays exceeding 20 minutes dropped from 75 percent to 8 percent at San Ysidro and from 34 percent to 0 percent at Otay Mesa. Meanwhile, the percentage of morning peak hours with delay exceeding 20 percent rose from 2 percent to 48 percent at San Ysidro and from 7 percent to 16 percent at Otay Mesa. On weekends, there was a small decrease (from 87 percent to 81 percent) at San Ysidro and a much larger decrease (from 96 percent to 44 percent) at Otay Mesa.

Figure 1. Trends in Hours wuth Delays of 20 Minutes or More, San Ysidro

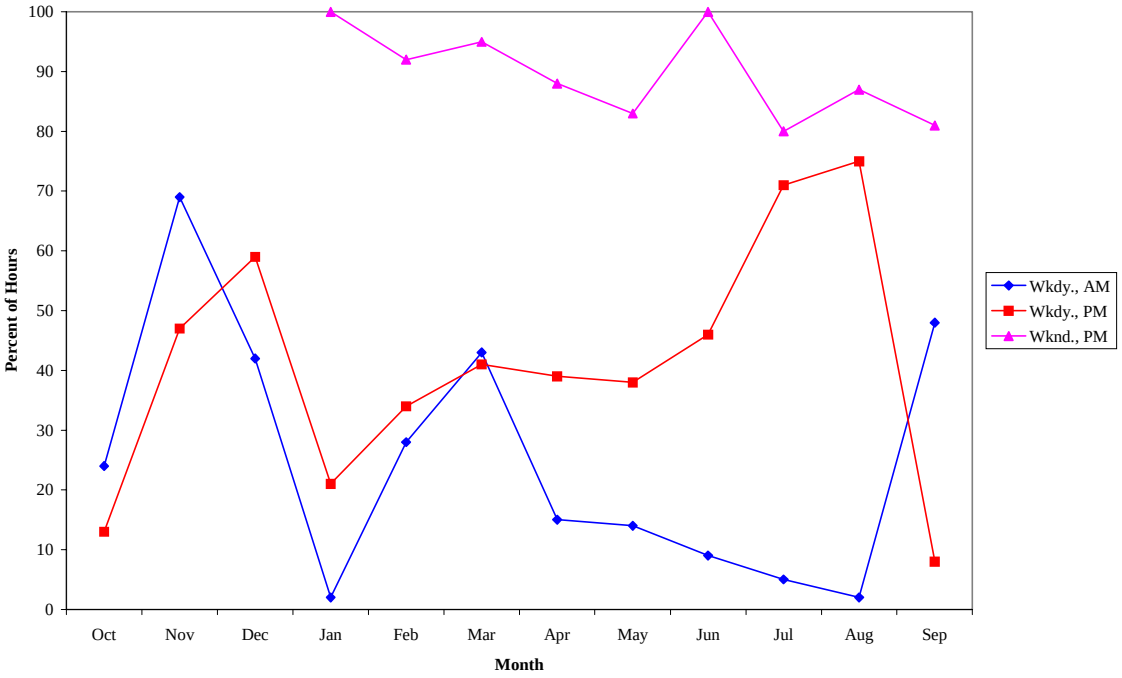
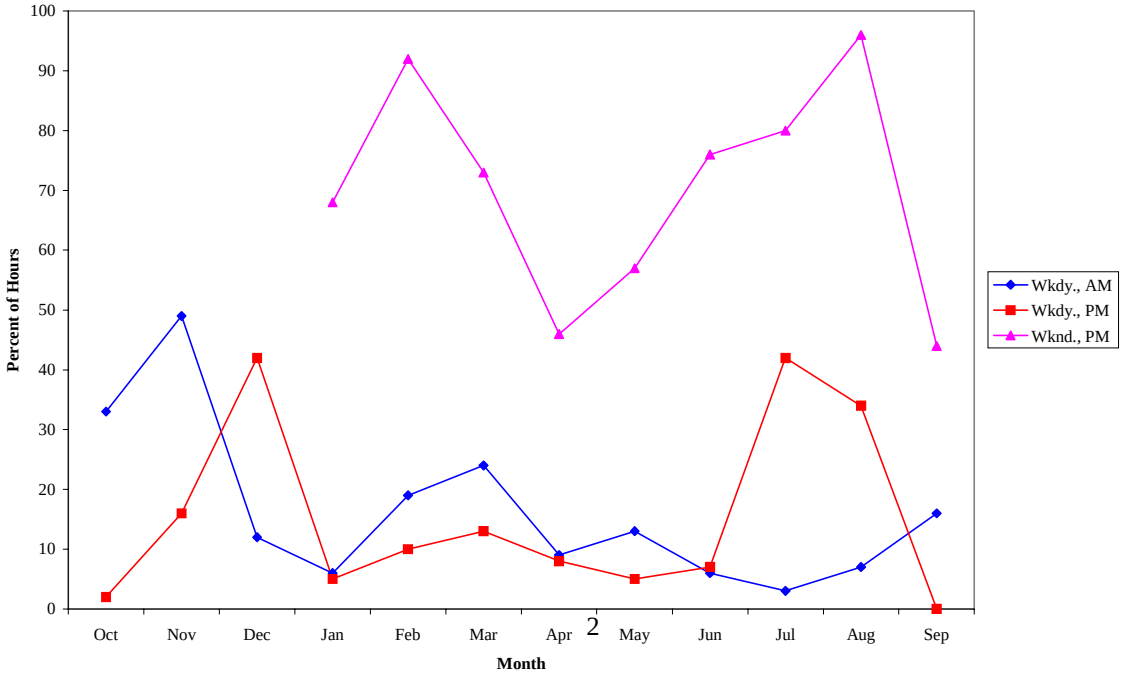


Figure 2. Trends in Hours with Delays of 20 Minutes or More, Otay Mesa



As discussed in previous reports, increases in delay reflect either increases in demand, decreases in output, or both, and decreases in delay reflect either decreases in demand or increases in output. The September data on numbers of vehicles processed show that changes in delay on weekdays were generally paralleled by changes in output: that is, both output and delay increased in the morning peak and decreased in the early afternoon. This is strong evidence that the shift in delay from afternoon to morning is related to a shift in demand. It was previously suggested that demand during the summer had decreased in the morning peak and increased in the early afternoon because of decreased work and school trips and increased shopping and recreation trips associated with summer vacations. The abrupt reversal of the delay patterns at the beginning of the school year provides strong confirmation of this suggestion. The large decrease in delay at Otay Mesa on weekends would also appear to be related to a decrease in recreational travel. When weekend demands are very high at San Ysidro, there is a tendency for some traffic to divert to Otay Mesa. Decreased overall travel on weekends is apt to show up first as a drop in demand at Otay Mesa, and this appear to be what happened in September.

Wait Times by Time of Day

Figures 3 and 4 present graphs of average waiting times and the standard deviation of waiting time by time of day for weekdays during September 1999. These give an idea of how waiting times vary for different times of day and also of the amount of variation in waiting times at particular times of day. All times are given according to the 24-hour or military clock, i. e. 17 = 1700 = 5:00 p.m., etc.

Figure 3. Wait Times, Weekdays, San Ysidro, September 1999

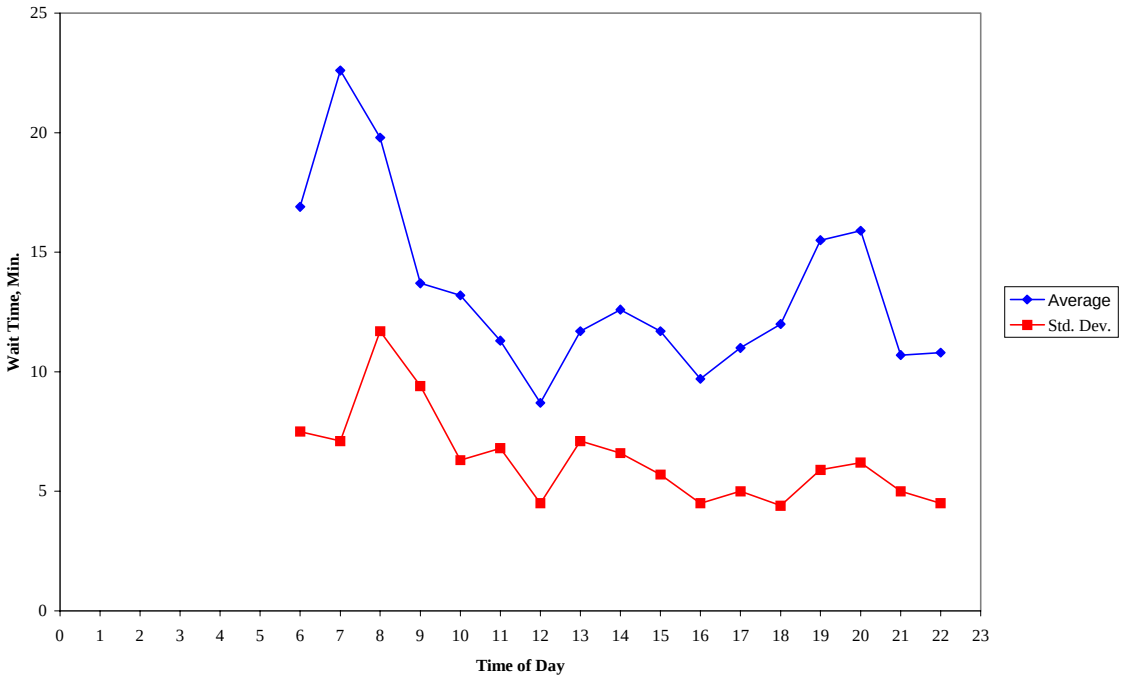
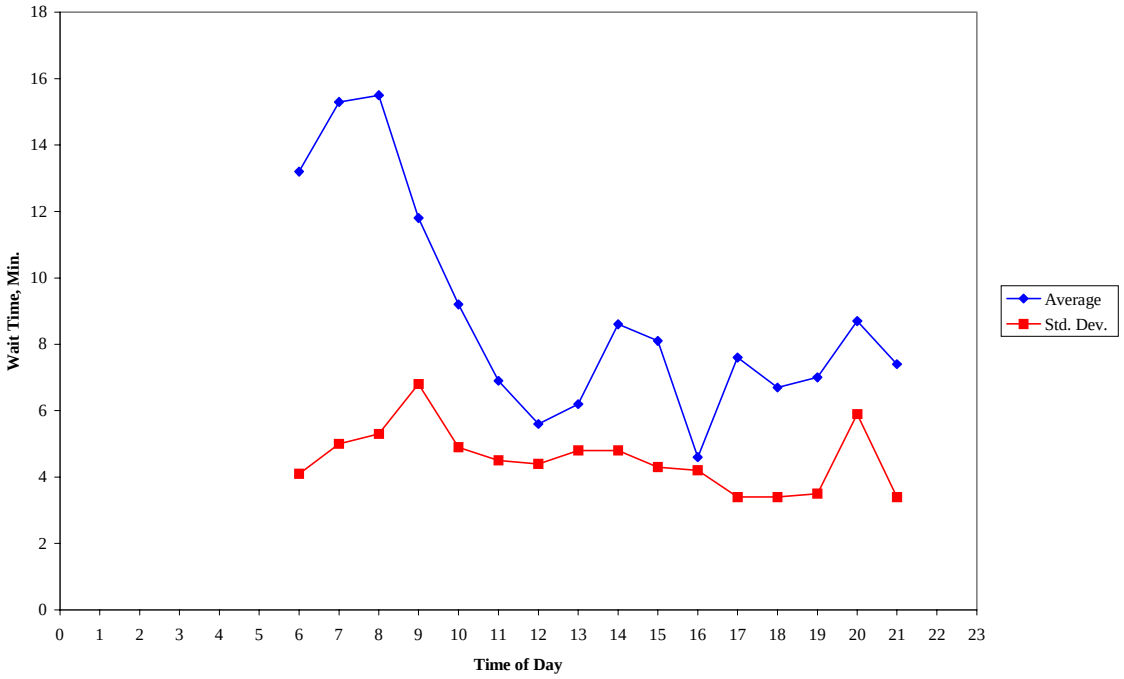


Figure 4. Wait Times, Weekdays, Otay Mesa, September 1999



During September, the longest waits at both border crossings were in the in the morning peak, in contrast to the experience of the past several months. As in the past, standard deviations are generally in the range of 5 to 10 minutes for all times of day. As a general rule, there is a probability of about 70% of experiencing a delay between of between the mean minus one standard deviation and the mean plus one standard deviation. Because the delay distributions are skewed, however, the median of the delay distribution is less than the mean (the value reported in Figures 3 and 4), but the probability of delays greater than the mean plus one standard deviation is greater than that of delays less than the mean minus one standard deviation.

Figures 5 – 10 show the overall distribution of wait time for the three time periods currently monitored. These graphs show the probability of wait times greater than a specified value. For instance, in Figure 5 shows that for morning peak at San Ysidro in September, the probability of a wait greater than or equal to 20 minutes was about 48 percent, and that of a wait greater than or equal to 40 minutes was about 4 percent.

Numbers of Vehicles Processed

Figures 11 and 12 show trends in the numbers of vehicles processed by the U. S. Customs Service and the Immigration and Naturalization Service at the two border crossings. These are significant because they provide insight into the reasons for changes in the average delay. In general, delay will increase if either demand increases without any increase in the number of vehicles processed or the number of vehicles processed declines, without any decrease in demand. Figures 11 and 12 show increases between August and September in the number of vehicles processed during the morning peak at both border crossings, and decreases for most other times of day.

Figure 5. Probability of Wait Time Greater Than Specified Amount, Weekday Morning Peak, San Ysidro, September 1999

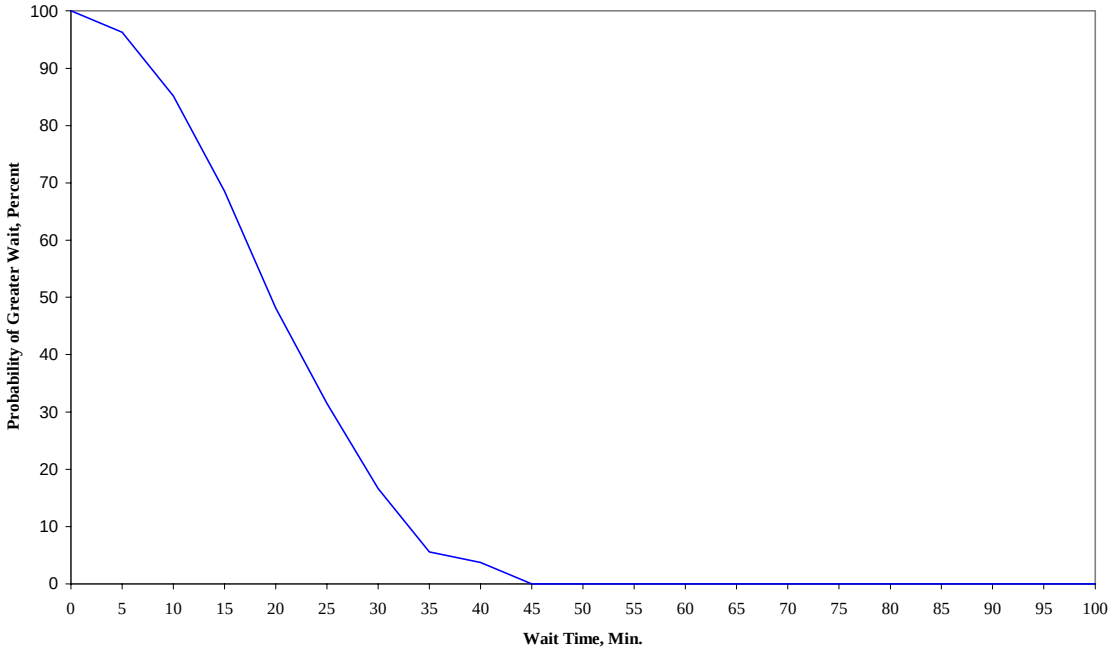


Figure 6. Probability of Wait Time Greater Than Specified Amount, Weekday Early Afternoon, San Ysidro, September 1999

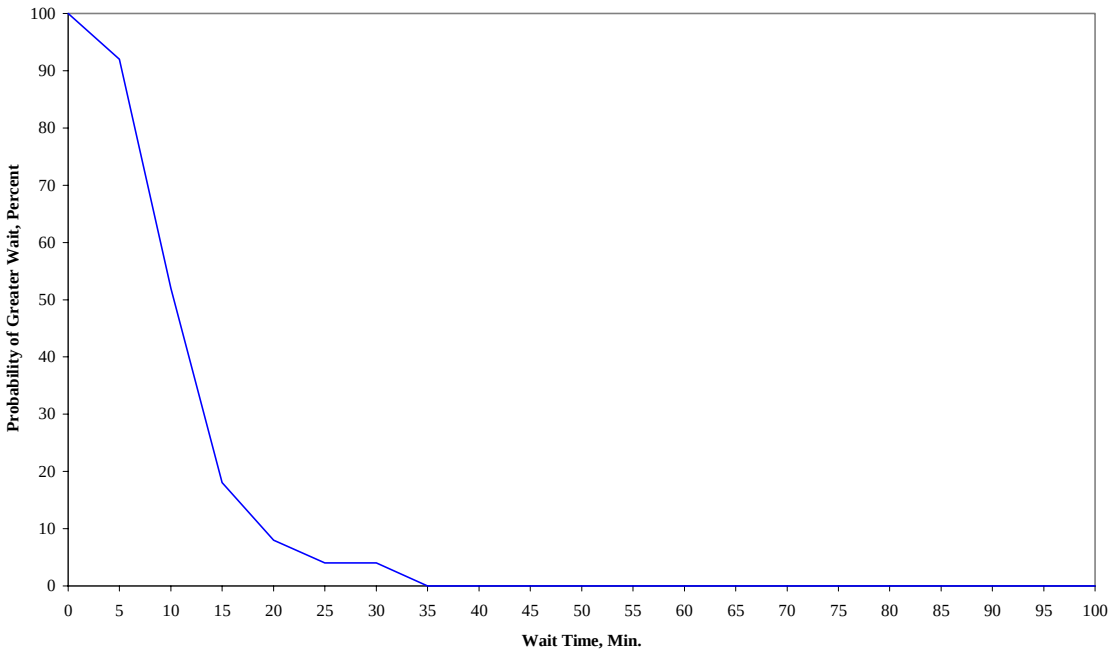


Figure 7. Probability of Wait Time Greater Than Specified Amount, Weekend Afternoons, San Ysidro, September 1999

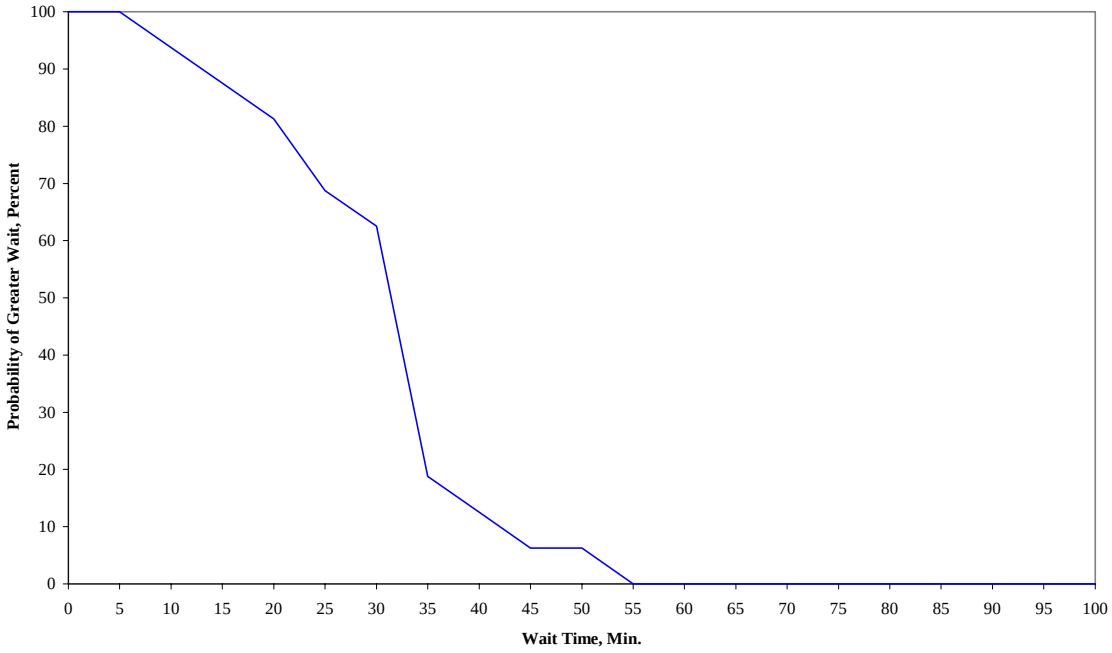


Figure 8. Probability of Wait Time Greater Than Specified Amount, Weekday Morning Peak, Otay Mesa, September 1999

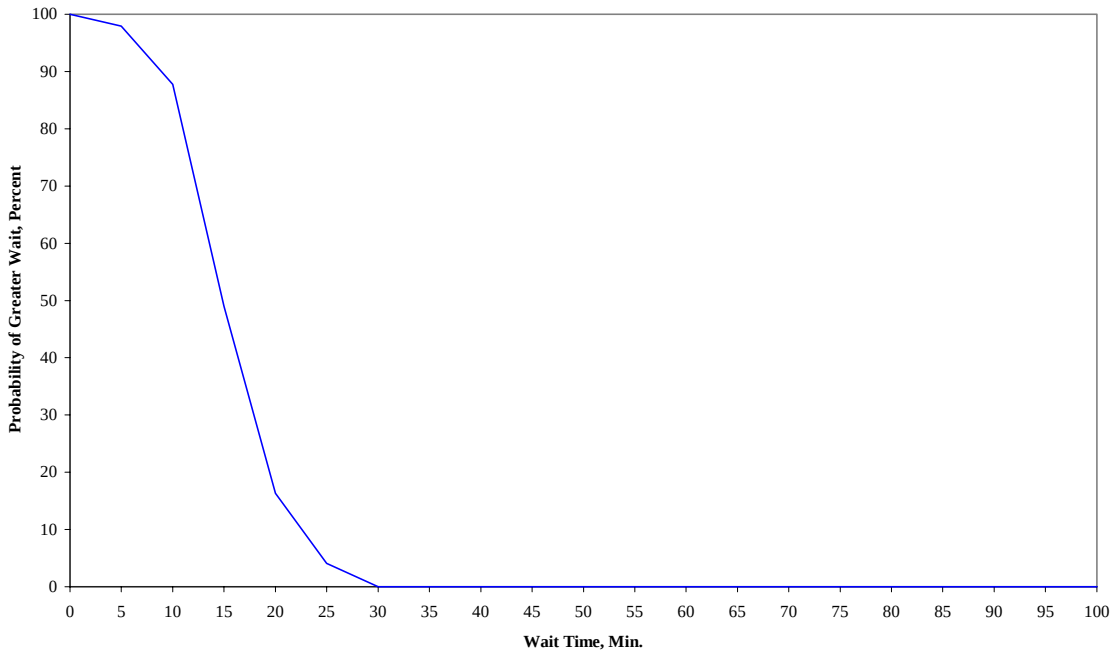


Figure 9. Probability of Wait Time Greater Than Specified Amount, Weekday Early Afternoon, Otay Mesa, September 1999

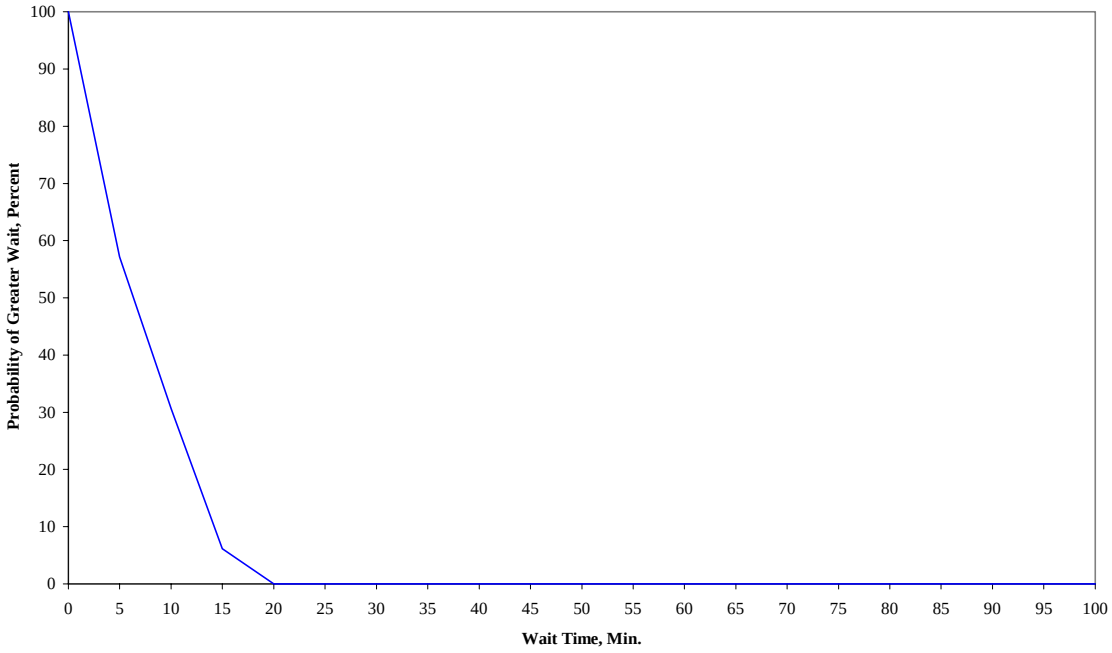


Figure 10. Probability of Wait Time Greater Than Specified Amount, Weekend Afternoons, Otay Mesa, September 1999

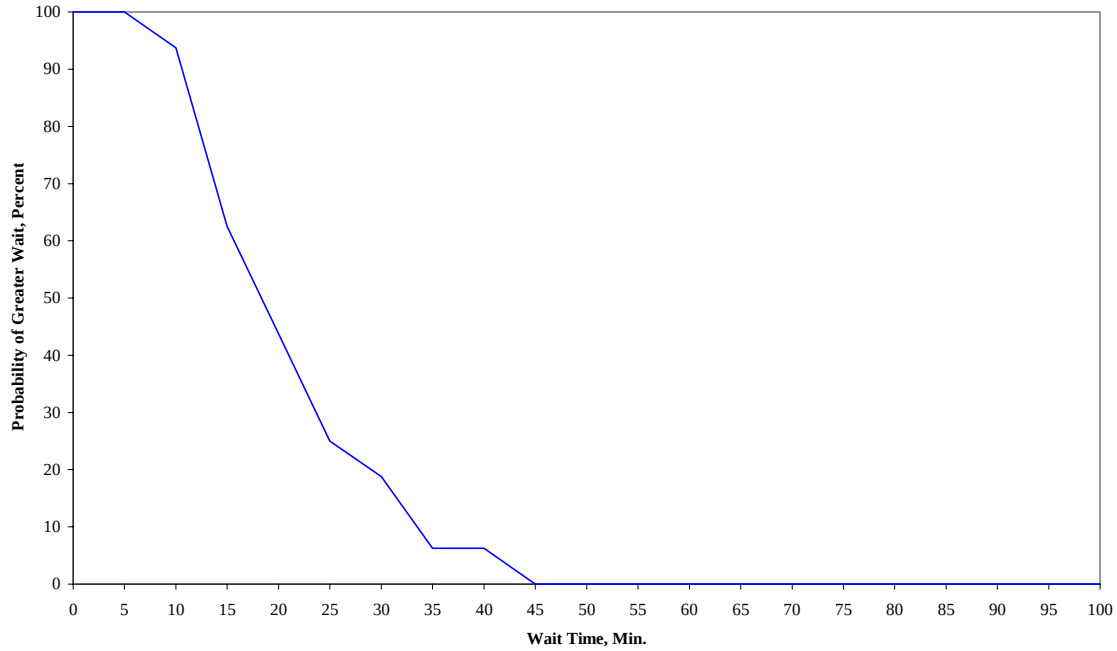


Figure 11. Average Number of Vehicles Inspected, Weekdays, San Ysidro

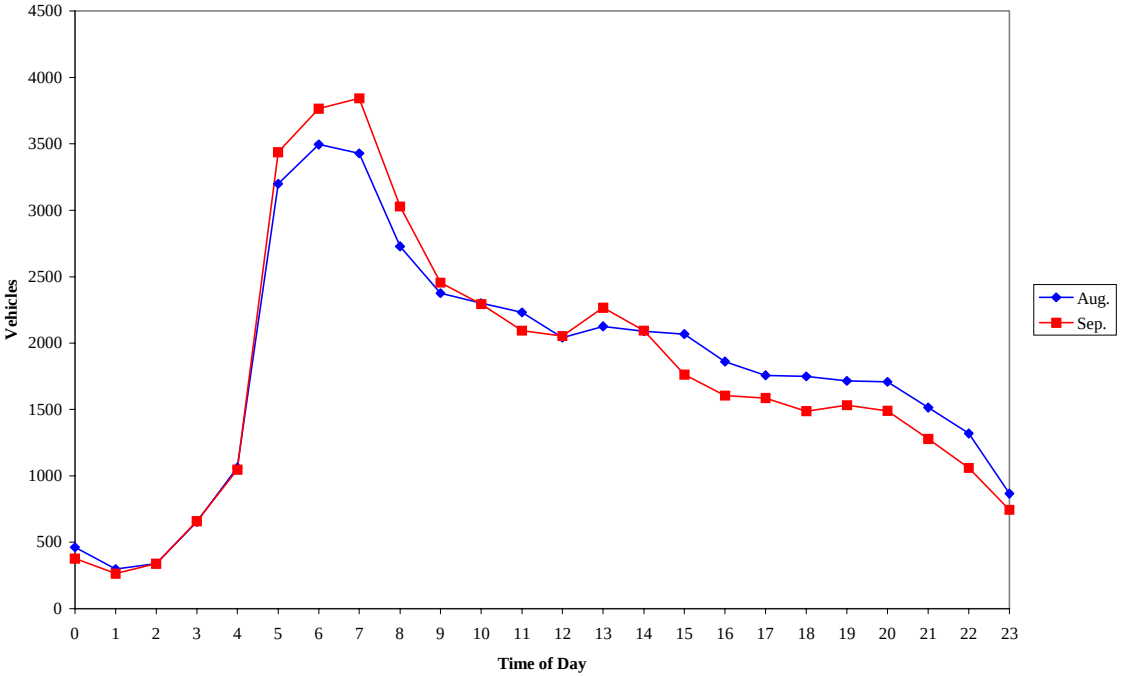
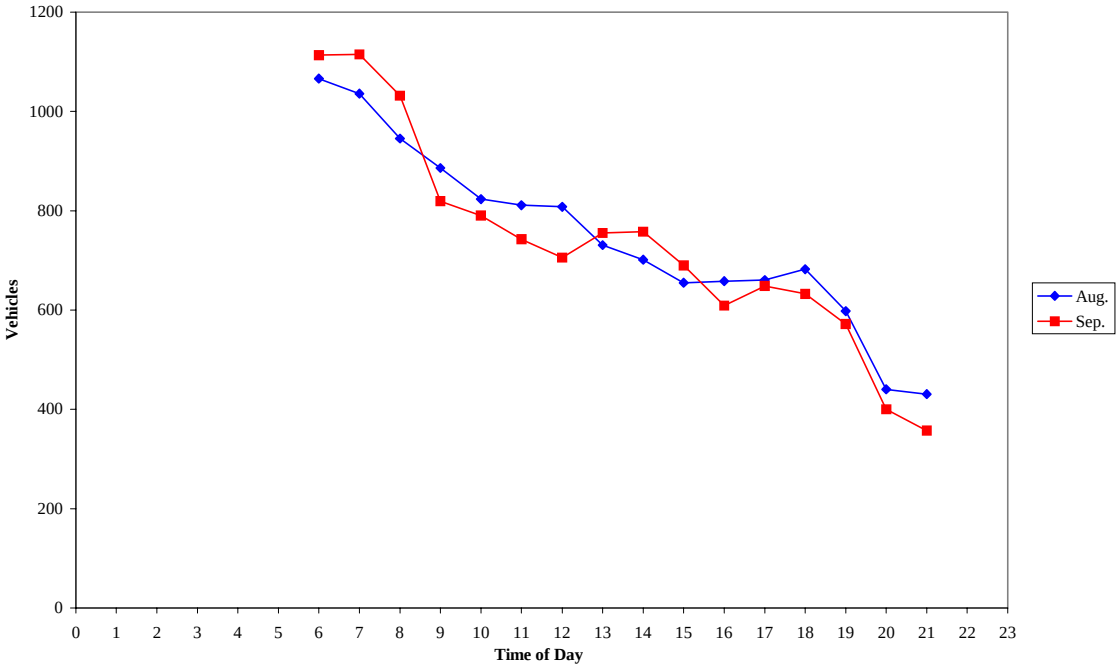


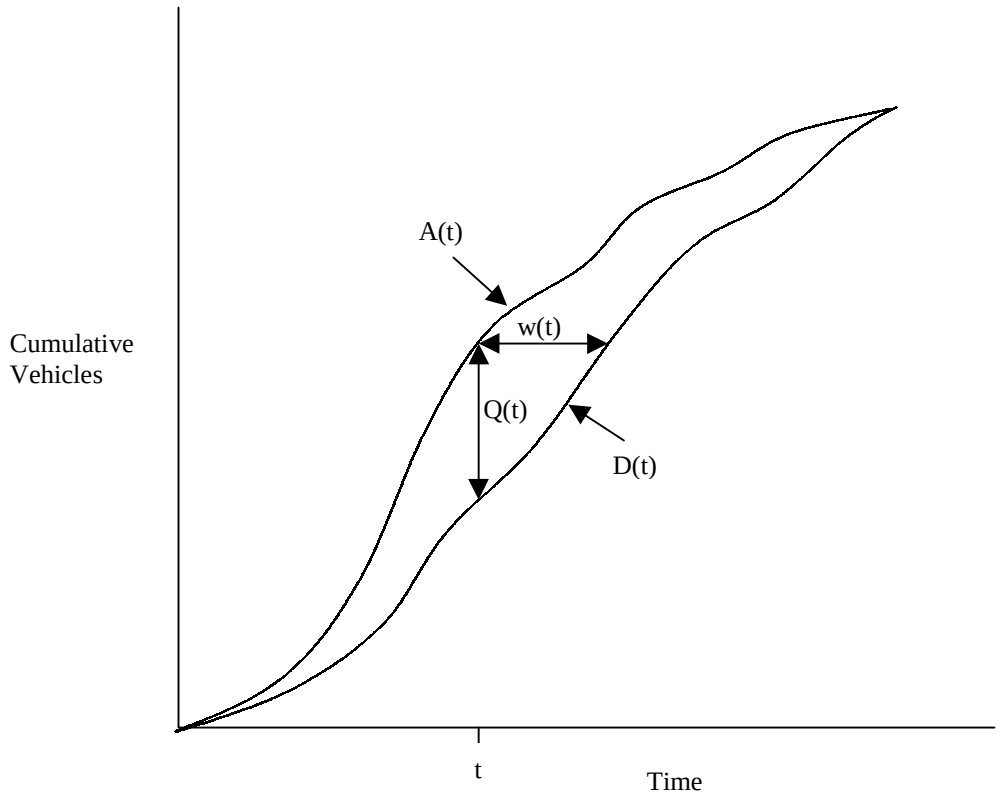
Figure 12. Average Number of Vehicles Inspected, Weekdays, Otay Mesa



Note on Methodology

The methodology used to estimate waiting times in queues at border checkpoints for San Diego Dialogue is based on some fundamentals of queuing theory. Figure 13 illustrates important features of the method.

Figure 13. Queuing Diagram



The diagram is a graph of the cumulative number of vehicles at the border crossing versus time. The line $A(t)$ represents the cumulative number of vehicles that have arrived at any time after some arbitrary time zero (at which time there is no queue) and the line $D(t)$ represents the cumulative number of vehicles that have departed from the queue by any given time. Thus the vertical distance between $A(t)$ and $D(t)$, labeled $Q(t)$, represents the number of vehicles in the queue at any time t, and the horizontal distance $w(t)$ represents the average wait time for a vehicle arriving close to time t. In cases in which the order of service is strictly first-come-first-served, $w(t)$ is the wait time of the vehicle arriving at t; however, if different vehicles move through the queue at different speeds, so

that the order of service is not strictly first in, first out, (as in this case) it is only an estimate of the average wait time for a vehicle arriving at approximately time *t*.

In the case of the San Diego border crossings, data on the queue output are provided by the U. S. Customs Service, which reports the total number of vehicles processed on an hourly basis. Estimates of the total number of vehicles in queue are derived from estimated queue lengths reported by Metro Networks every half hour. Average waiting times are calculated for every hour by dividing the estimated number of vehicles in queue by the number of vehicles processed during the hour beginning at that time and then multiplying by 60 to convert the waiting time to minutes. In other words, the estimated average wait time at 8:00 a.m. is 60 times the estimated number of vehicles in queue at 8:00 divided by the number of vehicles processed between 8:00 and 9:00.

The major difficulty in this procedure is estimating the total number of vehicles in the queue from the queue length data supplied by Metro Networks. The data reported are an estimate (based on the location of the end of the queue) of the number on vehicles in a single line from the upstream end of the queue to the gates. Because the lines split at several points as they move toward the gates, not all the lines are this long, and it is necessary to estimate the number of lines that are of various lengths. For instance, if the queue is very short, and there are *n* gates open, the total number of vehicles in the queue is approximately *n* times the queue length. Once the queue length exceeds that of the shortest line (from the point of the split to the gate), however, the total number of vehicles is less than *n* times the reported queue length. In theory, the total number of vehicles in queue is a function of the reported queue length and the particular gates that are open. In practice, however, no data are available on *which* gates are open, so the estimation procedure is actually based on the reported queue length and the *number* of gates that are open. At San Ysidro, the situation is further complicated by the fact that there are several entrances feeding the right side of the queuing area, and queues on these are not necessarily of equal length.

It should be emphasized that these calculations are only an *estimate* of the *average* delay at any given time. The true average delay will vary about that estimate, and in the absence of a detailed study, it is not possible to say exactly how large the error is nor whether the estimates may be biased. In addition, individual wait times will differ from the average, even if it is completely accurate, since different lines move at different speeds. Variations in line speed result from both random variations in processing time at the gates, and (more importantly) differences in the number of times the longer lines split. The primary purpose of these calculations is to track changes in delays over time, and they should be adequate for that purpose, since any biases should stay the same from one month to the next.