

# Route 74 - Old Stafford Intersection

## Study of Delay & Queuing Problems

CRCOG, November 25, 2008

A special study of traffic delay at the intersection of Route 74 and Old Stafford Road was conducted on two weekday mornings in November. The purpose was to test the validity of the level of service (LOS) analysis previously performed using standard highway capacity methods. Of concern was whether or not the level of delay estimated for traffic southbound on the Old Stafford Rd was calculated correctly. After observing traffic during two morning peak periods and manually measuring both delay and queue length, it is our conclusion that the original level of service calculations were done correctly, and that the results are representative of actual field conditions.

While the study validates the original delay calculations, it does not answer the more important question that the community must address. The question is what if any action should be taken to correct the problems at the intersection? At what point does the nature and scale of the traffic problems justify altering the historic Tolland Green, and what types of alterations are acceptable?

This small study does not answer the larger question, but the data analysis and results do provide helpful insights into the nature of the problems at the intersection of Route 74 and Old Stafford Road. Because the insights are valuable, both the analysis and some of the findings are presented in the pages that follow. A summary of the findings is presented below. The more detailed analysis following the summary discusses the high degree of variability in delay over the course of the morning peak period. The variability includes short peaks when queue lengths reach 15-20 cars, as well as brief lulls when there are no queues at all.

### Summary of Findings

The estimated average delay *calculated* using the *standard LOS method* is about 70 seconds. This is a fairly high level of delay that warrants a LOS rating of **F**. Calculations of queue length, using the same methodology, suggest that traffic backups will occasionally get very long during the peak hour. The 95<sup>th</sup> percentile queue length is estimated to be 11 cars. This means that 95% of the time the queue length will be less than 11 cars, but 5% of the time it will be 11 cars or longer.<sup>1</sup>

To determine if the standard LOS calculations were valid, traffic was observed over two weekday morning peak periods. The first day included simple traffic volume counts on all approaches as well as general observations of traffic operations. The second day involved measuring delay by recording time spent in a queue for every fifth car, and measuring queue length at 15-second intervals. Analysis of the data collected during the field observations yields results that are similar to the results from the standard LOS methods.

Table 1 provides a comparison of the standard LOS method (calculated delay & queue) and the field observations. The LOS method calculates average driver delay as 1 minute and 10 seconds (70 seconds). It also estimates the 95<sup>th</sup> percentile queue to be 11 cars. The field observations for the peak hour (60

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<sup>1</sup> The 95<sup>th</sup> percentile queue length is an important and standard measure used by traffic engineers. It is used to estimate how long storage lanes need to be at intersections.

minutes) yield an average delay of 55 seconds and a 95<sup>th</sup> percentile queue of 15 cars. The average for the field observations is about 15 seconds less than the delay estimate from the LOS method. However, the calculations used to estimate delay with the standard LOS methods require that the value be weighted to be more representative of the worst 15 minutes during the peak hour. Therefore, Table 1 also includes the data summary for the peak 15 minutes. For this shorter peak, the average delay is 1 minutes and 27 seconds (87 seconds), which is 17 seconds more than the LOS equivalent.

Table 1  
**Comparison of Calculated vs Observed Performance Measures**

LOS*	Delay average (min:sec)	Delay 95 <sup>th</sup> % (min:sec)	Delay max (min:sec)	Queue average (# cars)	Queue 95 <sup>th</sup> % (# cars)	Queue max (# cars)
<b>Calculated delay &amp; queue**</b>	<b>F</b>	<b>1:10</b>	-----	-----	<b>11</b>	-----
Field observations: <i>peak hour</i>	<b>F</b>	<b>0:55</b>	<b>2:18</b>	<b>3:06</b>	<b>4.6</b>	<b>15</b>
Field observations: <i>peak 15 min.</i>	<b>F</b>	<b>1:27</b>	<b>2:59</b>	<b>3:06</b>	<b>7.4</b>	<b>18</b>

\* For unsignalized intersections LOS E = 35-50 seconds and LOS F = 50 seconds or more.

\*\* Calculated delay is based on peak hour, but is weighted to be more representative of the peak 15 minutes.

### Day 1 Observations: Standard Intersection (Turning Movements) Count

The first step in the study was to recount traffic at the intersection to assure that the previous count was done properly and on a day that was representative of normal weekday morning traffic. The results are presented in Table 2 and Table 3. Since intersection turning movement counts are typically tabulated and assessed at 15-minute periods, Table 2 provides the traffic turn volumes for each 15-minute period during the 75-minute observation period. Based on the results, the peak hour is 7:00 am to 8:00 am. The total traffic volumes for the four highest 15-minute periods are highlighted in the last column.

Table 2

15-minute periods	Eastbound (SB)			Westbound (NB)			Southbound			Grand Total
	Route 74			Route 74			Old Stafford			
	Left	Through	Total	Through	Right	Total	Left	Right	Total	
<b>7:00-7:15 AM</b>	0	77	77	57	17	74	109	0	109	<b>260</b>
<b>7:15-7:30 AM</b>	1	76	77	57	21	78	86	0	86	<b>241</b>
<b>7:30-7:45 AM</b>	1	110	111	64	15	79	93	2	95	<b>285</b>
<b>7:45-8:00 AM</b>	2	108	110	76	17	93	65	1	66	<b>269</b>
<b>8:00-8:15 AM</b>	1	72	73	58	19	77	79	3	82	232

The peak hour total was calculated by summing the volumes for each of the four highest 15-minute periods (7:00-7:15, 7:15-7:30, 7:30-7:45, 7:45-8:00). The results are presented in Table 3. These results are fairly similar to the prior count that was done on June 6, 2007, which is also shown in Table 3.

Table 3

'Peak' Hour 7:00-8:00 am	Eastbound (SB)			Westbound (NB)			Southbound			Grand Total
	Route 74			Route 74			Old Stafford			
	Left	Through	Total	Through	Right	Total	Left	Right	Total	
11/4/2008	4	371	375	254	70	324	353	3	356	1055
prior: 6/8/2007	1	325	326	215	83	298	349	4	353	977

A notable feature of the traffic counts at the intersection is the high volume of left turns from Old Stafford Rd (356). The volume of left turns is nearly as high as the through volume eastbound on Route 74 (371), and it is higher than the through volume westbound on Route 74 (215).

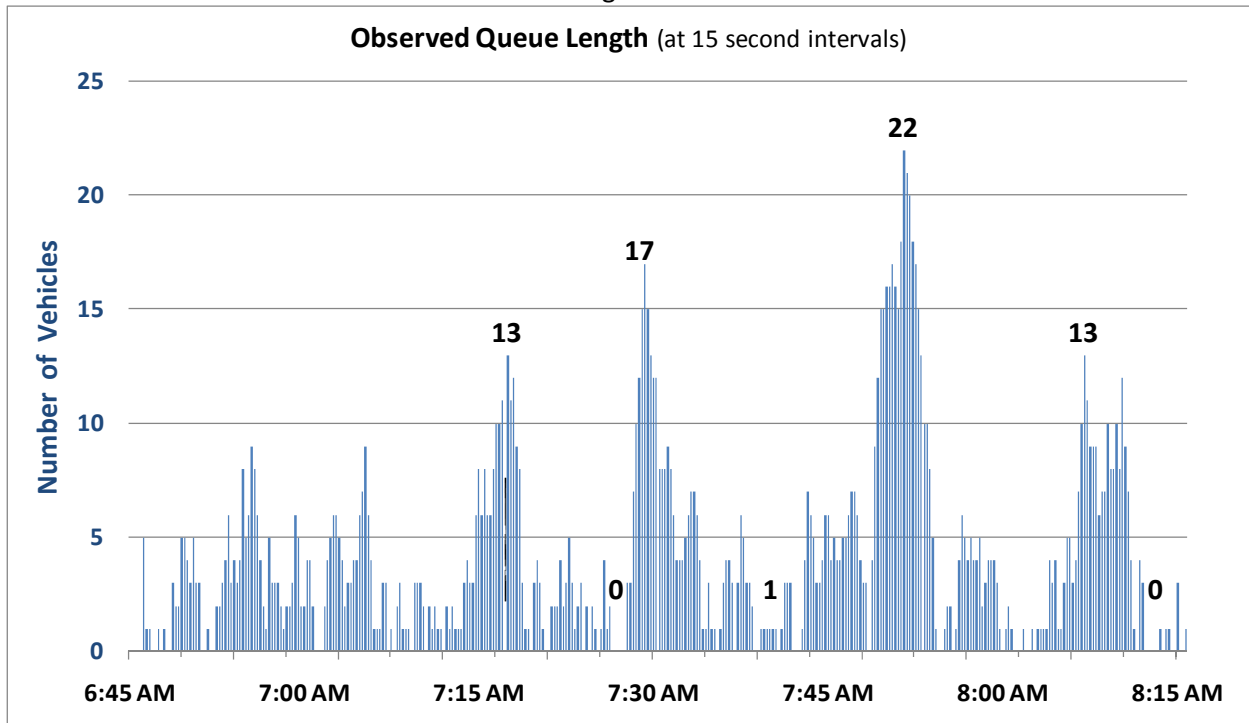
Informal observations of queue length on Day 1 indicated a pattern of wide fluctuations on queue length. Queue length would occasionally build up to 10-20 cars, but then subside to smaller queues often in the 3-6 range. Occasionally, there would be no queues at all.

**Day 2 Observations: Measuring Queue Length and Delay**

Day 2 was spent obtaining accurate measurements of queue length and of delay experienced by drivers in the queues on Old Stafford Rd. Two CRCOG staff members used stop watches to measure delay for a sample of cars, and to record queue length at regular time intervals. The watches were coordinated so the results of the two surveys could be compared and tracked over the same timeline. For Day 2 the observation period was started 15 minutes earlier than Day 1. It started at 6:45 am and ended at 8:15 am for a 90-minute observation period.

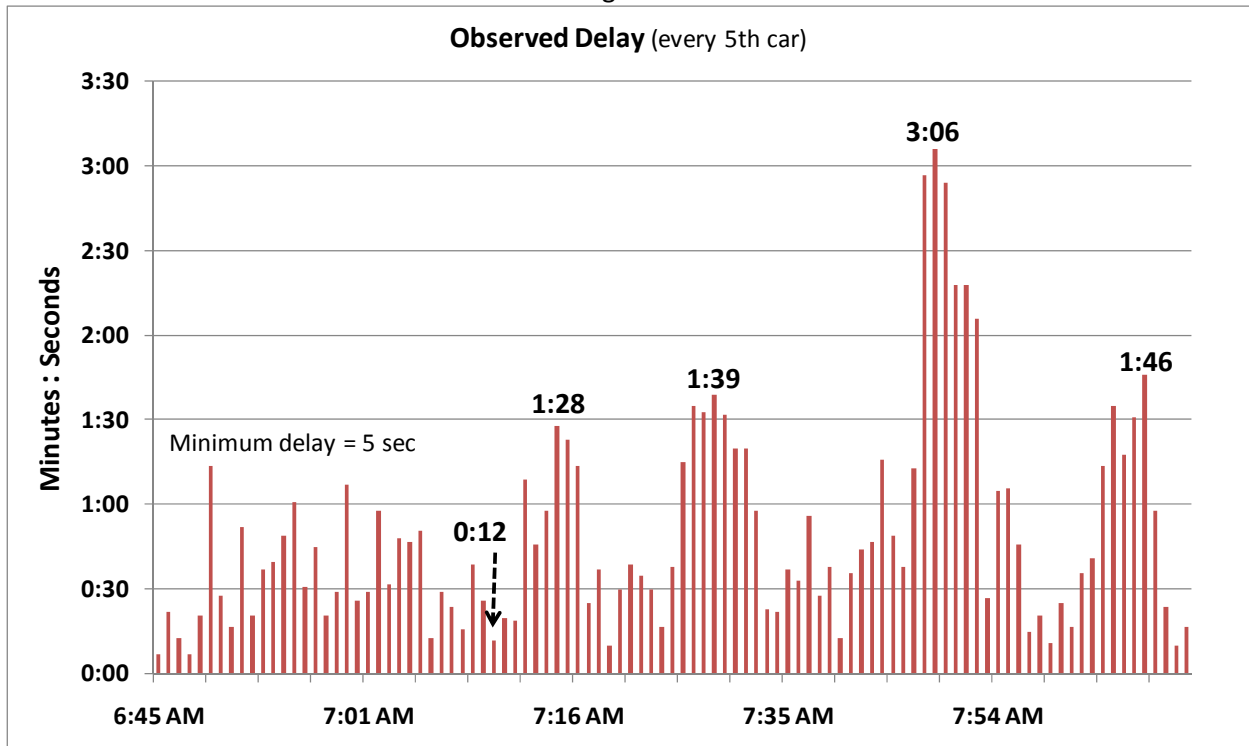
*Queue Observations.* To avoid introducing any sampling bias into the survey of queue length, the number of cars in the queue was recorded every 15 seconds. This short time interval allowed the collection of a very large sample of observation points, which in turn allowed accurate tracking of queue fluctuations. The value of the sampling procedure is illustrated in Figure 1. All the data is plotted against a timeline and it reveals a pattern of large ebbs and flows in traffic and queue length. At least four large peaks occurred during the 90-minute observation period. Queues peaked at approximately 7:20 (13 cars), 7:30 (17 cars), 7:50 (22 cars), and 8:10 (13 cars). During the ebbs in traffic between the peaks, queue lengths dropped to much smaller volumes (commonly 2-4 cars) or even disappeared entirely for 1-2 minute periods.

Figure 1



*Delay Observations.* To avoid introducing any sampling bias into the survey of vehicle delay, the delay was measured for every fifth car traveling southbound on Old Stafford Road. Cars were observed as they approached the intersection, and the time was recorded when the car reached the back of the queue (begin queue delay). The vehicle was observed while it moved up to the front of the queue. The time was recorded again when the car began to accelerate away from the stop sign (end queue delay). This sampling method avoided oversampling during slow periods and undersampling during busy traffic periods. Observing every fifth car yielded a 20-percent sample and a total of 99 observations during the 90-minute observation period. The results are presented in Figure 2

Figure 2



All the delay data is plotted against a timeline and it reveals a pattern similar to that seen in Figure 1. There are large ebbs and flows in traffic and vehicle delay over the 90-minute period. The same four large peaks are evident. Delay peaks at approximately 7:15 (1 min: 28 sec) cars, 7:30 (1 min: 39 sec), 7:50 (3 min: 6 sec), and 8:10 (1 min: 46 sec). In between the peaks, queues recede and associated delay drops to much smaller amounts. Due to an adjustment made to make the ‘measured delay’ comparable to the ‘calculated’ delay, five (5) seconds was added to each observed delay. This is explained below.

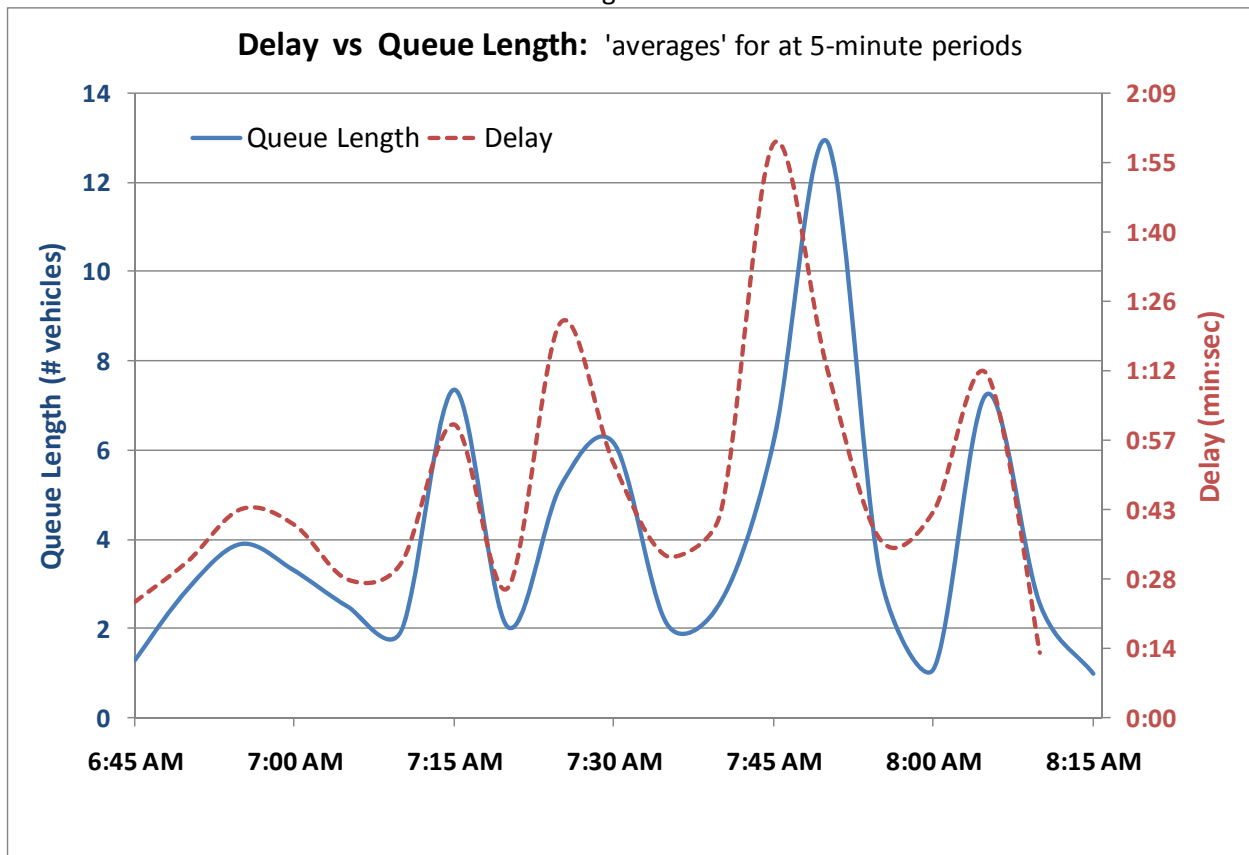
*Stop Control Delay = 5 Seconds.* The delay observed and ‘measured in the field’ on Day 2 was delay due to time spent in the queue and time waiting for a gap in traffic on Route 74. The field measurements did not account for another type of delay that is due exclusively to the presence of the stop sign on Old Stafford. This ‘stop control delay’ is included in the standard intersection capacity or LOS method that we are attempting to verify with this field study. Therefore, to assure the delay estimates are comparable, an adjustment was made to the delay observed in the field. This adjustment added 5 seconds to every vehicle observed in the field. The 5-second adjustment is explained below.

Five seconds is the minimum amount of delay experienced by every driver that approaches the stop sign on Old Stafford Road – even if there is no queue. It includes time lost *decelerating* to a stop and time lost *accelerating* back to normal speed. This is delay that is due strictly to the presence of the stop sign. It occurs at all times of day and regardless of traffic volumes. By comparison, vehicles on Route 74 have no stop sign, so they do not experience this type of delay. Without a stop sign on Route 74, drivers can travel through the intersection without losing any speed (no delay) due to a stop control device.

*Direct Comparison of Delay & Queue Length.* A direct comparison of queue length and vehicle delay is provided in Figure 3. In order to provide a meaningful graphic presentation of the two data sets on a single chart, the data was reduced by calculating the average for each 5-minute time period. The variables correlate fairly closely over the 90-minute observation period, and the four peaks discussed in

Figures 1 and 2 are also evident in Figure 3. However, the peaks are slightly reduced since they represent the *average* value for a 5-minute period rather than the *maximum* individual value.

Figure 3



### Other Field Observations

During the nearly three hours of data collection over two days, a variety of driver behaviors were noted. Since they have some bearing on the traffic operations at the intersection, these informal observations are summarized here.

*Difficulty Seeing Oncoming Traffic.* Due to the skewed angle at which Old Stafford intersects Route 74, many drivers found it difficult to monitor traffic from two directions of oncoming traffic (Route 74 eastbound and Route 74 westbound). To see eastbound (or southbound) traffic on Route 74, drivers had to really twist their necks to look back over their right shoulder. Once they identified a gap in the eastbound (southbound) traffic, they had to turn 180 degrees to observe the westbound (northbound traffic). This is a difficult maneuver for many drivers, and is one of the reasons most intersections are designed to intersect at a normal right angle.

*Queue Avoidance.* During the highest peaks, a few cars were observed bypassing the queue by travelling over the carriage road or using the short connector between Old Stafford and Route 74. On the latter bypass option, the drivers turned left onto Route 74 from an approach lane that typically serves right turn vehicles. However, very few drivers were observed practicing this avoidance behavior, and the behavior was limited to short periods when queues reached nearly maximum lengths. A total of five bypass movements were observed during 90 minutes of observations on Day 2.

*Cautious vs. Aggressive Drivers.* From informal observations over two days, it appears that a significant factor in queue length and delay is the degree of caution drivers exercise when selecting gaps in traffic. Some extremely cautious drivers waited long periods of time before they found a gap that they were comfortable entering. In some such cases, the queue of cars behind the driver grew fairly long. In contrast, there were also some aggressive drivers who never came to a full stop at the stop sign, but rolled through in order to take advantage of a gap. On several occasions, two or even three cars at a time would exit Old Stafford Road and enter the same gap in traffic on Route 74. In these cases, a queue of traffic that built up slowly would sometimes diminish quickly.

## **Conclusions**

There are four primary conclusions from the study.

1. The previous traffic counts conducted for the original intersection capacity analysis (level of service analysis) appear to be valid and representative of peak traffic conditions on a typical weekday morning.
2. The previous estimates of delay and queue that were calculated using the level of service analysis are comparable to the levels of delay and queue length as measured in the field as part of this study.
3. The measured level of delay falls into the range of delay that is considered to be a *poor* level of service under nationally accepted standards.
4. While the overall level of service for the peak hour is classified as poor, the level of delay fluctuates widely during the course of the hour. At its worst, the delay for individual drivers can be 1 to 3 minutes, but it can also be as little as 5-10 seconds during brief periods.