


Sometimes "Really Good" Time of Day Coordination Does Outperform Adaptive Control - The City of Roseville, California's Experience

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ABSTRACT

This study documented a traffic operations evaluation of the City of Roseville's implementation of an adaptive traffic signal control system. The purpose of this evaluation was to assess the effectiveness of the adaptive control system as compared to baseline conditions during which time-of-day coordinated signal control was utilized.

The 1.5-mile section of Sierra College Boulevard between Douglas Boulevard and Old Auburn Road has five signalized intersections, all of which are interconnected and operated in a coordinated fashion. In addition to this mainline segment, the evaluation efforts included two side street approaches to allow for quantification of the adaptive control system's effect on side-street vehicle delay. Weekday peak period travel time runs and side-street control delay analyses were conducted for conditions with and without the adaptive system. Following the implementation of the adaptive system, the City allotted a 30+ day period during which the corridor operations were monitored and fine-tuned by City and vendor staff. This 30-day period was utilized to allow the system to adjust to the recurring traffic patterns, and to build a system database of the fluctuating system demand.

Based on this study, the City concluded that their baseline condition, which made use of "really good" time of day coordination plans, was difficult for the adaptive system to outperform. This report documents the results of the evaluation study and the comparison of key performance measures for conditions with and without the adaptive system.

INTRODUCTION

Sierra College Boulevard is a north-south arterial roadway located in the southeast portion of the City. Adjacent properties receiving access from the project corridor include commercial retail, residential, and educational uses. This roadway plays an important role in the region's transportation network by providing a connection between Interstate 80 to the north and US 50 to the south, and includes one of the few crossings of the American River in eastern Sacramento County. Several distinct users characterize this corridor: routine regional commuters, commercial retail customers, as well as logging and other heavy vehicles. The traffic patterns resulting from this mix of users is largely predictable, with well-defined peak periods and direction distributions. This segment of Sierra College Boulevard has two lanes in each direction south of Indigo Creek Road and three lanes in each direction between Indigo Creek Road and Douglas Boulevard. This segment of Sierra College Boulevard has a posted speed limit of 45 mph. This corridor was independently selected by the City for implementation of this pilot project.

The 1.5-mile section of Sierra College Boulevard between Douglas Boulevard and Old Auburn Road has five signalized intersections, all of which are interconnected and operated in coordinated fashion. The eastbound Indigo Creek Road and westbound Old Auburn Road approaches to Sierra College Boulevard were also included to assess the adaptive control system's effect on side-street vehicles. These two approaches were identified due to their lane configurations, turning movement patterns, and available vantage points.

BASELINE CONDITION

Prior to the initiation of the adaptive pilot project, the study corridor operated with time of day signal coordination. **Table 1** provides a summary of the time of day periods and their associated cycle lengths that were in place at the onset of this study.

Table 1: Baseline Time of Day Coordination Parameters

Period	Time Period	Cycle Length
AM	7:00 am - 9:00 am	120 seconds
MID	9:00 am - 12:30 pm	
PM	12:30 pm - 6:30 pm	
Post-PM	6:30 pm - 7:00 pm	


Baseline Data Collection

Prior to the implementation of adaptive system, weekday peak period travel time runs were conducted for the Sierra College Boulevard corridor from Douglas Boulevard to Old Auburn Road to quantify existing travel time, delay, number of stops, and speed along the corridor. Travel time runs were conducted using the TruTraffic® computer software with GPS, and were performed in accordance with the Institute of Transportation Engineers' "floating vehicle" methodology. As required, a minimum of 10 peak-period travel time runs were collected for the weekday AM, mid-day, and PM peak periods. **Table 2** provides a summary of the baseline data collection parameters.

Table 2: Baseline Data Collection Parameters

Period	Time Period	# Travel Time Runs (NB/SB/Tot)+
AM	7:00 am - 8:30 am	10 / 11 / 21
MID	11:00 am - 12:30 pm	11 / 11 / 22
PM	4:30 pm - 6:30 pm	10 / 10 / 20
+NB = Northbound, SB = Southbound, Tot = Total		

Additionally, side-street control delay was determined in accordance with the procedures outlined in the Highway Capacity Manual (HCM 2010). This side-street delay analysis was conducted for the two previously identified locations. A survey period of 20 to 30 minutes was utilized during which vehicle arrivals and vehicle queues were recorded.

The baseline data collection was performed on Wednesday, November 16, 2011, which was determined to represent typical weekday conditions. Conditions were monitored to ensure the absence of unusual conditions such as weather, traffic accidents, road construction, emergency preemptions, etc.

PROJECT CONDITION

Following the implementation of the adaptive system, the City allotted an approximately 30-day period during which the corridor operations were monitored and fine-tuned by City and vendor staff. This 30-day period was utilized to allow the system to adjust to the recurring traffic patterns, and to build a system database of the fluctuating system demand.

Project Data Collection

As was completed for the baseline condition, weekday peak period travel time runs were conducted for the Sierra College Boulevard corridor from Douglas Boulevard to Old Auburn Road to quantify "with project" travel time, delay, number of stops, and speed along the corridor. As required, a minimum of 10 peak-period travel time runs were collected for the weekday AM, mid-day, and PM peak periods. **Table 3** provides a summary of the project data collection parameters.

Table 3: After Data Collection Parameters

Period	Time Period	# Travel Time Runs (NB/SB/Tot)+
AM	7:00 am - 8:30 am	10 / 10 / 20
MID	11:00 am - 12:30 pm	11 / 11 / 22
PM	4:30 pm - 6:30 pm	10 / 10 / 20
+NB = Northbound, SB = Southbound, Tot = Total		

Side-street control delay was collected for the two previously identified locations. A survey period of 20 to 30 minutes was utilized during which vehicle arrivals and vehicle queues were recorded.

The project data collection was performed on Tuesday, April 24, 2012, which was determined to represent typical weekday conditions. Conditions were monitored to ensure the absence of unusual conditions such as weather, traffic accidents, road construction, emergency preemptions, etc.


PERFORMANCE EVALUATION

The before and after data were compiled from TruTraffic® to facilitate a comparison of select measures of effectiveness (MOEs) for both Sierra College Boulevard and the two side-street approaches. **Table 4** provides a summary of the MOEs utilized for the performance evaluation of the system.

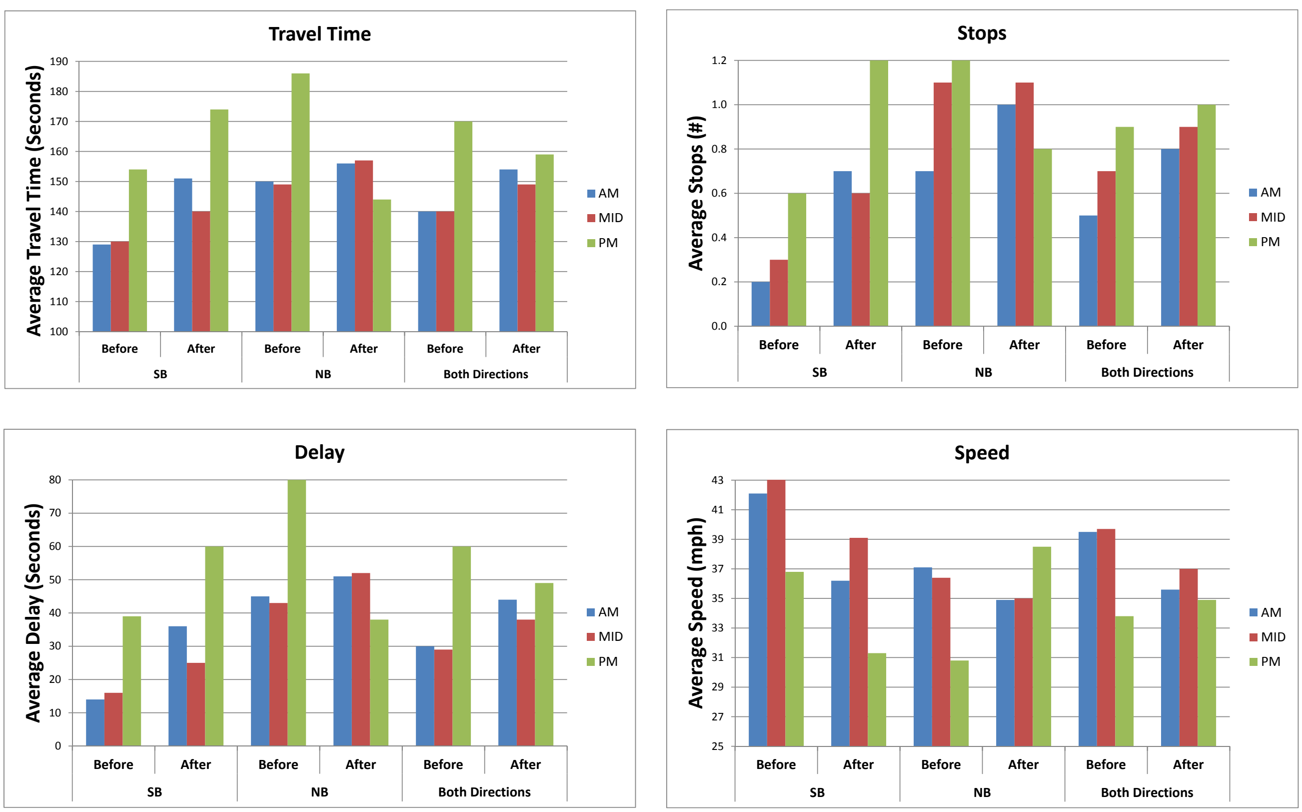
Table 4: Measures of Effectiveness

MOE	Unit	Facility
Average Travel Time	seconds	Sierra College Boulevard
Average Delay	seconds	
Average Stops	number	
Average Speed	mph	
Average Delay per Stopped Vehicle	seconds	Side Streets
Average Delay per Approach Vehicle	seconds	
Percent Vehicles Stopped	percent	

Sierra College Boulevard Results

Graphs depicting the comparison data for Sierra College Boulevard operations are presented in **Figure 1**.

Figure 1 - Sierra College Boulevard Results

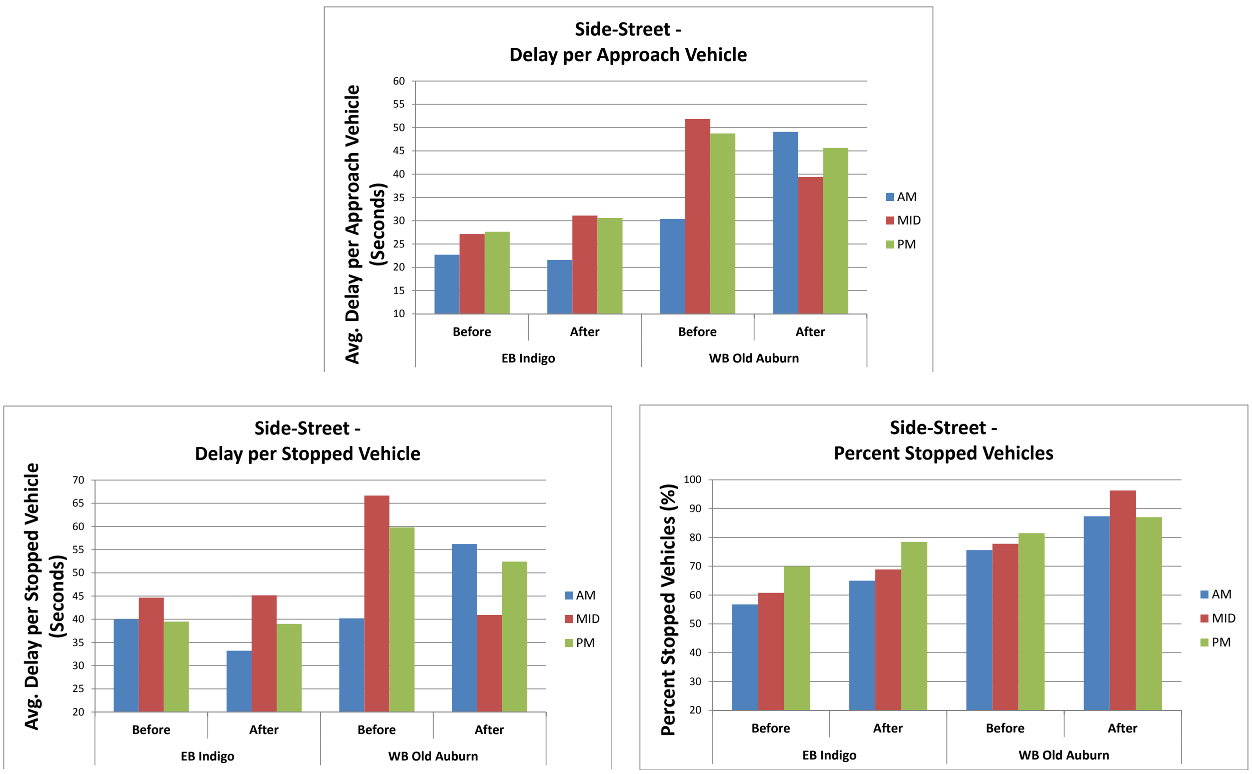


Source: Travel time runs conducted on Wednesday, November 16, 2011 (Before), and Tuesday, April 24, 2012 (After). Kimley-Horn and Associates, Inc.

Side-Street Results

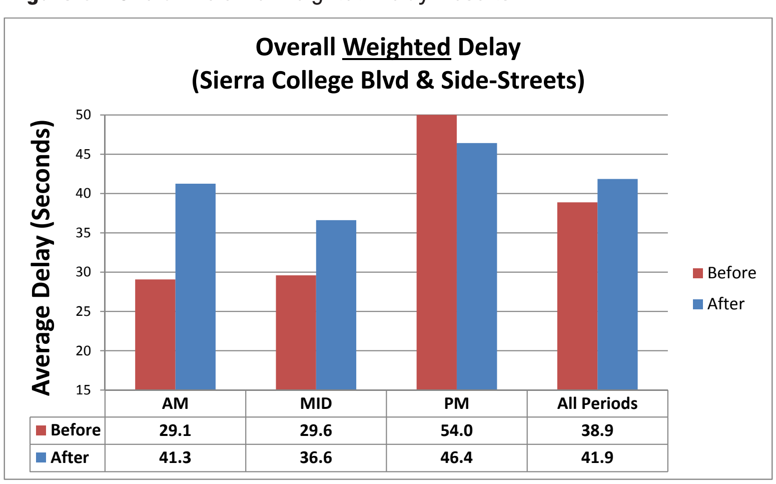
Figure 2 presents the comparison data for the two side-street approaches. Three MOEs are presented for the side-streets: Delay per Approach Vehicle (both those that stopped and those who didn’t), Delay per Stopped Vehicle, and Percent Stopped Vehicles. The data collection methodology utilized for this evaluation included recording of the total number of vehicles approaching (both those vehicles who stopped and those who did not) during the specified intervals, as well as the amount of delay experienced by those vehicles who stopped (completely). The calculation of percent stopped vehicles was simply the total number of stopped vehicles divided by the total approach volume.

Figure 2 - Side-Street Results



Source: Travel time runs and side-street data collection conducted on Wednesday, November 16, 2011 (Before), and Tuesday, April 24, 2012 (After). Kimley-Horn and Associates, Inc.

Figure 3 - Overall Volume Weighted Delay Results



	AM	MID	PM	All Periods
Before	29.1	29.6	54.0	38.9
After	41.3	36.6	46.4	41.9

Overall Results

In an effort to provide a more broad view of the effect of the implementation of the adaptive control system, an “overall” or “combined” data analysis was completed. As depicted in **Figure 3**, the average delay for Sierra College Boulevard (“Average Delay”) and the side streets (“Average Delay per Approach Vehicle”) were weighted by the corresponding hourly volumes and summarized for each peak period, as well as for a combination of all peak periods (AM, MID, and PM).

CONCLUSIONS

The following conclusions are offered based on the data presented in this report:

- When average delay for Sierra College Boulevard and the side streets (using "Average Delay" for Sierra College Boulevard and "Average Delay per Approach Vehicle" for the side streets) is volume weighted by the corresponding hourly volumes, an overall assessment of the project corridor demonstrates a 12.2 second increase of delay during the AM peak period, a 7.0 second increase of delay during the mid-day peak period, and a 7.6 second decrease of delay during the PM peak period with the addition of adaptive control.
- Travel time, and consequently delay, number of stops, and speed worsened with the addition of adaptive control for all three peak periods and for both directions of Sierra College Boulevard with the exception of northbound during the PM peak period.
  - » Northbound during the PM peak period experienced a 23 percent decrease in travel time and approximately one-half the delay when compared to the baseline condition.
  - » The average speed for the northbound direction of travel during the PM peak period increased by 25 percent.
- Generally speaking, the northbound travel direction was only marginally worse than the baseline condition for all time periods. Conversely, the southbound travel direction experienced a more significant degradation of traffic operating conditions with the addition of adaptive control.
- As for the two side-street approaches, adaptive control demonstrated mixed results at both locations, across all three time periods. Generally, the eastbound Indigo Creek Road approach improved during the AM peak period and the Old Auburn Road approach improved during the mid-day and PM peak periods.
- Adaptive control reduced the delay at the left-turns on Sierra College Boulevard and the side-street approaches by using shorter cycle lengths. However, the short cycle lengths resulted in numerous public complaints about short side-street green times that cut off queues of vehicles before they could make it through the green light. While not a continuous problem, these complaints were frequent and staff were unsuccessful in addressing these concerns.
- Additional enhancements to an adaptive control software addressing such concerns as the sudden arrival of large side street vehicle queues could make traffic adaptive a more viable option for the City of Roseville in the future.

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