

**CEDAR CREST BOULEVARD CORRIDOR**  
**POST-IMPROVEMENT REVIEW**

April 2012

*Prepared by:*

**Lehigh Valley Planning Commission**

*for the*

**Lehigh Valley Transportation Study**

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## INTRODUCTION

### Background on the Congestion Management Process (CMP)

The Safe Accountable Flexible Efficient Transportation Equity Act – A Legacy for Users (SAFETEA-LU), the nation’s surface transportation program, made changes to metropolitan and statewide planning efforts with regard to the Congestion Management Process (CMP). Known as the Congestion Management System (CMS) under previous federal transportation law, the CMP represents a systematic approach that provides for the safe and effective management and operation on new and existing transportation facilities through the use of demand reduction and operational management strategies. The CMP is required to be developed and implemented as an integral part of the metropolitan planning process in Transportation Management Areas (TMAs), urbanized areas over 200,000 population, and it represents the state of the art practice in addressing congestion.

The Lehigh Valley Transportation Study (LVTS), the metropolitan planning organization (MPO) for the Lehigh Valley, is responsible for the development, implementation, and continued operation of the CMP. The Lehigh Valley Planning Commission (LVPC) provides technical staff for the LVTS and prepares the CMP for MPO adoption.

The CMP is consistent with the emphasis on management and operations contained within SAFETEA-LU. Impediments to capacity additions as a congestion mitigation technique have driven efforts to extract more capacity from existing infrastructure through the use of management and operational approaches. Consequently, the CMP has grown to become an objectives-driven, performance-based approach to managing congestion.

The CMP helps metropolitan planning organizations to:

- Identify congested locations
- Determine the causes of congestion
- Develop alternative strategies to mitigate congestion
- Evaluate the potential of different strategies
- Propose alternative strategies that best address the causes and impacts of congestion
- Track and evaluate the impact of previously implemented congestion management strategies

The CMP represents a departure from the past practices of the CMS. The current emphasis is on obtaining maximum travel capacity on existing infrastructure through the utilization of management and operations practices, although not completely abandoning capacity adding infrastructure improvements. This shift is a result of the limited funding available for large-scale capacity projects, the long time frames needed to plan and build new infrastructure, and the potential adverse impacts on communities, land use, and air quality. Traveler concerns on congestion are now being addressed through better management and operations of the existing transportation infrastructure.

## **Relationship between CMP and the Congested Corridor Improvement Program**

The Congested Corridor Improvement Program (CCIP) intent is to implement low-cost, quick turn-around improvements to alleviate congestion expeditiously. The goal of the CCIP is a 20% reduction in peak hour travel times within the improved corridors. Projects that are identified in the Congestion Management Process become candidate projects for PennDOT's CCIP. Candidate projects are submitted by various metropolitan planning organizations and rural planning organizations into a statewide list of projects. PennDOT selects from this statewide candidate list those with the best merits for further study. This process led to the selection of the Cedar Crest Boulevard Corridor for further study.

## **Need for Post-Improvement Review of Improvement Strategy Effectiveness**

A process for the periodic assessment of the effectiveness of improvements made was implemented. This process involved a coordinated program of data collection used to gauge whether implemented improvements or strategies were successful at reducing levels of congestion. As documented in the CMP, various data collection efforts may include, but not be limited to the following:

- Level-of-Service – Delay
- Travel Speeds
- Travel Times
- Travel Time Index
- Vehicle Throughput
- Person Throughput
- On-Time Performance
- Incident Occurrence Rates
- Incident Duration
- Customer Satisfaction Surveys

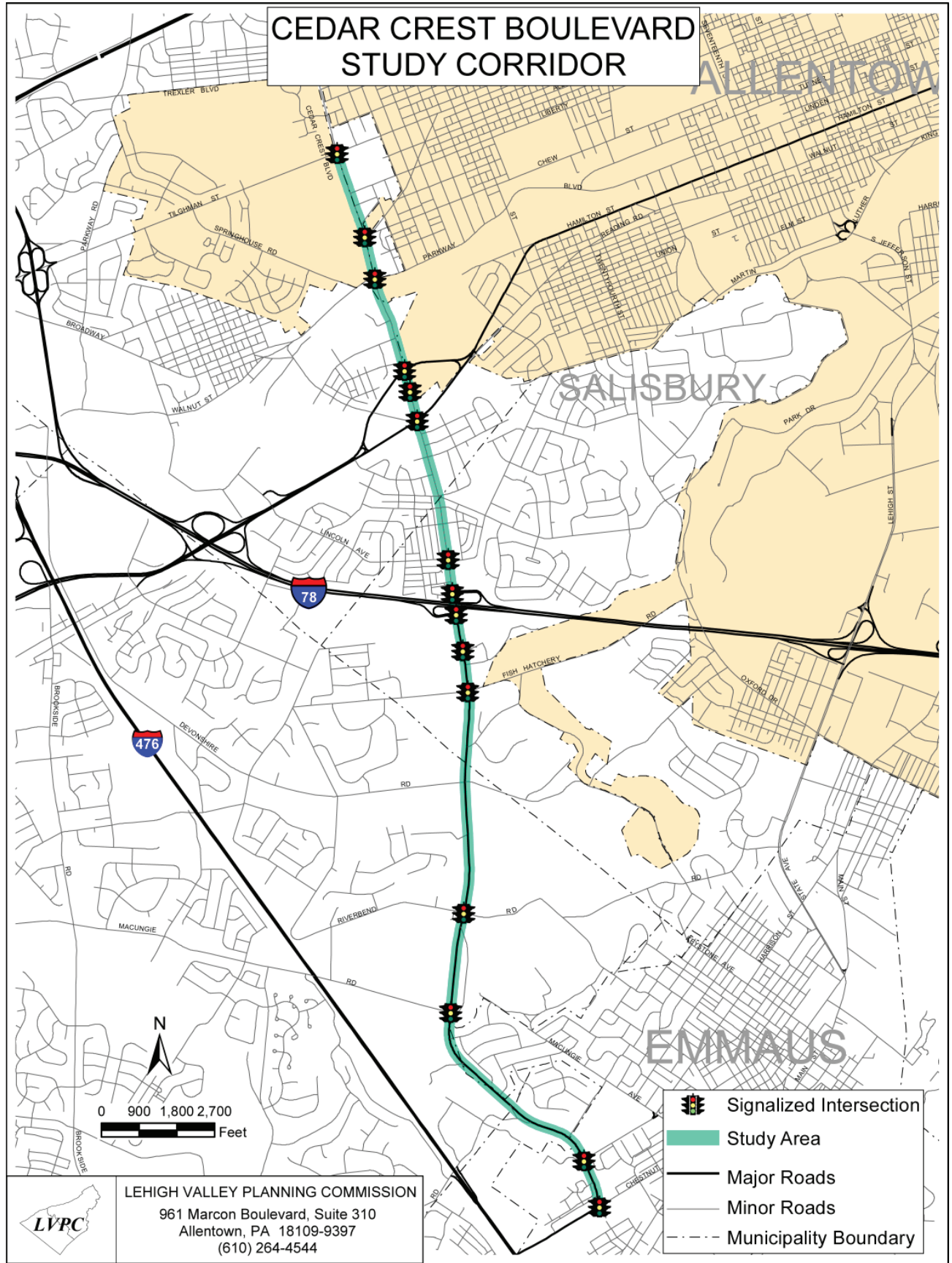
Appropriate data collection efforts will be chosen on a corridor by corridor basis taking into account existing data sources necessary for the pre-versus-post improvement scenarios. Performance monitoring will help achieve the desired reduction in congestion by allowing for adjustments to be made in the selection of strategies.

## **Study Location**

The Cedar Crest Boulevard study corridor begins at its intersection with Tilghman Street (SR 1002) in South Whitehall Township and Allentown, runs south through the City of Allentown, Salisbury Township, Lower Macungie Township, Upper Milford Township, and terminates at Chestnut Street (SR 2005) in Emmaus Borough. The corridor is located entirely in Lehigh County. PennDOT owns the corridor in its entirety. The portion of the corridor from Tilghman Street (segment/offset 0054/1335) to I-78 (segment/offset 10/0000) is SR 1019. The portion from I-78 (segment/offset 170/2097) to Chestnut Street in Emmaus (segment/offset 10/0000) is SR 0029. See the following project location map.



# Project Location Map



## EXISTING CONDITIONS

### Corridor Description

This corridor was originally defined as Route 22 to Chestnut Street. Three of the 18 signalized intersections located in the north end of the corridor were not included in this effort at the direction of PennDOT since they were considered in conjunction with a retail development. The elimination of the three traffic signals shortens the corridor to 5.13 miles between the northern terminus of Tilghman Street (SR 1002) and the southern terminus of Chestnut Street (SR 2005).

The corridor is divided into three sections. The first section runs from Tilghman Street to Hamilton Boulevard Bypass. This section is 1.09 miles long and has a two-lane cross-section with turning lanes at major intersections. A center left turn lane is present from Tilghman Street (SR 1002) to Broadway (SR 2008). The first section of corridor borders predominantly residential land uses. However, retail/commercial, park land, and educational/institutional land uses are also present. It is classified as a principal arterial, is an undivided corridor, and is posted for 40 mph.

The second section runs from Hamilton Boulevard Bypass to Fish Hatchery Road (SR 2010). This section is 1.45 miles long and has both two-lane and four-lane cross sections. This portion of corridor borders primarily retail/commercial and medical/institutional land uses. It is classified as a principal arterial, is both undivided and divided with mountable curbs, and posted for 40 mph between the Hamilton Boulevard Bypass and Hamilton Boulevard and 45 mph between Hamilton Boulevard and Fish Hatchery Road.

The third section runs 2.60 miles from Fish Hatchery Road (SR 2010) to Chestnut Street (SR 2005). This portion of corridor fronts primarily residential and agricultural land uses but does abut educational/institutional land uses also. It is classified as a principal arterial, is undivided, and is posted for 45 mph between Fish Hatchery Road (SR 2010) to Lower Macungie Road (SR 2012). The section from Lower Macungie Road to Chestnut Street is posted at 40 mph.

The entire corridor is located within the urbanized area. Fifteen traffic signals are located in the corridor. They are found at Tilghman St., Chew St., Broadway, Hamilton Boulevard Bypass, The Shops at Cedar Point driveway, Hamilton Boulevard, Lincoln Ave., I-78 westbound ramps, I-78 eastbound ramps, Lehigh Valley Hospital driveway, Fish Hatchery Rd., Riverbend Rd., Lower Macungie Rd., North St., and Chestnut St.

The northern portion of the corridor between Tilghman Street and Broadway contains a mix of retail/commercial and residential development to the east. The western side of the corridor abuts Trexler Park. Between Broadway and the Hamilton Boulevard Bypass, the Cedar Creek Park fronts both sides of the roadway while Cedar Crest College is located on the southeast end of the corridor. Residential development abuts the corridor on the southwest. Retail/commercial development occupies the corridor in its entirety between the Hamilton Boulevard Bypass and Hamilton Boulevard. The section of corridor between Hamilton Boulevard and I-78 contains mostly residential with some interspersed commercial development. The area between I-78 and Fish Hatchery Road contains primarily medical facilities. Farmland, low density residential, and the Lehigh County Country Club are the only land uses between Fish Hatchery Road and Lower Macungie Road. This farmland could be subject to development pressures as the economy recovers and the resulting impact would be additional traffic in the corridor. Between Lower Macungie Road and Chestnut Street, the western side contains a golf course and apartments while the east side contains both single family detached housing, apartments, and the Emmaus High School.

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The Cedar Crest Boulevard corridor is important for a number of reasons. First, it carries SR 1019/SR 29 in a north/south path through the City of Allentown's west end, connecting with portions of South Whitehall Township, Salisbury Township, Lower Macungie Township, Upper Milford Township, and ultimately Emmaus Borough. It provides access to varied retail and commercial developments, Dorney Park and Wildwater Kingdom amusement park, as well as the Lehigh Valley's largest medical campus, Lehigh Valley Hospital, and numerous other medical institutions along the corridor. Traffic along the corridor was anticipated to increase by about 9,000 average daily traffic (ADT) as a result of the 550,000 square foot Lehigh Valley Hospital expansion.

Second, the corridor was rated as the first priority CMS corridor yet to be studied by the Lehigh Valley Transportation Study. The reasons for the high priority ranking are twofold: the projected 2030 level-of-service for the corridor is "E" and the 1998-2000 accident rate was 8% higher than the statewide average for this type of facility. In 2000, this corridor was measured at a level-of-service D utilizing the Lehigh Valley Regional Travel Demand Forecasting Model. Traffic volumes along the corridor ranged from 10,100 in the southern portion to 26,100 around the I-78 interchange. In 2030, the Lehigh Valley Regional Travel Demand Forecasting Model predicts this volume to increase to 16,900 and 34,800, respectively. The corridor experiences primarily morning and afternoon peak hour congestion on a daily (recurring) basis as well as incident-driven congestion with a higher than statewide average for the facility type. In addition, the corridor is one of the longer corridors identified in the CMS.

## **Pedestrian Facilities**

Sidewalks and pedestrian crossings are located at some of the intersections and intersection approaches along the corridor. Pedestrian crossings are more prominent than sidewalks. Sidewalks exist at the following locations:

- Southeast quadrant of the Tilghman Street/Cedar Crest Boulevard intersection
- Between most of the Hamilton Boulevard Bypass and Hamilton Boulevard
- On the eastern side of Cedar Crest Boulevard between Pine Street and North Street (adjacent to Emmaus High School)
- Between most of North Street and Chestnut Street

Traffic signals with pedestrian push buttons include:

- Tilghman Street
- Chew Street
- Hamilton Boulevard Bypass
- Shops at Cedar Point
- Hamilton Boulevard
- Lincoln Avenue
- Lehigh Valley Hospital Access/Juniper Road
- Fish Hatchery Road
- North Street
- Chestnut Street

## Public Transportation Services

Public transportation services are provided by the Lehigh and Northampton Transportation Authority (LANta). The corridor is served by the following bus routes:

- 107 Hanover Avenue – Crest Plaza
- 218 LCCC – Walnutport
- 213/613 Lehigh Valley West – Fogelsville
- 102 Bethlehem – Lehigh Valley Hospital Cedar Crest
- 322 Hamilton Boulevard – Trexlertown

Buses on these routes generally run every 30 to 60 minutes.

## RECOMMENDED IMPROVEMENTS

In August 2006, Edwards and Kelsey, PennDOT's consultant, completed a study titled *Congested Corridor Improvement Program - Cedar Crest Boulevard*. The report made recommendations for immediate (within 6 months, low cost), short-term (0 – 3 years), and long-term (4 – 10 years) improvements in the corridor as follows:

### Immediate Improvement Recommendations

- Traffic Signal Optimization and Coordination – Time-based coordination and optimization of traffic signal timings to enhance the operation of every signalized intersection on the corridor. The signalized intersections would be divided into three groups and coordinated together with the same signal cycle lengths, phases, splits, and offsets. Each group would have its own coordination and include the following intersections:
  - ◇ Chew Street, Broadway/Parkway Boulevard, Hamilton Boulevard Bypass, Shops at Cedar Point, and Hamilton Boulevard
  - ◇ Lincoln Avenue, I-78 Westbound Ramp, I-78 Eastbound Ramp/Professional Park Drive, Lehigh Valley Hospital/Juniper Road, and Fish Hatchery Road
  - ◇ North Street and Chestnut Street

### Short-Term Improvement Recommendations

- Time-based Coordination and Operation of Traffic Signal Timings
- Traffic Signal Operation – Installation of a closed loop system from Tilghman Street to Fish Hatchery Road to allow for remote monitoring of traffic signals and possible operation of a traffic-responsive system. GPS Time Source units should be installed at each of the intersections on the southern end of the corridor and optimized signal timings should be inputted into the controllers.
- Traffic Signal Phase Change – The addition of protected-permitted phase changes will enhance the operation of the Tilghman Street and Shops at Cedar Point intersections. The eastbound, westbound and northbound left turn phases will be changed at Tilghman Street. The Shops at Cedar Point has an exclusive northbound left turn lane and will be improved with a protected-permitted left turn phase.

## **Long-Term Improvement Recommendations**

- Tilghman Street Intersection Improvements – Construct an additional through lane in both directions at Tilghman Street to enhance the operation of traffic at the intersection. The construction of an additional southbound left turn lane at Tilghman Street will improve left turn movements.
- Broadway/Parkway Boulevard Intersection Improvements – Construct an additional through lane in both directions to enhance traffic operations at this intersection.
- Lower Macungie Road Intersection Improvement – Construct a northbound left turn lane. The lane will be lengthened 300 feet and will involve widening the bridge over the Little Lehigh Creek.
- Variable Message Signs – Deploy small variable message signs in advance of Route 22 in the southbound direction and in advance of I-78 in the northbound direction to alert motorists of incidents on the highway and help redirect traffic away to alternate routes.
- Indian Creek Road Intersection Improvement – Reconfigure Cedar Crest Boulevard and Indian Creek Road to enhance the safety of the intersection.

## **IMPLEMENTED IMPROVEMENTS**

PennDOT implemented the following improvements within the corridor:

### **Time Base Coordination with GPS**

- Cedar Crest Blvd./Chestnut St. – Signal modifications, new controller, uninterrupted power source (UPS), emergency preemption
- Cedar Crest Blvd./North St. – retiming, yellow Light Emitting Diodes (LEDs), emergency preemption
- Cedar Crest Blvd./Lower Macungie Rd. – retiming, yellow LEDs
- Cedar Crest Blvd./Riverbend Rd. – new controller, retiming, yellow LEDs

### **Closed Loop System – Spread Spectrum Radio**

- Cedar Crest Blvd./Fish Hatchery Rd. – closed loop system loops, retiming, UPS
- Fish Hatchery Rd./Lehigh Valley Hospital – retiming
- Cedar Crest Blvd./Lehigh Valley Hospital – closed loop system phone drop, retiming, UPS
- Cedar Crest Blvd./I-78 eastbound off ramp – closed loop system loops, retiming, UPS
- Cedar Crest Blvd./I-78 westbound off ramp – closed loop system loops, retiming, UPS
- Cedar Crest Blvd./Lincoln Ave. – closed loop system loops, retiming, UPS
- Cedar Crest Blvd./Hamilton Blvd. – closed loop system loops and phone drop, new controller, retiming, emergency preemption
- Cedar Crest Blvd./Shops at Cedar Point – new controller, retiming, emergency preemption, LEDs
- Cedar Crest Blvd./Hamilton Blvd. Bypass – closed loop system loops, new controller, retiming, emergency preemption
- Cedar Crest Blvd./Broadway/Parkway Blvd. – closed loop system loops and phone drop, new controller, retiming, emergency preemption
- Cedar Crest Blvd./Chew St. – new signal, retiming, emergency preemption, ADA ramps
- Cedar Crest Blvd./Tilghman St. – new signal, retiming, emergency preemption, ADA ramps, lengthen eastbound left turn lane

## DATA COLLECTION FOR PRE- AND POST-IMPROVEMENT SCENARIOS

The LVPC conducted pre-improvement data collection on Tuesday, October 20, 2009 and Thursday, October 22, 2009. Machine traffic counters collected travel volume data on Tuesday, October 20 and on Thursday, October 22 between Pine Street and Moravian Blvd. in the southern part of the corridor and between Chestnut Drive and Parkway Blvd. in the north in 15 minute intervals. Data from the counts conducted on Tuesday was utilized to determine the AM, mid-day, and PM peak hours of traffic (4 consecutive 15 minute intervals of the highest traffic volumes). The peak hours varied depending on the location of the counters. On Cedar Crest Blvd., between Pine St. and Moravian Blvd., the peak hours are as follows:

AM	7:00 – 8:00
Mid-Day	11:30 – 12:30
PM	5:00 – 6:00

On Cedar Crest Blvd. between Chestnut Drive and Parkway Blvd., the peak hours are as follows:

AM	8:00 – 9:00
Mid-Day	12:00 – 1:00
PM	4:45 – 5:45

Given these peak hours of operation, the decision was made to conduct the speed and delay runs starting about ½ hour before and ending about ½ hour after the peak periods.

Travel speed and delay runs were conducted in the corridor for the AM, mid-day, and PM peak hours, with the highest traffic volumes occurring during the PM peak. The travel speed and delay study provides information on how long it takes to travel the 5.13 mile corridor and the causes of delay. The study was conducted during the three time periods, utilizing a combination of the average vehicle and floating vehicle methods. The average vehicle method requires the driver to perform several runs of the corridor while traveling the average speed of the traffic stream by use of their judgement. This approach was utilized on one-lane portions of the corridor. The floating vehicle method was applied where the corridor contained passing lanes. This technique has the driver floating with the traffic by attempting to safely pass as many vehicles as pass the test vehicle. An observer in the vehicle records causes of delay, stopping points, and the running time between checkpoints. Five travel runs were conducted in each direction for each time period.

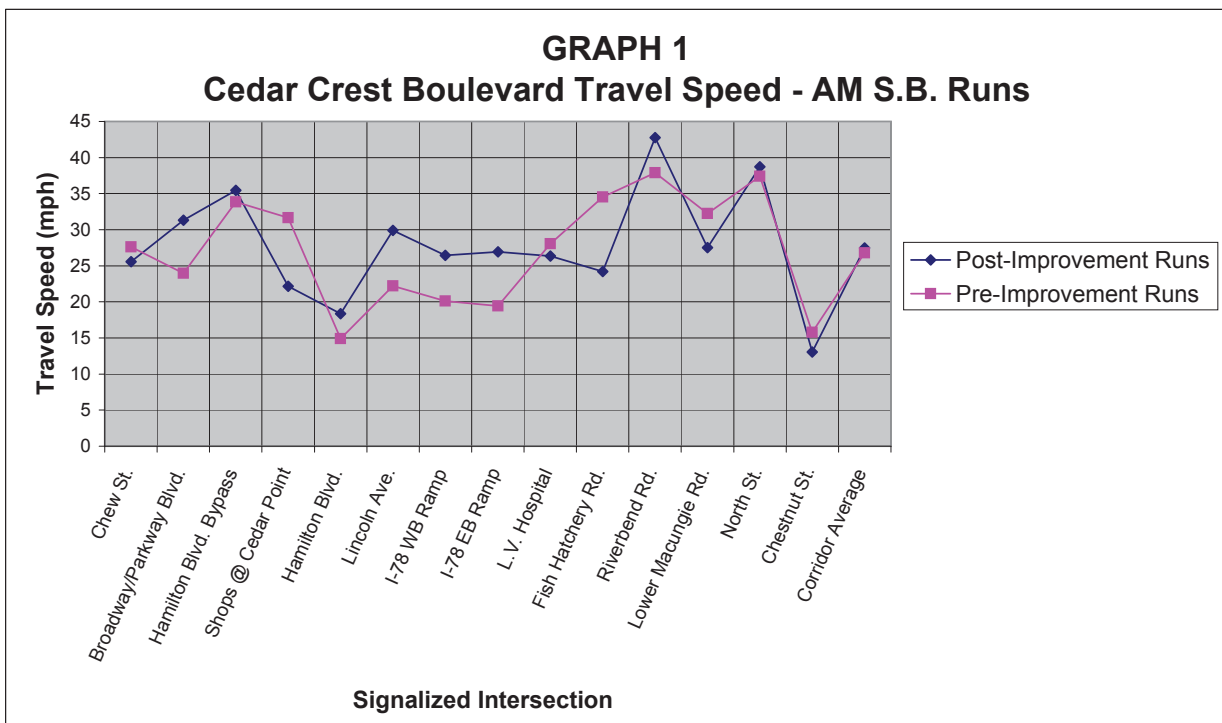
Post-improvement data collection efforts were conducted on Wednesday, January 11, 2012. Again, travel speed and delay runs were conducted and mirrored those performed for the pre-improvement data collection effort.

Pre-improvement and post-improvement data collection efforts, under ideal conditions, should be conducted during the same month and same day of week to eliminate any bias in traffic differences. Data collection scheduling issues did not allow for post-improvement data to be collected on the same month or day as the pre-improvement data. The 2009 and 2010 Pennsylvania Traffic Data reports from PennDOT were reviewed for traffic volume equilibrium factors that are utilized to remove seasonal and daily bias from traffic volume data. Thursdays in October had a factor of 0.881 while Wednesdays in January had a factor of 0.889 for arterial roads. Although these factors apply to traffic volumes and not travel speeds, a correlation was drawn based upon the factors that the differences in data collection by time of year and day of week were statistically insignificant to affect traffic volumes and thus travel speeds.

## POST-IMPROVEMENT REVIEW ANALYSIS AND FINDINGS

The following six graphs depict operating conditions during both the pre-improvement (2009) and post-improvement (2011) periods on the corridor. The average travel speed of all five runs by time period by direction by section of corridor are portrayed. Also, the average travel speed of the corridor as a whole by direction by time period is shown.

Graph 1 depicts average travel speeds on the corridor for the AM peak period for all five southbound travel runs conducted. Data points depict the average travel speed between signalized intersection segments. For example, the section of corridor between Chew Street and Broadway/Parkway Boulevard had an average travel speed of 23.98 mph and 31.34 mph for the pre- and post-improvement scenarios, respectively. Eight of the 15 corridor segments (53%) had travel speeds increase as a result of the implemented improvements. The average travel speed for the entire corridor increased by 0.67 mph from 26.78 mph to 27.45 mph.

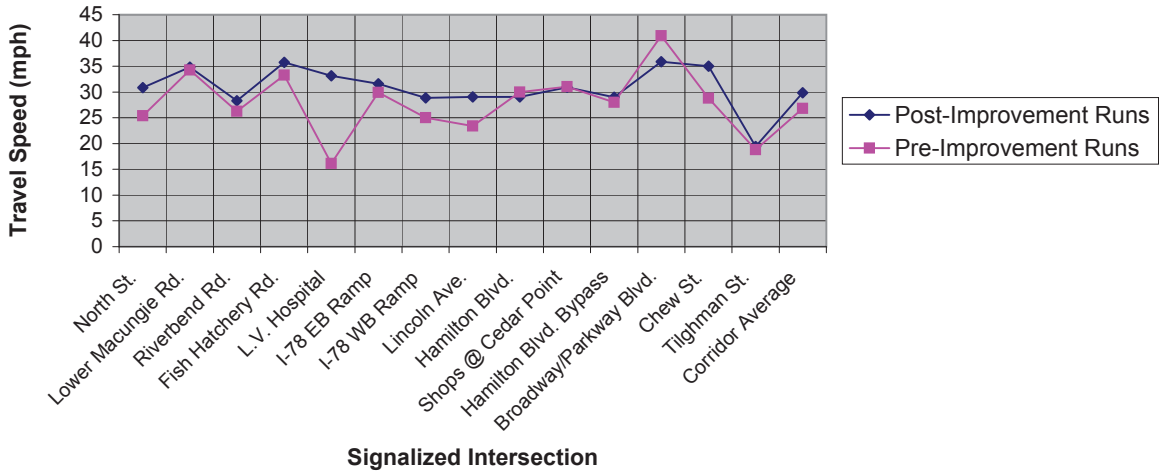


Graph 2 depicts average travel speeds on the corridor for the AM peak period for all five northbound travel runs conducted. Eleven of the 15 corridor segments (73%) had travel speeds increase as a result of the implemented improvements. The average travel speed for the entire corridor increased by 3.05 mph from 26.83 mph to 29.88 mph.

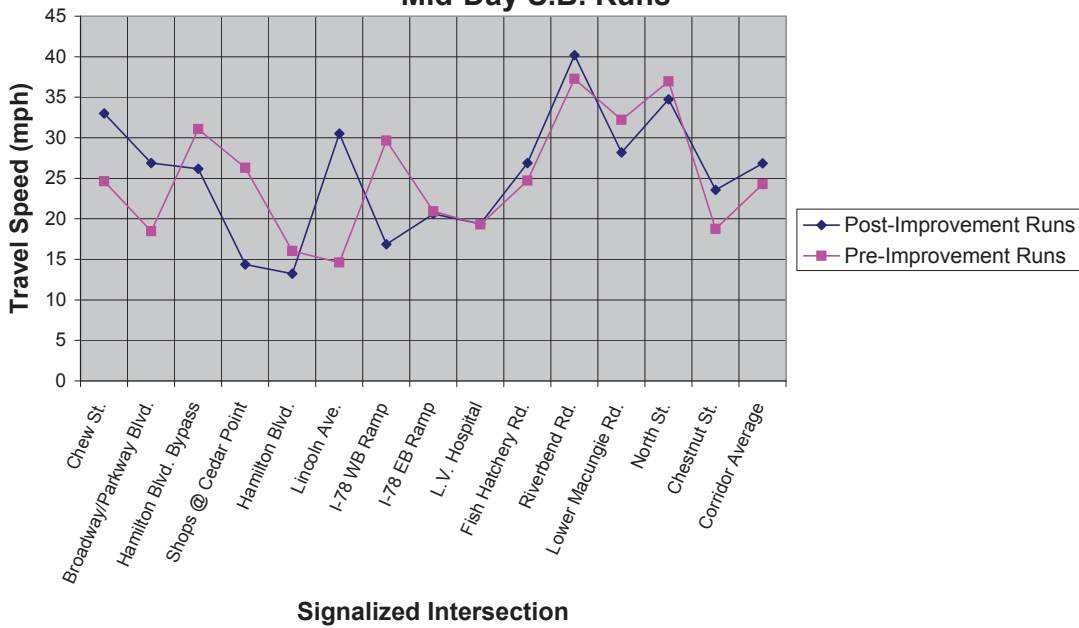
Graph 3 depicts average travel speeds on the corridor for the mid-day peak period for all five southbound travel runs conducted. Seven of the 15 corridor segments (47%) had travel speeds increase as a result of the implemented improvements. The average travel speed for the entire corridor increased by 2.57 mph from 24.26 mph to 26.83 mph.

Graph 4 depicts average travel speeds on the corridor for the mid-day peak period for all five northbound travel runs conducted. Ten of the 15 corridor segments (67%) had travel speeds increase as a result of the implemented improvements. The average travel speed for the entire corridor increased by 3.48 mph from 24.68 mph to 28.16 mph.

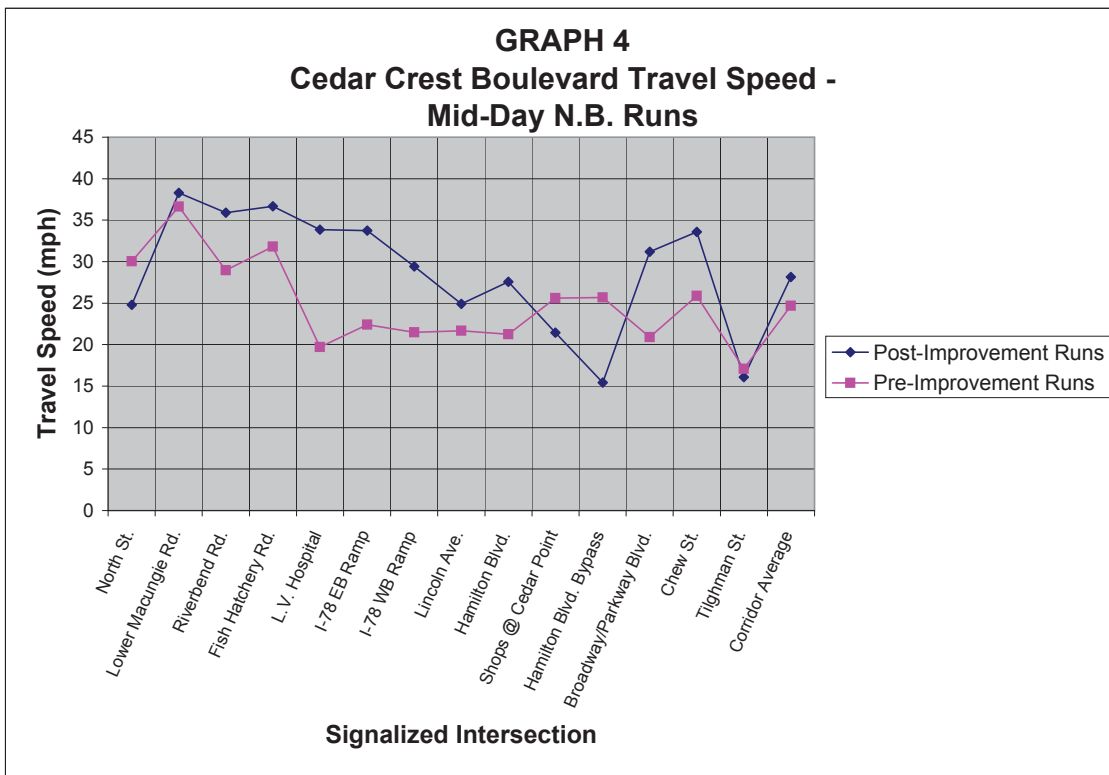
**GRAPH 2  
Cedar Crest Boulevard  
Travel Speed - AM N.B. Runs**



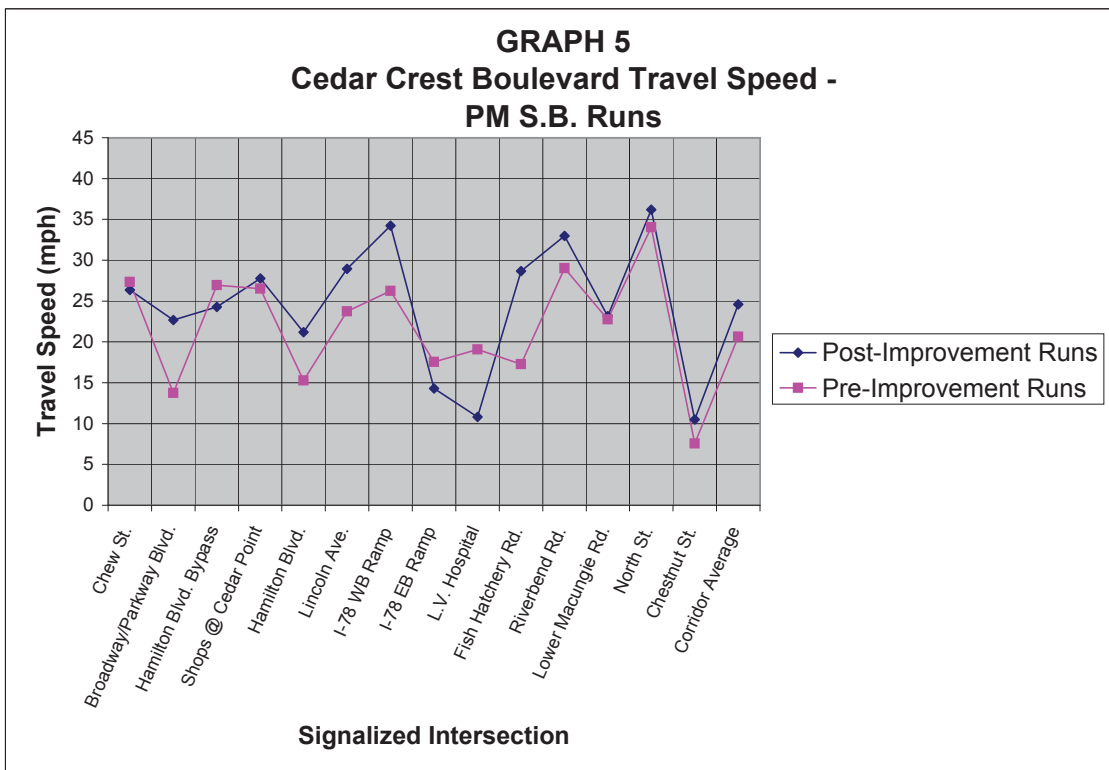
**GRAPH 3  
Cedar Crest Boulevard Travel Speed -  
Mid-Day S.B. Runs**



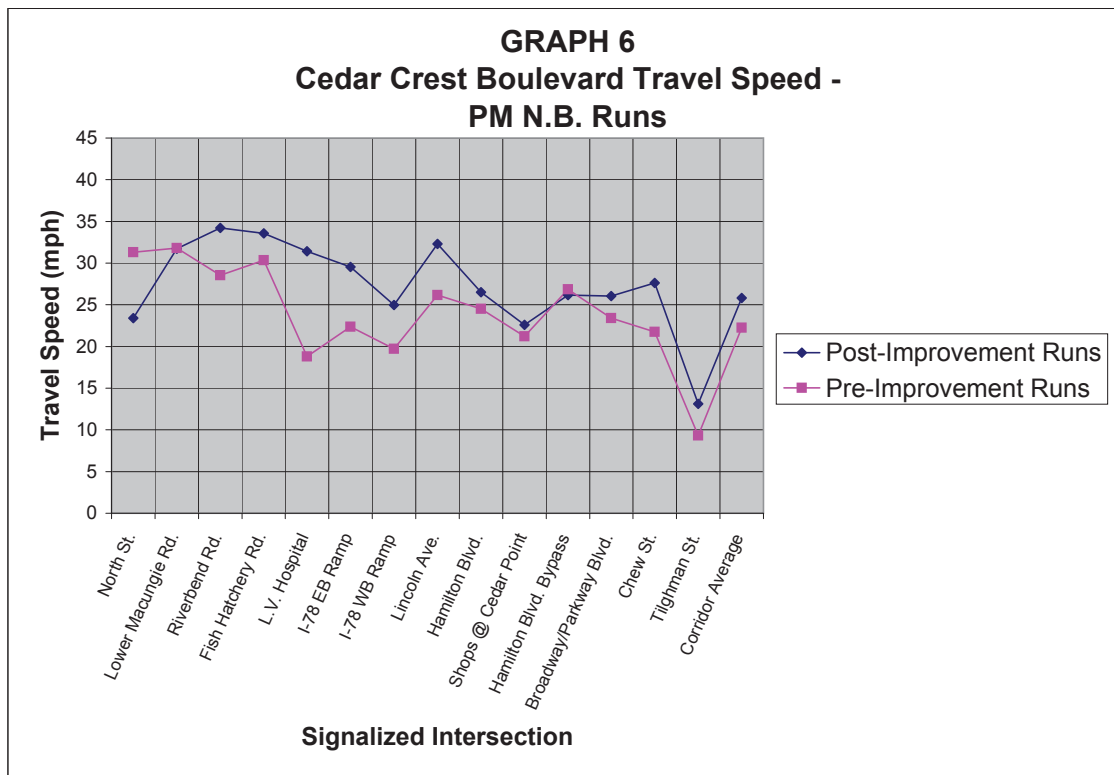




Graph 5 depicts average travel speeds on the corridor for the PM peak period for all five southbound travel runs conducted. Ten of the 15 corridor segments (67%) had travel speeds increase as a result of the implemented improvements. The average travel speed for the entire corridor increased by 3.96 mph from 20.64 mph to 24.60 mph.



Graph 6 depicts average travel speeds on the corridor for the PM peak period for all five northbound travel runs conducted. Eleven of the 15 corridor segments (73%) had travel speeds increase as a result of the implemented improvements. The average travel speed for the entire corridor increased by 3.53 mph from 22.27 mph to 25.80 mph.

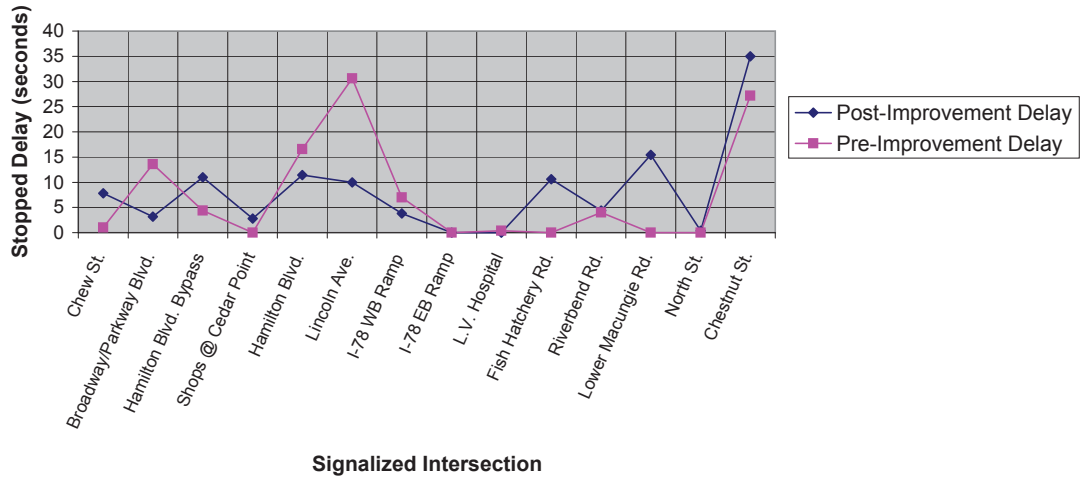


Graphs 7 through 12 depict the average cumulative stopped delay of all five runs by time period by direction by section of corridor. Graph 7 depicts cumulative average stopped delay on the corridor for the AM peak period for all five southbound travel runs conducted. For example, the section of corridor between Chew Street and Broadway/Parkway Boulevard had an average stopped delay of 13.6 seconds and 3.2 seconds for the pre- and post-improvement scenarios, respectively. Five of the 15 corridor segments (33%) had stopped delay decrease as a result of the implemented improvements. The average stopped delay for the entire corridor increased by 11 seconds from 104.8 seconds to 115.8 seconds.

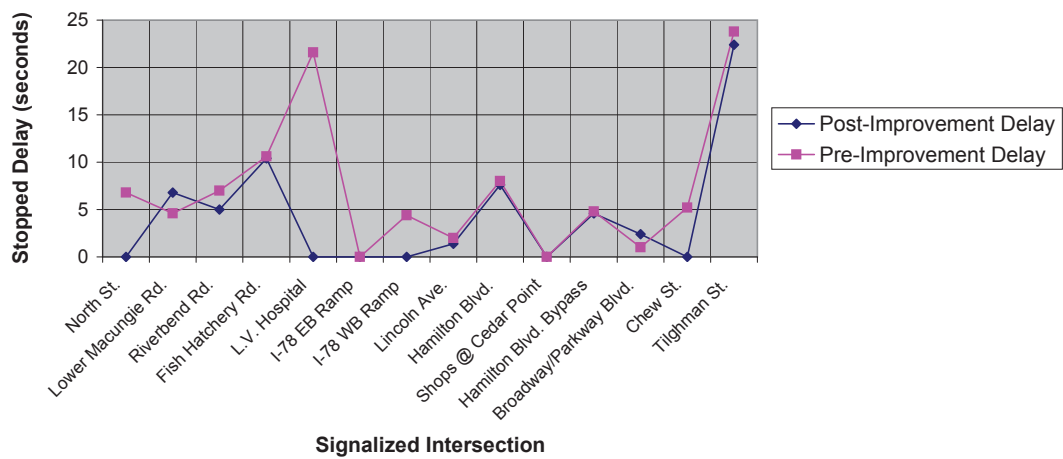
Graph 8 depicts cumulative average stopped delay on the corridor for the AM peak period for all five northbound travel runs conducted. Ten of the 15 corridor segments (67%) had stopped delay decrease as a result of the implemented improvements. The average stopped delay for the entire corridor decreased by 39.2 seconds from 99.8 seconds to 60.6 seconds.

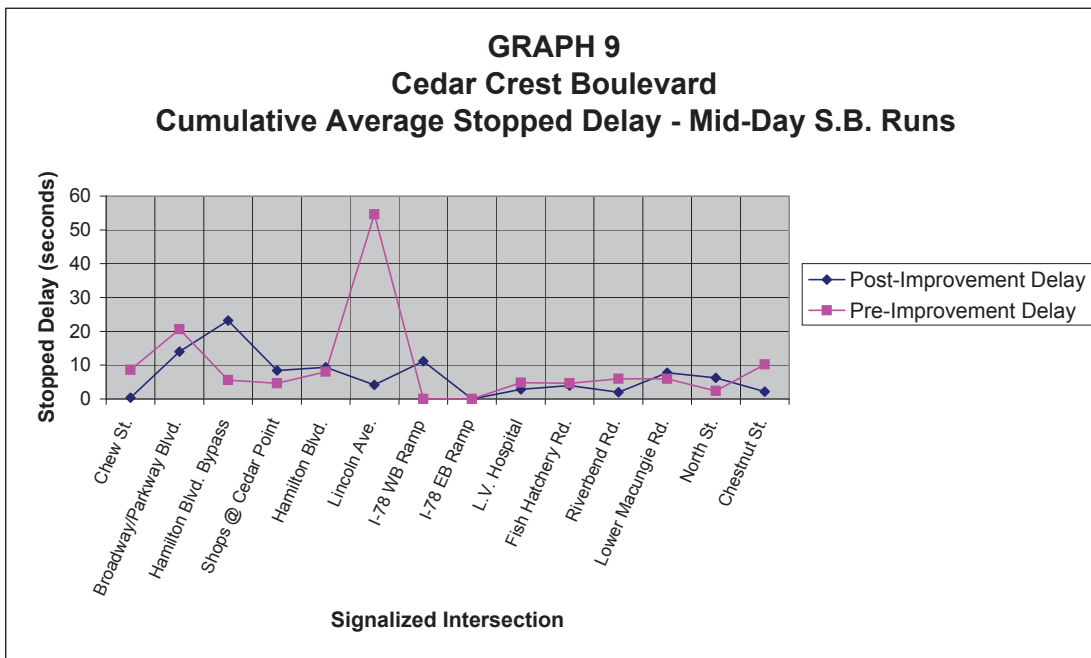
Graph 9 depicts cumulative average stopped delay on the corridor for the mid-day peak period for all five southbound travel runs conducted. Seven of the 15 corridor segments (47%) had stopped delay decrease as a result of the implemented improvements. The average stopped delay for the entire corridor decreased by 40.2 seconds from 136 seconds to 95.8 seconds.

**GRAPH 7**  
**Cedar Crest Boulevard**  
**Cumulative Average Stopped Delay - AM S.B. Runs**

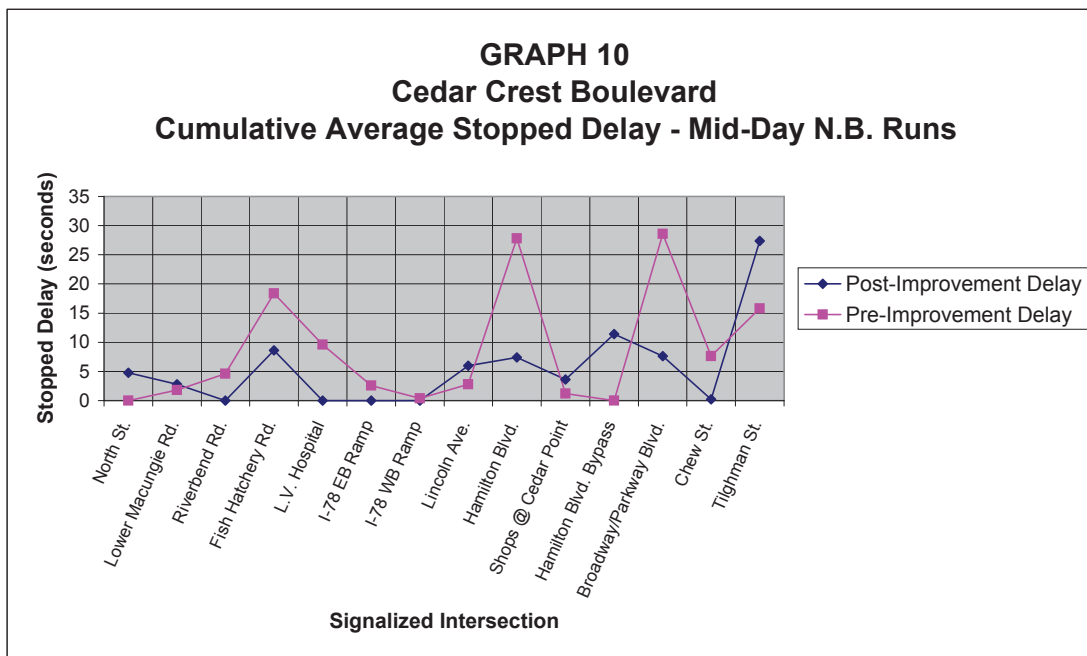


**GRAPH 8**  
**Cedar Crest Boulevard**  
**Cumulative Average Stopped Delay - AM N.B. Runs**

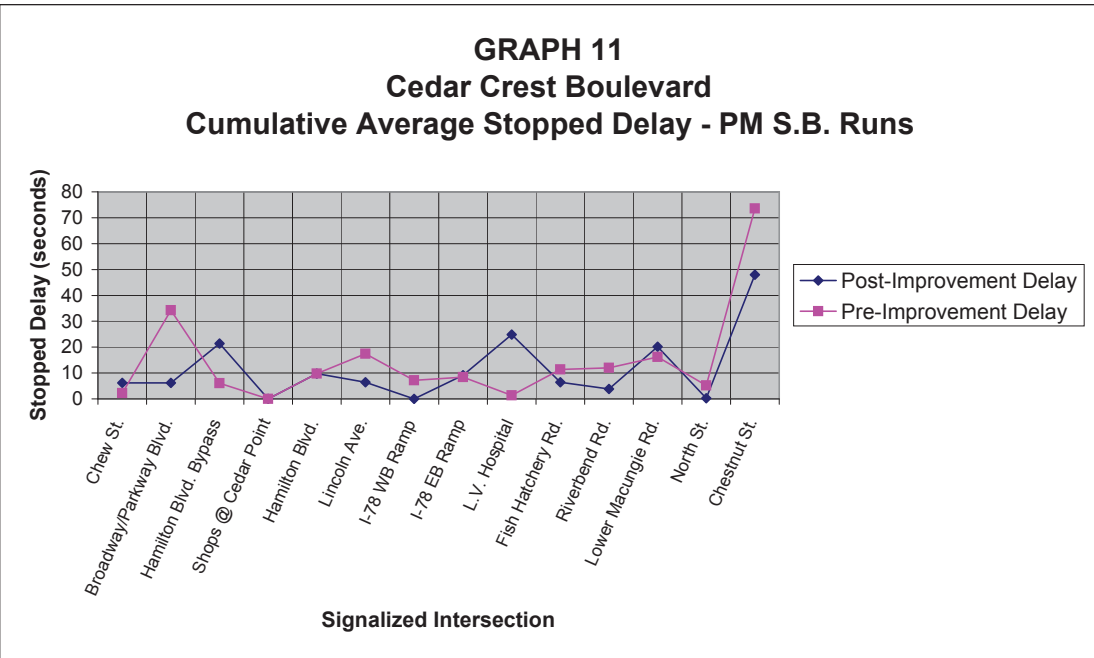




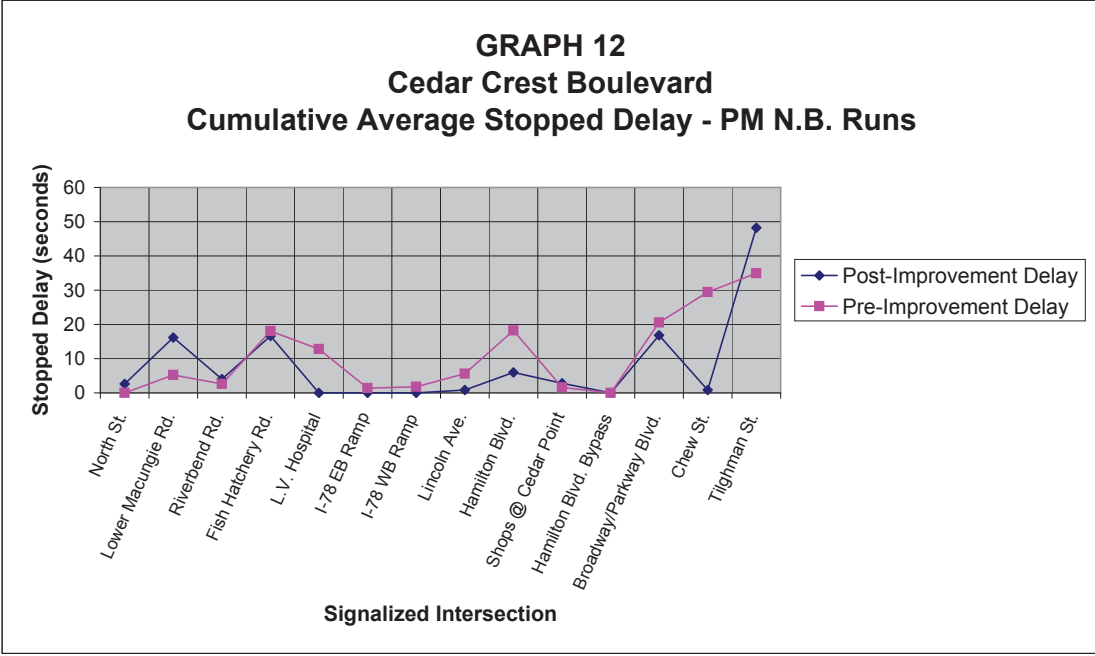
Graph 10 depicts cumulative average stopped delay on the corridor for the mid-day peak period for all five northbound travel runs conducted. Eight of the 15 corridor segments (53%) had stopped delay decrease as a result of the implemented improvements. The average stopped delay for the entire corridor decreased by 41.4 seconds from 121.2 seconds to 79.8 seconds.



Graph 11 depicts cumulative average stopped delay on the corridor for the PM peak period for all five southbound travel runs conducted. Seven of the 15 corridor segments (47%) had stopped delay decrease as a result of the implemented improvements. The average stopped delay for the entire corridor decreased by 42.4 seconds from 205 seconds to 162.6 seconds.



Graph 12 depicts cumulative average stopped delay on the corridor for the PM peak period for all five northbound travel runs conducted. Eight of the 15 corridor segments (53%) had stopped delay decrease as a result of the implemented improvements. The average stopped delay for the entire corridor decreased by 37.4 seconds from 152.2 seconds to 114.8 seconds.



As mentioned earlier in this report, the goal of the CCIP is a 20% reduction in peak hour travel times within the improved corridor. To measure the effectiveness of improvements implemented along the corridor, summary statistics were compiled for all five travel runs conducted in the corridor for the morning, mid-day, and afternoon peak periods by direction both prior to and

after improvements were implemented. Table 1 depicts the change in travel times (measured in seconds) and the percent reduction in travel times.

**TABLE 1**

	Change in Travel Times (seconds)					
	Southbound			Northbound		
	Pre-Improvement	Post-Improvement	% Reduction	Pre-Improvement	Post-Improvement	% Reduction
<b>AM</b>	3,537	3,384	4.33%	3,476	3,129	9.98%
<b>Mid-Day</b>	3,878	3,464	10.68%	3,743	3,289	12.13%
<b>PM</b>	4,489	3,974	11.47%	4,196	3,595	14.32%

Travel times decreased as a result of the implemented improvements in all instances. The greatest reductions occurred during the PM peak period with an 11.47% reduction in southbound travel times and a 14.32% reduction in northbound travel times. The mid-day period had the next largest reduction in travel times at 10.68% for the southbound movement and 12.13% for the northbound movement. The smallest reduction in travel times occurred during the AM peak period at 4.33% for the southbound movement and 9.98% for the northbound movement.

Although the improvements did not achieve the CCIP goal of a 20% reduction in travel times, tangible and significant travel time reductions were still realized. In addition, significant reductions in stopped delay were also realized as depicted in Table 2. Percentage reductions in stopped delay ranged from 20.68% for the PM southbound movement to 39.28% for the AM northbound movement. The southbound AM movements saw an increase in delay by 10.5%, but delay in the corridor overall decreased in the morning peak.

**TABLE 2**

	Change in Stopped Delay (seconds)					
	Southbound			Northbound		
	Pre-Improvement	Post-Improvement	% Change	Pre-Improvement	Post-Improvement	% Change
<b>AM</b>	524	579	-10.50%	499	303	39.28%
<b>Mid-Day</b>	680	479	29.56%	606	399	34.16%
<b>PM</b>	1,025	813	20.68%	761	574	24.57%

In summary, the amount of stopped delay within most segments of the corridor has decreased while some corridor segments increased in delay. However, the overall net impact was one of shorter durations of delay within the corridor. Similarly, corridor segment travel times decreased in most instances. Corridor-wide travel times were reduced as a result of the implemented signal improvements.

## FIELD OBSERVATIONS

Some rather peculiar observations were made during the travel speed and delay runs. The corridor as a whole did not experience congestion throughout the peak period, but rather experienced sporadic congestion at specific locations, usually in one direction only and usually in the direction opposite of the test vehicle. For example, long queues of congestion were noticed in



the northbound movement approaching Tilghman St. while heading southbound. Long queues of congestion were also observed heading southbound toward Lincoln Ave. Again, this was usually witnessed while heading northbound. Once we got caught in the southbound movement approaching this intersection and experienced this delay. Another area of peculiarity was the northbound traffic approaching Lower Macungie Rd., which, on occasion, backed up considerably past Moravian Blvd. (again, occurring while heading southbound). This particular backup likely occurred due to the choke point of the 2-lane bridge over Lehigh Creek (allowing for only one lane in each direction) on Cedar Crest Blvd. just south of the Lower Macungie Road traffic signal. Northbound vehicles wishing to turn left at the signalized intersection may hold up traffic behind them, which, if the queues are long enough, allow for only one lane of traffic on the bridge (there is no stacking room for a dedicated left turn lane on the bridge).

A steadily increasing and consistent period of congestion was anticipated to occur during the peak hour. Instead, congestion occurred sporadically within the peak periods. This may be caused, in part, by the weak economy and resulting drop in traffic volumes. Had the economy been strong and robust, the traffic volumes would likely have been higher resulting in greater levels of congestion for longer durations of time, not the sporadic, directional intense congestion experienced in the field.

## **GENERAL RECOMMENDATIONS**

Traffic signal retiming and coordination are cost effective ways to reduce traffic congestion. PennDOT and the City of Allentown should work to coordinate and retime traffic signals where appropriate. Consideration should be given by municipalities to develop traffic signal retiming schedules. Such schedules would allow for the periodic review of traffic signal operations and adjustments of cycle lengths to allow for better traffic flow. Retiming of signals is one of the most cost-effective improvements that can be made. For more information on this topic, the Federal Highway Administration has produced a video, brochures, and PowerPoint presentation on the merits of signal retimings in alleviating congestion. It appears on the Southwestern Pennsylvania Commission's website and can be accessed at [http://spcregion.org/trans\\_ops\\_traff.shtml](http://spcregion.org/trans_ops_traff.shtml).

## GLOSSARY

**Closed Loop Traffic Signal System** – Traffic signal systems that contain a feedback loop between the traffic characteristic inputs received and the desired output. Closed loop systems have sensors that detect when traffic is present and a controller that makes decisions based on the traffic conditions.

**Congested Corridor Improvement Program** – A program of the Pennsylvania Department of Transportation (PennDOT) to identify some of the more severely congested corridors in the Commonwealth in order to define and implement needed low-cost, quickly implementable improvements. The goal of the CCIP is a 20 percent reduction in peak hour travel time on the improved transportation corridor.

**Controller** – The device used to operate and control the signal displays using signal timing provided by the user, master controller, or central signal system.

**Emergency Preemption** – An electronic device mounted on traffic signal mast arms that senses the arrival of emergency service providers and gives preferential signal phases to those responders.

**GPS Time Source Units** – Controller units that utilize times from global positioning satellites that eliminate any discrepancy between times within controllers. This allows for more accurate time-based coordination between intersections.

**Lehigh Valley Regional Travel Demand Forecasting Model** – A computer simulation model used to forecast travel.

**Lehigh Valley Transportation Study (LVTS)** – The Metropolitan Planning Organization for Lehigh and Northampton Counties. LVTS is made up of members from PennDOT Central Office, PennDOT District 5, Allentown, Bethlehem, Easton, Lehigh Valley Planning Commission, Lehigh and Northampton Transportation Authority (LANta), Lehigh-Northampton Airport Authority (LNAA), Lehigh County, and Northampton County.

**Level of Service** – A qualitative measure describing operational conditions within a traffic stream in terms of such factors as speed, travel time, freedom to maneuver, traffic interruptions, comfort and convenience, and safety. Six levels of service exists ranging from A to F, with level of service A representing the best operational conditions and level of service F the worst.

**Metropolitan Planning Organization (MPO)** – A federally mandated transportation policy-making organization that sets local transportation priorities.

**Permitted Left Turn** – A turning movement that is made through a conflicting pedestrian or opposing vehicle flow. Thus, a left-turn movement that is made at the same time as the opposing through movement.

**Phone Drop** - Allows for signal timings to be changed remotely rather than through the controller box located in the field.

**Principal Arterial** – A classification of signalized streets that serve primarily through-traffic and provide access to abutting properties as a secondary function.

**Protected Left Turn** – A turning movement that is made without conflicting movements, such as turns made during an exclusive left-turn phase.

**Spread Spectrum Radio** – A wireless type of operation for traffic signals that utilize radio frequencies rather than wires buried beneath pavement surfaces. This is a more durable type of operation not subject to pavement wire breakage resulting from freeze/thaw cycles.

**Traffic Signal Optimization and Coordination** – Optimization of traffic signals involves revising timing plans to accommodate changes in traffic volumes and patterns resulting from land developments, roadway construction projects, detours, etc. Coordination is a tool to provide the ability to synchronize multiple intersections to enhance the operation of one or more directional movements in the system. A well-timed, coordinated system permits continuous movement at a safe speed along an arterial or throughout a network of major streets with minimum stops and delays, which, reduces fuel consumption and improves air quality.

**Transportation Management Areas** - A Transportation Management Area (TMA) is an area designated by the Secretary of Transportation, having an urbanized area population of over 200,000, or upon special request from the Governor and the MPO designated for the area.

**Travel Time Index** – The ratio of peak period to non-peak period travel time. This index indicates the additional time spent on a trip made during peak traffic hours when compared to an identical off-peak trip. A travel time index value of 1.2 means that a 30 minutes free flow trip will take 36 minutes (20% additional time) during the peak hour period or a 20% delay due to congestion.

**Uninterrupted Power Source** – An alternate power source used to power traffic signals during power outages.