

# TRAFFIC SIGNAL COORDINATION PLAN FOR BACKUS AVENUE IN DANBURY, CT

## INTRODUCTION

Within the Housatonic Valley Region, Backus Avenue is a priority corridor to determine opportunities for extending signal coordination and to include intersections that currently operate independently. The Backus Avenue corridor is approximately 1.5 miles long from Apple Ridge Road to Segar Street.



The purpose of this study was to evaluate operating conditions of traffic control signals operations along Park Avenue, Backus Avenue and Kenosia Avenue, herein referred as Backus Avenue corridor, develop preliminary signal coordination plans as well as make recommendations for improvement of operating efficiency.

## EXISTING ROADWAYS

Backus Avenue is a four lane east-west roadway in Danbury extending from Kenosia Avenue on the west to the Route 7 Northbound Off-Ramp on the east. Backus Avenue provides access to the Danbury Fair Mall from Route 7 and Route 6. The posted speed limit is 35 miles per hour. Turn lanes are provided at the Backus Avenue/Kenosia Avenue and Backus Avenue/Route 7 Southbound Ramps intersections.



Land use along Backus Avenue is primarily retail oriented with the Danbury Fair Mall and associated retail activity. Backus Avenue also provides access to major employers along Kenosia Avenue and Route 6 located north of the corridor.

Kenosia Avenue is a two-lane north-south roadway that connects Route 6 and Backus Avenue. Kenosia Avenue provides access to a major employer located on Apple Ridge Road. With the exception of southerly portion of the Kenosia Avenue, along the frontage of Danbury Square Mall, Kenosia Avenue is relatively narrow and predominantly marked for one lane of travel in each direction. The Route 6/Kenosia Avenue intersection, located north of the project area is planned for



intersection improvements as part of a Route 6 improvement (Project No. 34-288).

Backus Avenue changes to Park Avenue east of the Route 7 Northbound Off-Ramp. Park Avenue is a two-lane east-west roadway with turn lanes provided at intersection locations. The Park Avenue/Segar Street intersection is the eastern limit of the signal coordination study area.

### EXISTING (2002) TRAFFIC VOLUMES

Average daily traffic (ADT) volumes were provided by the City of Danbury and are shown in Table 1.

Table 1  
Existing (2002) Average Daily Traffic Volumes

Location	2002 ADT (in vehicles per day)		
	Weekday	Saturday	Sunday
<b><u>Kenosia Avenue</u></b>			
b/w Route 6 and Boulevard Ave.	13,000	10,000	8,000
b/w Boulevard Ave. and Appleridge Rd.	14,000	11,000	9,000
b/w Appleridge Rd. and Kenosia Ave.	17,000	12,000	11,000
<b><u>Backus Avenue</u></b>			
b/w Kenosia Ave. and Route 7 SB Ramps	18,000	15,000	12,000
b/w Rte. 7 SB Ramps and Sugar Hollow Rd.	16,000	15,000	15,000

Source: Based on ADT data provided by the City of Danbury.

A detailed traffic counting program was undertaken by the City of Danbury in August, 2002. Traffic counts were conducted during the weekday A.M. and P.M. peak periods at the following locations along the Backus Avenue and Kenosia Avenue corridors:

- Kenosia Avenue and Boulevard Drive;
- Kenosia Avenue and Apple Ridge Road;
- Backus Avenue and Kenosia Avenue;
- Backus Avenue and Danbury Square Mall Drive;
- Backus Avenue and Danbury Fair Mall West Driveway;
- Backus Avenue and Danbury Fair Mall Entrance Drive/Route 7 SB Ramps;
- Backus Avenue and Sugar Hollow Road;
- Park Avenue and Route 7 NB Ramps; and,



- Park Avenue and Segar Street.

Figure 1 presents the existing (2002) peak hour traffic volumes in the study area during the A.M. and P.M. peak hours. The lowest side street approach peak hour traffic volume was recorded on the Strawberries Driveway of 1 vehicle and 18 vehicles during the A.M. and P.M. peak periods respectively. The highest side street approach peak hour volume (743 vehicles) was recorded on the Route 7 Southbound Ramps during the A.M. peak period. During the P.M. peak period, the highest side street approach volume was recorded on Kenosia Avenue in the southbound direction (1028 vehicles).

Table 2 shows two-way peak hour traffic volumes at selected locations along Backus Avenue and Park Avenue during the A.M. and P.M. peak hours.

Table 2  
**Existing (2002) Two-way A.M. and P.M. Peak Hour  
 Traffic Volumes along Backus Avenue and Park Avenue**

Location	A.M. Peak Hour Traffic Volumes		P.M. Peak Hour Traffic Volumes	
	EB	WB	EB	WB
<b><u>Backus Avenue</u></b>				
East of Kenosia Avenue	324	983	1,211	597
East of Danbury Square Mall	334	973	1,401	785
West of Route 7 Southbound Ramps	339	973	1,257	573
East of Route 7 Southbound Ramps	229	560	460	415
East of Sugar Hollow Road	226	775	465	443
<b><u>Park Avenue</u></b>				
East of Segar Street	300	654	579	417

Source: Based on turning movement counts conducted by the City of Danbury in August, 2002.

As indicated in Table 2, on Backus Avenue, the westbound traffic volumes are higher than the eastbound during the A.M. period. During the P.M. period, this condition reverses when the eastbound traffic volumes are higher than the westbound. Along Park Avenue, a similar observation can be made relative to the traffic volumes.

This directional peaking was considered in developing coordination concepts.

## OVERVIEW OF SIGNALIZATION

Pertinent information on traffic signal volumes, signal spacing, coordination, and ownership are provided in Table 3.

Table 3  
**Signalized Intersection Spacing along the Backus Avenue Corridor**

Signalized Intersection	Signal Spacing	Existing Systems (1)	Signal Owner (2)	Signal Rev. Date (3)
Kenosia Avenue and Apple Ridge Road	-	-	C	1988
Backus Avenue and Kenosia Avenue	2145'	A1	C	1996
Backus Avenue and Danbury Square Mall	550'	A2	C	1989
Backus Avenue and West Mall Entrance	420'	A3	C	1989
Backus Avenue and Danbury Fair Mall/Rt. 7	2145'	-	S	1985
Backus Avenue and Sugar Hollow Road	1040'	B1	C	1997
Park Avenue and Route 7 NB	320'	B2	C	2001
Park Avenue and Segar Street	360'	B3	C	1997

Note: (1) "A" denotes System 1 and "B" denotes System 2.

(2) "C" denotes City of Danbury and "S" denotes Connecticut DOT.

(3) Represents the year the signal was last revised.

Source: Wilbur Smith Associates

As indicated in Table 3, there are two existing signal systems along the Backus Avenue Corridor. System 1 between Kenosia Avenue and the Danbury Fair Mall West Entrance operates under a time based coordination system. System 2 between Sugar Hollow Road and Segar Street at the Route 7 overpass is controlled by a central computer system located in the Danbury City Hall. The side street approaches along Backus Avenue have detectors for actuation purposes.

System 1 operates on a 95 second cycle length while System 2 operates on a 75 second cycle length during the P.M. peak hour period.

## EXISTING SIGNAL HARDWARE AND EQUIPMENT

An inventory of the existing signal hardware and equipment along the Backus Avenue and Park Avenue corridor was conducted. The findings indicate the following:



- All City owned and maintained signalized intersections use a Type 170 signal controller;
- The Backus Avenue/Kenosia Avenue and Backus Avenue/Route 7 Southbound Ramps/Danbury Fair Mall Main entrance intersections have mast arm mounted signals;
- The remaining intersections have span wire mounted signals;
- Vehicle detection is provided on the side-street approaches at all the City signals along with system detectors located along Backus Avenue/Park Avenue;
- The Backus Avenue/Park Avenue system has a fiber-optic interconnect to the City's central computer system;
- With the exception of the intersection of Kenosia Avenue and Apple Ridge Road intersection, emergency vehicle pre-emption equipment does not exist at any other intersections along the Park Avenue/Backus Avenue corridor; and,
- Concurrent pedestrian phases, without pedestrian displays equipment are provided at the intersections of Kenosia Avenue and Apple Ridge Road intersection as well as all intersections located along Park Avenue.

## EXISTING SIGNAL COORDINATION AND INTERCONNECTION

The three (3) types of traffic signal control operations along the Backus Avenue Corridor include the following:

1. Interconnected and coordinated: The traffic signals located on Park Avenue, just easterly of Backus Avenue are physically connected by fiber optic cable. The control signals are coordinated by a central computer system located in City Hall.
2. Not interconnected but coordinated: The traffic signals located on Backus Avenue, between Park Avenue and Kenosia Avenue, are not

interconnected. However, they are coordinated utilizing internal Time Base Coordinators (TBC) located in the signal controller timers.

3. Not interconnected or coordinated: The traffic signal located at the intersection of Danbury Fair Mall Driveway/ Route 7 interchange as well as Kenosia Avenue and Apple Ridge Road intersection are not interconnected or coordinated. They operate in isolated free mode.

## **FUTURE ROADWAY PROJECTS**

An exclusive left turn lane will be provided on the Backus Avenue eastbound approach as a result of the proposed intersection improvement at the Backus Avenue/Kenosia Avenue intersection. This project will be undertaken by the developer of the Cendant Mobility facility in coordination with the City of Danbury. The City of Danbury anticipates that this project will be complete by 2005.

## **EVALUATION OF COORDINATION POTENTIAL**

The coordination potential of a roadway corridor depends on criteria such as roadway characteristics, corridor flow characteristics, traffic signal spacing, traffic operations, and safety. These criteria for the Backus Avenue corridor are described in the following sections.

### **Roadway Characteristics**

Backus Avenue is a four lane roadway between Kenosia Avenue on the west and Sugar Hollow Road on east. Turn lanes are provided on Backus Avenue at key intersections with Kenosia Avenue and Danbury Main Mall/Route 7 Southbound Ramps.

Park Avenue is also a four lane roadway between Sugar Hollow Road and Segar Street. Turn lanes are provided on Park Avenue at the Route 7 Northbound Ramp intersection.

## **Corridor Flow Characteristics**

The 2002 average daily traffic volume on the Backus Avenue corridor was recorded between 15,000 to 20,000 vehicles per day. The traffic flows on Backus Avenue were higher in the westbound direction than the eastbound during the A.M. peak period. Conversely, the traffic flows were higher in the eastbound direction than the westbound during the P.M. peak period.

During the A.M. peak hour period, the northbound left turn volume on the Route 7 Southbound off-ramp at the Backus Avenue intersection was 510 vehicles per hour and the westbound right turn volume on Backus Avenue at the Kenosia Avenue intersection was 799 vehicles per hour. The southbound left turn volume on Kenosia Avenue at Backus Avenue was 888 vehicles per hour and the eastbound right turn volume on Backus Avenue at Route 7 Southbound Ramps was 939 vehicles per hour during the P.M. peak hour period. This suggests a directional peaking in the corridor.

The 2002 average daily traffic volume on Park Avenue was recorded at approximately 16,000 vehicles per day. Park Avenue, like Backus Avenue, showed a similar traffic flow pattern during the A.M. and P.M. peak period.

The 2002 average daily traffic volume on Kenosia Avenue was recorded between 10,000 and 17,000 vehicles per day.

## **Traffic Operations**

When intersection STOP delays are taken into account, the average vehicle travel speed along the Backus Avenue corridor is approximately 20 miles per hour in both directions. The posted speed limit on Backus Avenue is 35 miles per hour. Running speeds in the corridor (speeds between intersections excluding stops) ranged from 35 to 40 miles per hour.

## **Traffic Signal Spacing**

The traffic signal spacing in the Backus Avenue corridor ranges from 320 to 2,145 feet.

## **COORDINATION CONCEPT**

There is a potential to coordinate the Backus Avenue and Danbury Fair Mall/Route 7 SB Ramps intersection with the Backus Avenue System 1. System 1 operates under a 95 second cycle during the P.M. peak period. In the eastbound direction, the Backus Ave./Danbury Fair Mall/Route 7 SB Ramp

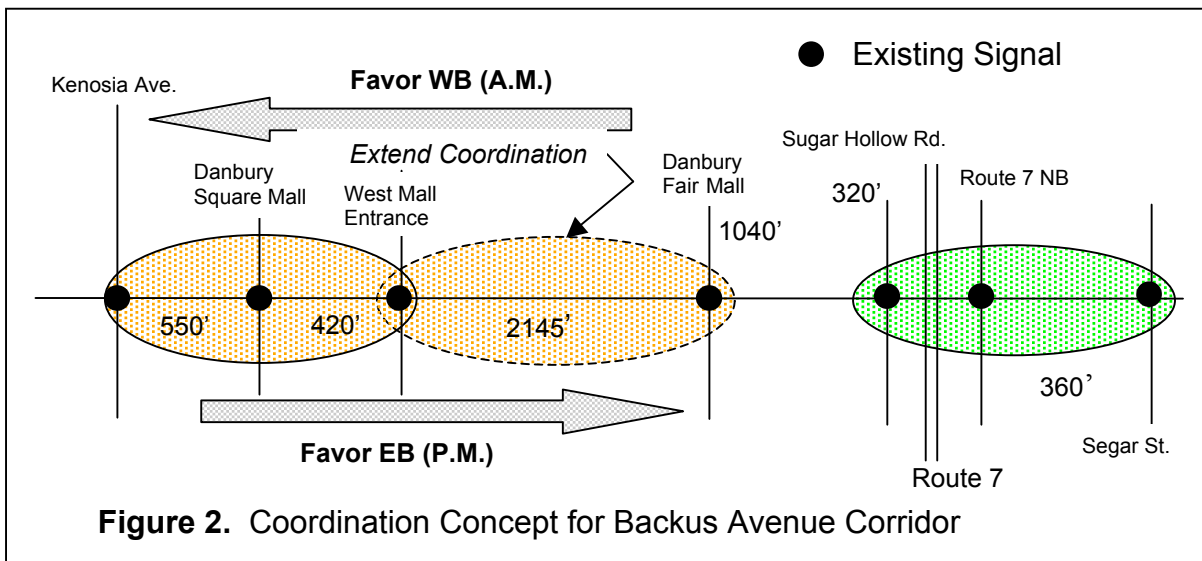


intersection consists of a channelized continuous right turn lane from Backus Avenue to the Route 7 Southbound on-ramp. In the westbound direction, the Backus Ave./Kenosia Ave. intersection contains an exclusive right turn lane from Backus Avenue to Kenosia Avenue.

Based on the corridor flow characteristics, it is evident that the westbound direction in the A.M. and the eastbound direction in the P.M. have high traffic volumes. Therefore, the following coordination concept should be considered:

- Favor westbound traffic in the A.M. peak period;
- Favor eastbound traffic in the P.M. peak period; and,
- Provide a balanced progression for other time periods.

The above concept is shown in Figure 2.



As shown in the figure, the coordination for signal system 1 is extended to include the Backus Avenue/Danbury Fair Mall/Route 7 SB Ramps intersection.

The westbound progression on Backus Avenue during the A.M. begins at the Danbury Fair Mall/Route 7 SB Ramps intersection and moves westbound traffic to the end of the corridor at the Kenosia Avenue intersection, where there is an exclusive right turn lane for the heavy right turning traffic volume. The right turning traffic gets a significant amount of green time at the intersection.

During the P.M. peak period, the eastbound progression begins with the southbound left turn movement on Kenosia Avenue at the Backus Avenue intersection and moves traffic eastbound to the end of the corridor at the Danbury Fair Mall/Route 7 SB Ramps intersection, where there is a continuous right turn lane onto the Route 7 Southbound Ramps.

To extend the coordination including the Backus Avenue/Danbury Fair Mall/Route 7 SB Ramps, the following are needed:

- Provide a common background cycle for signal operation. Cycle lengths can vary by time of day;
- Modify existing controller to accommodate coordination; and,
- Extend coordination from the Backus Avenue/Danbury Fair Mall West driveway east to the Backus Avenue/Danbury Main Mall/Route 7 Southbound Ramps.

Signal system 2 which begins east of the Route 7 Southbound Ramps should not be altered. The Kenosia Avenue/Apple Ridge Road intersection should continue to operate independently.

### **TIME SPACE DIAGRAM**

Figure 3 shows a time-space diagram for the suggested coordination concept during the P.M. peak period. It assumes operation on a 90 second cycle, with other cycle lengths, the specific “offsets” will be modified to retain progressive speeds of about 35 miles per hour. Progression is favored in the eastbound direction to achieve a through bandwidth of 38 seconds.

### **BACKUS AVENUE SYNCHRO MODEL**

An existing P.M. peak hour traffic model was developed using the SYNCHRO software package. SYNCHRO is a traffic engineering tool commonly used for highway capacity and signal coordination analysis. Existing (2002) P.M. peak hour traffic volumes and the traffic signal timings provided by the City of Danbury were input into the SYNCHRO model.

Based on the proposed intersection improvement at the Backus Avenue/Kenosia Avenue intersection, an existing conditions model was developed for analysis purposes. The existing conditions model with proposed roadway improvements was considered as the “Before” condition for analysis. The “After” condition included the Backus Avenue/Danbury Fair Mall/Route 7 Southbound Ramps intersection to be part of the coordinated system. The system cycle length and traffic signal timings were obtained through an optimization process. System wide performance measures were obtained for comparing the “Before” and “After” conditions.

Table 4 provides a comparison of the “Before” and “After” analysis on Backus Avenue during the P.M. peak hour condition.

Table 4  
**Comparison of SYNCHRO Performance Measures on Backus Avenue  
 Existing Weekday P.M. Peak Hour Condition**

Performance Measure (Average per vehicle)	Backus Ave. Eastbound		Backus Ave. Westbound	
	Before	After	Before	After
Travel Time (in Seconds)	45	36	33	35
Delay Time (in Seconds)	24	14	10	13
Travel Speed (in Miles Per Hour)	14	18	21	19
Number of Stops	0.6	0.5	0.6	0.6

Source: Wilbur Smith Associates.

As indicated in Table 4, average travel time and delay reduce while average travel speed increases in the eastbound direction. A 29 percent increase in average travel speed is achieved in the eastbound direction. In the westbound direction, the average travel speed decreases by approximately 10 percent.

The results indicate that there is a benefit in the eastbound direction (which is the major direction of traffic flow during the P.M. peak hour) with the inclusion of the Backus Avenue/Route 7 Southbound Ramps/Danbury Fair Mall Main Entrance. It is important to note that this analysis did not consider the Kenosia Avenue/Apple Ridge Road intersection to be part of the coordinated system.

The existing P.M. peak hour traffic volumes were increased by 17 percent to generate future P.M. peak hour traffic volumes.

Table 5 provides a comparison of the “Before” and “After” analysis on Backus Avenue during the P.M. peak hour condition under future conditions.

Table 5  
**Comparison of SYNCHRO Performance Measures on Backus Avenue  
 Future Weekday P.M. Peak Hour Condition**

Performance Measure (Average per vehicle)	Backus Ave. Eastbound		Backus Ave. Westbound	
	Before	After	Before	After
Travel Time (in Seconds)	128	40	37	39
Delay Time (in Seconds)	107	18	14	17
Travel Speed (in Miles Per Hour)	5	17	18	17
Number of Stops	0.6	0.4	0.5	0.5

Source: Wilbur Smith Associates.

As indicated in Table 5, with an increase in traffic volumes, a significant improvement in travel time and delay are observed in the eastbound direction. It is important to note that the suggested coordination concept favors eastbound progression, therefore a slight increase in travel time and delay are obtained.

A SYNCHRO/SimTraffic animation of traffic flow showing the “before” and “after” condition was developed for the analysis for the P.M. peak hour condition. The animation model visually indicates the benefit in favoring the eastbound direction during the P.M. peak hour period.

Table 6 provides a comparison in levels of service along Backus Avenue between “Before” and “After” conditions during the P.M. peak hour period.

Table 6  
**Comparison of Levels of Service on Backus Avenue  
 Future Weekday P.M. Peak Hour Condition**

Intersection	Before	After
Backus Avenue and Kenosia Avenue	C	C
Backus Avenue and Danbury Sq. Mall	F	B
Backus Avenue and West Entrance	E	B
Backus Ave. and Danbury Mall Main Entrance	B	C

Source: Wilbur Smith Associates.

As indicated in Table 6, the levels of service at the Backus Avenue/Danbury Square Mall and Backus Avenue/Danbury Fair Mall West Entrance intersections improve by optimizing signal timings under a 90 second cycle length.

### **CORRIDOR RECOMMENDATIONS**

The following recommendations emerge from the Backus Avenue Corridor Coordination Study:

- Install fiber-optic communication along the Backus Avenue corridor between the intersections of Backus Avenue and Sugar Hollow Road and Kenosia Avenue and Backus Avenue. The communication cable is to be routed to the Central Traffic Control Center in Danbury City Hall.
- The proposed fiber communication network is to be provided with the future potential for extension to incorporate the intersections of Kenosia Avenue and Apple Ridge Road, Kenosia Avenue and Boulevard Drive as well as Mill Plain Road and Kenosia Avenue.
- Replace or modify the traffic controllers located between the intersections of Backus Avenue and Sugar Hollow Road and Kenosia Avenue and Apple Ridge Road to incorporate fiber optic communication cable.
- Provide coordinated traffic signal operations along the entire Backus Avenue corridor from the intersections of Backus Avenue and Sugar Hollow Road to Kenosia Avenue and Backus Avenue. This will require extending coordination east of the Danbury Fair

Mall westerly driveway to include the Danbury Fair Mall Main Entrance/Route 7 SB Ramps intersection.

- Favor westbound progression in the A.M. peak period, favor eastbound traffic in the P.M. peak period, and provide a balanced progression for other time periods.
- In future, extend traffic signal coordination to the intersection of Kenosia Avenue and Mill Plain Road.
- Provide emergency vehicle pre-emption along the entire Backus Avenue corridor.
- The City is to seek Federal and State funds for implementation of the recommended measures. HVCEO is to assist the City in identifying source as well as obtaining funds for the project.