TRAFFIC ENGINEERING REPORT

ROUTE 101A WIDENING

Nashua, New Hampshire

Prepared for the

City of Nashua

Prepared by

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In Association with
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EXECUTIVE SUMMARY

ES-1 Study Overview

Among the recommendations in the December 2002 final report of the Route 101A Corridor Master Plan and Improvements Program was an Early Action Program that included the widening of Route 101A to a uniform seven lane cross-section from the Merrimack border to Somerset Parkway in Nashua. In support of the preliminary design effort, Fay, Spofford & Thorndike (FST) has analyzed the traffic operations for both the existing and future design year, along the network of intersections in the Route 101A project corridor.

ES-2 Existing/Future No-build Conditions

Results of the traffic analysis for intersections along the project corridor under existing traffic volumes and projections for the two future build years of 2017 and 2027 are summarized in Table ES-1. Currently, the majority of the signalized intersections in the study area operate at an acceptable level of service for the peak periods evaluated. The exception being the Thornton Rd./Deerwood Dr. intersection during the morning and evening weekday peak hours when the intersection operates at LOS "F". Although the remaining intersections operate with an acceptable level of delay, traffic demands are approaching intersection capacity, especially the Sunapee St./Townsend Street intersection. Conditions are even worse at the unsignalized intersections of Capital and State Street, where the heavy volumes on Route 101A make it very difficult to turn left.

Continued growth along Route 101A and the region in general will further strain traffic operations in the study area. Increased delays and traffic demands result in over half the intersections operating over capacity and/or at LOS "E" of "F" during at least one of the peak periods evaluated in the year 2027. These findings are consistent with those included in the Route 101A Corridor Master Plan and Improvements Program completed in 2002.

ES-3 Recommended Improvements

In the development of the final improvement concepts as part of this project, the recommendation of the corridor master plan to provide a uniform seven lane cross-section was first analyzed. Although the additional lanes on Route 101A did produce an improvement in traffic operations, there remained some locations that were still expected to experience congestion during peak periods. Following an assessment of varying alternatives at these problem areas, a final recommended improvement concept was identified.

Table ES-2 presents future build traffic operations at the studied intersections under the recommended alternative. Consistent with the master plan, the final recommendations call for the widening of Route 101A to provide a uniform seven lane cross-section consisting of three through lanes in each direction and exclusive left turns lanes at signalized intersections. To address operation issues on the section between Thornton Road/Deerwood Drive and Blackstone Drive, the improvement plan also includes adding a second left turn lane from Route 101A

TABLE ES-1 – Existing and Future No-Build Traffic Operations

	Existing			2017 No Build			2027 No-Build		
Weekday AM Peak Hour	v/c	Delay (s)	LOS	v/c	Delay (s)	LOS	v/c	Delay (s)	LOS
Signalized									
Celina Ave.	0.49	7.1	A	0.59	8.5	A	0.62	9.8	A
Cellu Dr./Nimcor Dr.	0.61	12.2	B	0.74	14.4	B	0.80	18.0	B
Blackstone Dr.	0.64	10.1	B	0.75	12.9	B	0.79	14.4	B
Thornton Rd./Deerwood Dr.	1.01	92.7	F	1.22	161.6	F	1.33	204.6	F
Sunapee St./Townsend West	0.99	40.8	D	1.16	97.2	F	1.23	125.3	F
Building 19	0.82	7.4	A	0.96	18.2	B	1.02	32.9	C
Somerset Pkwy.	0.78	19.0	B	0.94	30.0	C	1.04	49.8	D
Unsignalized									
Capitol St.	>2	>200	F	>2	>200	F	>2	>200	F
State St.	>2	>200	F	>2	>200	F	>2	>200	F
Weekday PM Peak Hour									
Signalized									
Celina Ave.	0.64	16.5	B	0.76	20.0	C	0.81	20.4	C
Cellu Dr./Nimcor Dr.	0.76	25.0	C	0.90	43.8	D	0.95	66.3	E
Blackstone Dr.	0.82	14.5	B	0.96	30.2	C	1.03	48.8	D
Thornton Rd./Deerwood Dr.	1.29	157.1	F	1.56	272.8	F	1.69	320.0	F
Sunapee St./Townsend West	0.97	33.6	C	1.14	71.6	E	1.23	102.5	F
Building 19	0.90	22.9	C	1.06	60.0	E	1.13	77.4	E
Somerset Pkwy.	0.75	16.0	B	0.88	20.3	C	0.97	26.8	C
Unsignalized									
Capitol St.	>2	>200	F	>2	>200	F	>2	>200	F
State St.	>2	>200	F	>2	>200	F	>2	>200	F
Saturday Midday Peak Hour									
Signalized									
Celina Ave.	0.50	10.7	B	0.58	12.2	B	0.62	13.8	B
Cellu Dr./Nimcor Dr.	0.63	11.4	B	0.75	15.0	B	0.80	16.4	B
Blackstone Dr.	0.62	5.9	A	0.73	6.4	A	0.78	6.8	A
Thornton Rd./Deerwood Dr.	0.84	21.3	C	1.00	47.7	D	1.07	75.0	E
Sunapee St./Townsend West	0.78	13.8	B	0.95	27.1	C	1.02	45.5	D
Building 19	0.78	15.3	B	0.91	27.5	C	0.97	41.3	D
Somerset Pkwy.	0.55	12.6	B	0.65	14.0	B	0.72	15.7	B
Unsignalized									
Capitol St.	>2	>200	F	>2	>200	F	>2	>200	F
State St.	>2	>200	F	>2	>200	F	>2	>200	F

eastbound to Thornton Road, closing the median opening on Route 101A at State Street and installing a traffic signal at Capitol Street. Implementation of these recommended improvements is anticipated to result in acceptable traffic operating conditions on this section of Route 101A during the morning, evening and Saturday mid-day peaks in the 2027 design year.

TABLE ES-2 - Future Build Traffic Operations

	2017 Build			2027 Build		
Weekday AM Peak Hour	v/c	Delay (s)	LOS	v/c	Delay (s)	LOS
Signalized						
Celina Ave.	0.59	8.6	A	0.62	8.9	A
Cellu Dr./Nimcor Dr.	0.54	7.5	A	0.59	6.7	A
Blackstone Dr.	0.55	4.4	A	0.58	4.8	A
Capitol St.	0.68	8.2	A	0.71	11.3	B
Thornton Rd./Deerwood Dr.	0.79	19.1	B	0.94	32.8	C
Sunapee St./Townsend West	0.93	17.9	B	0.98	15.3	B
Building 19	0.68	4.9	A	0.70	4.8	A
Somerset Pkwy.	0.95	24.1	C	1.04	41.9	D
Unsignalized						
State St.	0.13	10.9	B	0.14	11.4	B
Weekday PM Peak Hour						
Signalized						
Celina Ave.	0.64	6.3	A	0.67	6.5	A
Cellu Dr./Nimcor Dr.	0.67	12.2	B	0.74	13.9	B
Blackstone Dr.	0.66	4.8	A	0.70	4.4	A
Capitol St.	0.74	11.5	B	0.76	10.4	B
Thornton Rd./Deerwood Dr.	0.99	40.9	D	1.00	40.4	D
Sunapee St./Townsend West	0.79	12.3	B	0.88	19.6	B
Building 19	0.71	10.3	B	0.81	8.9	A
Somerset Pkwy.	0.88	19.9	B	0.97	26.5	C
Unsignalized						
State St.	0.14	11.0	B	0.14	10.8	B
Saturday Midday Peak Hour						
Signalized						
Celina Ave.	0.60	11.2	B	0.64	12.0	B
Cellu Dr./Nimcor Dr.	0.59	11.8	B	0.62	10.7	B
Blackstone Dr.	0.50	3.0	A	0.57	3.4	A
Capitol St.	0.54	4.0	A	0.54	4.9	A
Thornton Rd./Deerwood Dr.	0.67	13.8	B	0.81	15.8	B
Sunapee St./Townsend West	0.67	13.1	B	0.75	15.4	B
Building 19	0.63	7.8	A	0.66	8.6	A
Somerset Pkwy.	0.66	11.3	B	0.72	12.5	B
Unsignalized						
State St.	0.16	11.6	B	0.15	11.1	B

1 INTRODUCTION

1.1 Overview

Among the recommendations in the December 2002 final report of the Route 101A Corridor Master Plan and Improvements Program was an Early Action Program that included the widening of Route 101A. The intention of the widening is to provide a uniform seven lane cross-section (three through lanes in each direction with a center left turn lane) along Route 101A from the Merrimack border to Somerset Parkway in Nashua.

In support of the preliminary design effort for this element of the Early Action Program, Fay, Spofford & Thorndike (FST) has analyzed the traffic operations along the network of intersections in the Route 101A project corridor. This network extends from the intersection of Route 101A and Celina Avenue southeasterly to the intersection of Route 101A and Somerset Parkway, entirely within the City of Nashua, and includes the following intersections:

Signalized	**Unsignalized**
Celina Avenue	Capitol Street
Cellu Drive & Nimcor Drive	State Street
Blackstone Drive	
Thornton Road & Deerwood Drive	
Sunapee Street & Townsend West	
Building 19 driveway	
Somerset Parkway	

Traffic operations in this network were evaluated during the weekday morning and evening peak hours and the Saturday midday peak under existing conditions as well as those for the projected design years of 2017 and 2027. At those locations where several improvement alternatives were being considered, analysis as part of the screening process examined the evening peak hour, which was the more critical. This report summarizes the results of this analysis.

1.2 Intersection Capacity Analysis Methodology

Capacity analysis measures the effectiveness with which an intersection can process the traffic demands upon it. Capacity analysis for the study-area intersections along Route 101A were performed in accordance with the methodologies set forth in the 2000 Highway Capacity Manual (HCM). Level of service (LOS) is a commonly used and accepted measure of the effectiveness of peak-hour traffic operations at an intersection. It takes into account automobile and truck volumes, roadway width, speed, grade, parking restrictions, pedestrian activity and traffic control devices.

LOS is designated in a range of levels from "A", which is the optimal condition where roadway operations are at their best, to "F" which indicates traffic jam conditions. LOS A through D are typically associated with acceptable levels of peak-hour traffic operations. At

LOS E, the ratio of the approach volume to capacity, or v/c ratio, of an intersection is generally between 90 and 100 percent of its theoretical capacity. Traffic congestion is considered to be unacceptable at LOS E or F.

LOS is indexed to the calculation of average vehicle delay in seconds per vehicle. There are separate indices, however, for operations at signalized and unsignalized intersections; these are shown in Table 1. Furthermore, LOS is typically reported differently for a signalized intersection than for an unsignalized intersection. For a signalized intersection, the LOS reflects the average estimated delay among all vehicles traveling through the intersection during the analysis period, unless it is specified to represent that of a particular approach or lane group. For an unsignalized intersection, the LOS is generally that of a critical turning movement exiting or entering a side street, since through traffic on the main street is assumed to flow unimpeded by entering or crossing traffic.

TABLE 1 - Intersection Level-of-Service Criteria

Level of Service	Signalized Delay (sec/veh.)	Unsignalized Delay (sec/veh)
A	Less than or equal to 10.0	Less than or equal to 10.0
B	10.1 to 20.0	10.1 to 15.0
C	20.1 to 35.0	15.1 to 25.0
D	35.1 to 55.0	25.1 to 35.0
E	55.1 to 80.0	35.1 to 50.0
F	Greater than 80.0	Greater than 50.0

Source: Highway Capacity Manual, 2000.

2 EXISTING CONDITIONS

2.1 Intersection Geometrics

Throughout the project corridor, Route 101A generally consists of a five lane cross-section that provides a left-turn bay, one through lane, and a shared through/right-turn lane on intersection approaches. On the eastern most section of the corridor, the cross-section increases to provide additional through and/or turn lanes at intersections with the Building 19 driveway and Somerset Parkway. The following discussion offers more detail on the lane arrangements at intersections within the project area.

Celina Avenue

At the intersection, Route 101A is comprised of an exclusive left turn lane with two general purpose lanes westbound and an exclusive left turn lane with three general purpose lanes on the eastbound approach. Celina Avenue is primarily a two-lane roadway providing access to commercial interests south of Route 101A. Its' approach to Route 101A widens to provide two lanes, a shared left-turn/through lane and a right-turn lane. Across from Celina Avenue is a single-lane approach commercial driveway forming the fourth leg of the intersection.

Cellu/Nimcor Drives

Cellu Drive and the roadway opposite, Nimcor Drive, form a four-way signalized intersection. Both drives serve commercial interests on both sides of Route 101A. Cellu Drive varies from three to five lanes; at its approach to Route 101A there are a left-turn lane, a shared left-turn/through lane and a right-turn lane. The Nimcor Drive approach has a left-turn lane and a shared through/right-turn lane. The lane arrangement on Route 101A is similar to that at Celina Avenue with an exclusive left turn lane and two general purposes lanes on both approaches with a fourth, exclusive right, lane on the eastbound approach

Blackstone Drive

Blackstone Drive is a collector roadway serving a residential neighborhood north of Round Pond. It forms a three-leg signalized intersection, with a left-turn lane and a right-turn lane in its approach to Route 101A. Two general purpose lanes are provided on Route 101A eastbound and westbound in addition to an exclusive eastbound lane for left turns.

Capitol and State Streets

Southeast of Blackstone Drive, two roads serve a number of industrial interests south of Route 101A: Capitol Street and State Street. Both roads are wide two-lane roads, and each has a single lane approach to Route 101A. Median breaks in Route 101A at both roads allow left turning traffic to enter Route 101A heading westbound. Both intersections are unsignalized, with a small shopping center opposite Capitol Street effectively creating a four-leg intersection, while State Street forms a three-leg intersection. Route 101A westbound consists of two general purpose lanes with an exclusive left turn lane at each intersection. Similarly, Route 101A provides two general purpose lanes in the eastbound direction with an exclusive left turn lane at Capitol Street and a exclusive lanes for u-turns at State Street.

Thornton Road/Deerwood Drive

Thornton Road and the road opposite, Deerwood Drive, meet to form a four-way intersection that is signalized. Thornton Road is a major collector roadway, serving many residential neighborhoods north of Route 101A, as well as New Hampshire Community Technical College. Its wide approach is striped for two lanes which function as a shared left/through lane and an exclusive right turn lane. Deerwood Drive serves a residential neighborhood south of Route 101A, and has a single-lane approach for left-turn, through, and right-turn movements. In addition to an exclusive westbound right turn lane, Route 101A consists of an exclusive left turn and two general purpose lanes in each direction.

Sunapee Street/Townsend West

Sunapee Street and the road opposite, Townsend West, intersect Route 101A to a four-way signalized intersection. Sunapee Street is a collector road serving residential neighborhoods north of Route 101A, while Townsend West serves industrial interests to the south. Sunapee

Street consists of a single approach lane for left-turn, through, and right-turn movements. Two approach lanes, shared left/through and exclusive right, are provided on the Townsend West approach. Lane arrangements on both Route 101A approaches consist of an exclusive left turn with two general purpose lanes.

Building 19 driveway

At the driveway entrance to Building 19, a four-way intersection is formed with the single-lane approach driveway to a small shopping center opposing it on the north side of Route 101A. The intersection is signalized, with the Building 19 approach consisting of a left-turn lane, a shared left-turn/through lane and a right-turn lane. Eastbound on Route 101A, the roadways cross-section provides an exclusive left turn lane and two general purpose lanes with the outside lane widened slightly provide a short, unmarked right turn lane.. A wider cross-section is found on the westbound approach allowing for an exclusive left turn lane with three general purpose lanes.

Somerset Parkway

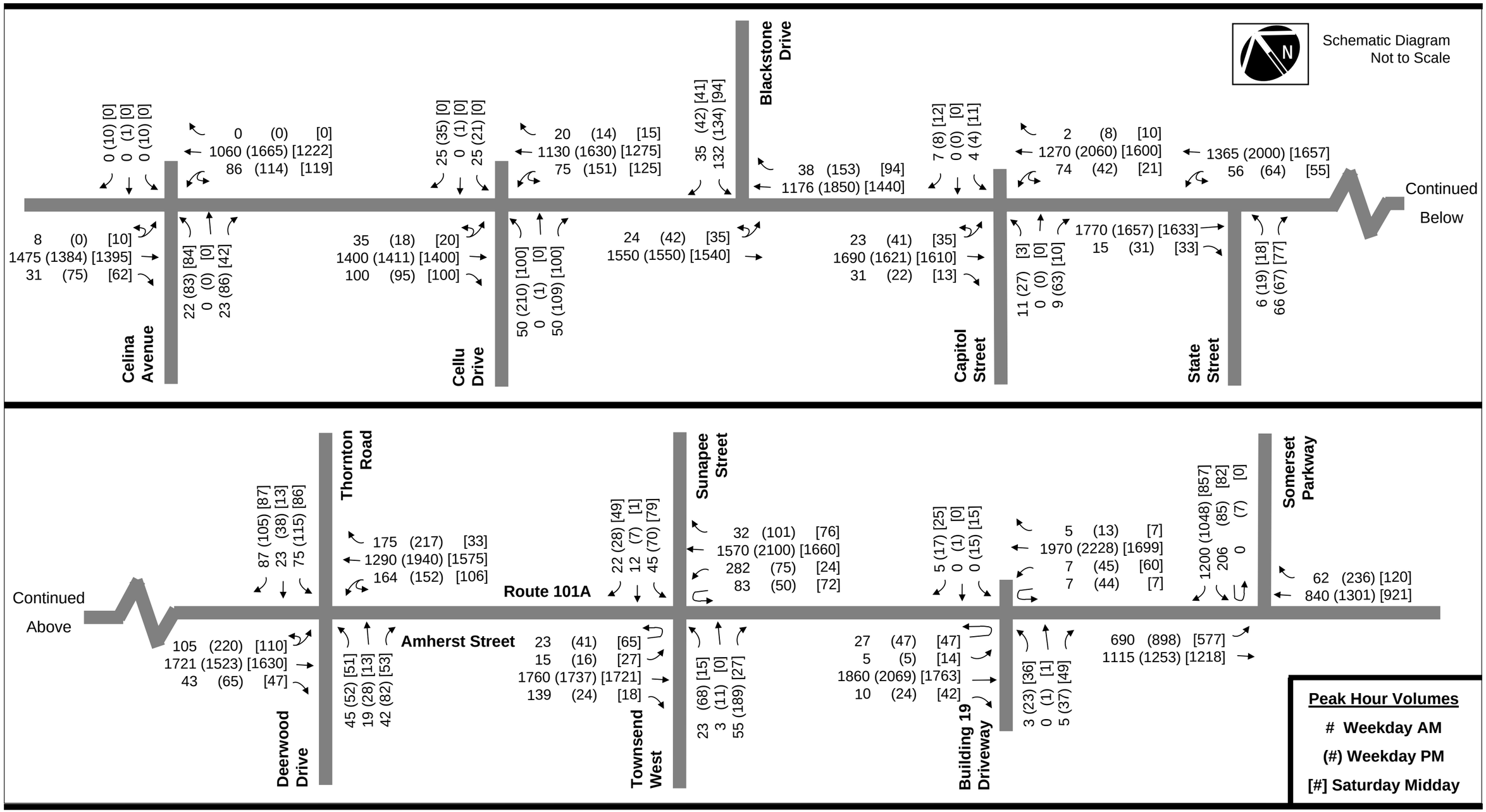
Somerset Parkway is a median-divided four-lane roadway that serves as a bypass from Route 101A to the F.E. Everett Turnpike Exit 8. Its approach at Route 101A forms a three-leg signalized intersection, consisting of two left-turn lanes and two right-turn lanes. The roadway cross-section on Route 101A at this intersection consists of three through lanes both eastbound and westbound with a single westbound right turn lane and a double left turn lane eastbound.

2.2 Traffic Volumes

In order to evaluate traffic operation conditions for the study-area intersections, manual turning movement counts done in September 2006 were obtained from the Nashua Regional Planning Commission (NRPC); these counts supplemented turning movement counts obtained from available recent traffic studies submitted for other projects in the study area. Figure 1 shows the weekday AM, weekday PM, and Saturday midday peak-hour traffic volumes at the intersections in the study area.

Currently, weekday peak hour volumes (both directions) in the study area range between approximately 2,600 to 4,500 vph, increasing from east to west. Total traffic during the evening peak hour is generally 20% higher than in the morning. On weekdays the roadway also exhibits a directional commuter flow with approximately 55% of the traffic traveling eastbound in the morning and the same percentage heading to the west in the evening.

Weekend mid-day volumes generally fall in between the morning and evening peak hour volumes, ranging from 2,800 to 3,600 vph. Unlike the weekday peak periods, there is no directional trend evident during the mid-day peak with a 50/50 split between eastbound and westbound traffic.



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2007 Existing
Peak Hour Traffic Volumes

Route 101A Widening and Improvements
City of Nashua, New Hampshire

Figure 1

2.3 Traffic Operations

Table 2 summarizes the traffic operations of the study-area intersections under existing conditions. The operations are measured in terms of volume-to-capacity (v/c) ratio, average delay in seconds per vehicle, and LOS. These results form the basis for comparison to traffic operations in future scenarios.

TABLE 2 - Existing Traffic Operations

Weekday AM Peak Hour	v/c	Delay (s)	LOS
Signalized			
Celina Ave.	0.49	7.1	A
Cellu Dr.	0.61	12.2	B
Blackstone Dr.	0.64	10.1	B
Thornton Rd./Deerwood Dr.	1.01	92.7	F
Sunapee St./Townsend West	0.99	40.8	D
Building 19	0.82	7.4	A
Somerset Pkwy.	0.78	19.0	B
Unsignalized			
Capitol St.	>2	>200	F
State St.	>2	>200	F
Weekday PM Peak Hour			
Signalized			
Celina Ave.	0.64	16.5	B
Cellu Dr.	0.76	25.0	C
Blackstone Dr.	0.82	14.5	B
Thornton Rd./Deerwood Dr.	1.29	157.1	F
Sunapee St./Townsend West	0.97	33.6	C
Building 19	0.90	22.9	C
Somerset Pkwy.	0.75	16.0	B
Unsignalized			
Capitol St.	>2	>200	F
State St.	>2	>200	F
Saturday Midday Peak Hour			
Signalized			
Celina Ave.	0.50	10.7	B
Cellu Dr.	0.63	11.4	B
Blackstone Dr.	0.62	5.9	A
Thornton Rd./Deerwood Dr.	0.84	21.3	C
Sunapee St./Townsend West	0.78	13.8	B
Building 19	0.78	15.3	B
Somerset Pkwy.	0.55	12.6	B
Unsignalized			
Capitol St.	>2	>200	F
State St.	>2	>200	F

2.4 Intersection Safety

FST obtained accident data from the Nashua Police Department for calendar year 2005 and the first seven months of 2006. Table 3 lists the number of incidents occurring at the study-area intersections. Review of this limited data does not indicate a significant accident rate at any intersection in particular. NHDOT crash rate map, based on 2005 data also did not indicate a high accident rate in the project corridor. The NRPC is currently conducting a Regional Safety Study that will include a thorough analysis of accident rates along the project corridor.

TABLE 3 - Accidents by Intersection

Intersection	2005	2006 (Jan.-Jul.)
Signalized		
Celina Ave.	NR	NR
Cellu Dr./Nimcor Dr.	4	5
Blackstone Dr.	1	1
Thornton Rd./Deerwood Dr.	5	1
Sunapee St./Townsend West	9	3
Building 19	NR	NR
Somerset Pkwy.	13	7
Unsignalized		
Capitol St.	4	1
State St.	5	2
TOTAL	41	20

NR: not reported

2.5 Traffic Signal Warrants

As part of the Route 101A widening, the Corridor Master Plan recommended the installation of a traffic signal at the Capitol Street intersection. Prior to the installation of a traffic signal at any location, an engineering study referred to as a signal warrant analysis must be performed. Recognizing that there are the only two locations in the project area where there are unsignalized median openings and that they are in close proximity to each other, it was decided early in the project to conduct a warrant analysis at both Capitol and State Street.

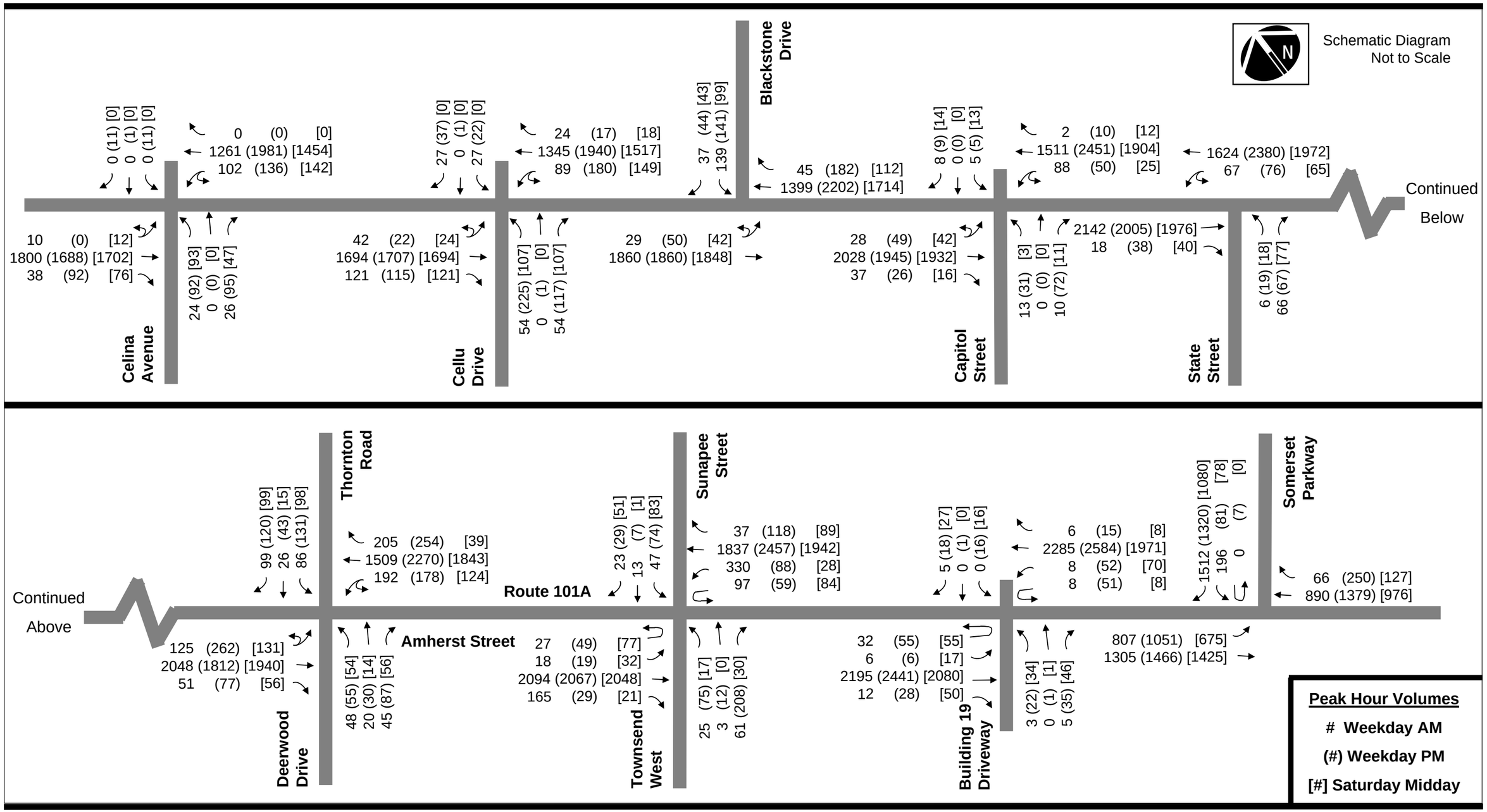
In September 2006 the NRPC conducted a signal warrant analysis for the unsignalized intersections of Route 101A at Capitol Street and at State Street. Such analysis follows the criteria set forth by the Federal Highway Administration in the Manual on Uniform Traffic Control Devices (MUTCD). In the NRPC analysis, Capitol Street did not meet any warrants for signalization, while State Street did meet the warrants for eight-hour volume (interruption of continuous traffic), for four-hour volume, and for peak-hour volume. Further discussion on the applicability of this warrant analysis is provided in Section 4.2 of this report. Although the approach volumes on Route 101A at both intersections were comparable, the volume of traffic approaching Route 101A on State Street was found to be above the thresholds for the referenced warrants while the Capitol Street volumes were below warrant thresholds.

3 FUTURE NO-BUILD CONDITIONS

3.1 Development of Future Design Year Volumes

In order to analyze future traffic operations, future traffic volumes were projected based on model data provided by the NRPC. The current NRPC travel demand forecasting model, developed in 2003, is maintained and run using TransCad, a leading GIS and transportation modeling software. The model covers all 12 communities in the Nashua planning region and is calibrated to on-the-ground traffic counts conducted between 1999 and 2003. It is a 24-hour model calibrated to average weekday traffic counts. To arrive at peak hour numbers, the assumption is made that changes in traffic volumes at the 24-hour level are consistent with those during the peak hours.

After validating that existing traffic volume data correlated with 2007 NRPC projections, rates of traffic volume change for 2017 and for 2027 were derived from the model's traffic projections for those years. The growth factors derived from the NRPC model were respectively applied to current peak hour volumes and turning movements to arrive at projected No-Build volumes for the 2017 and 2027 design years. Figures 2 and 3 show the projected weekday AM, weekday PM, and Saturday midday peak-hour traffic volumes at the intersections in the study area for the 2017 No-Build and 2027 No-Build design scenarios respectively.



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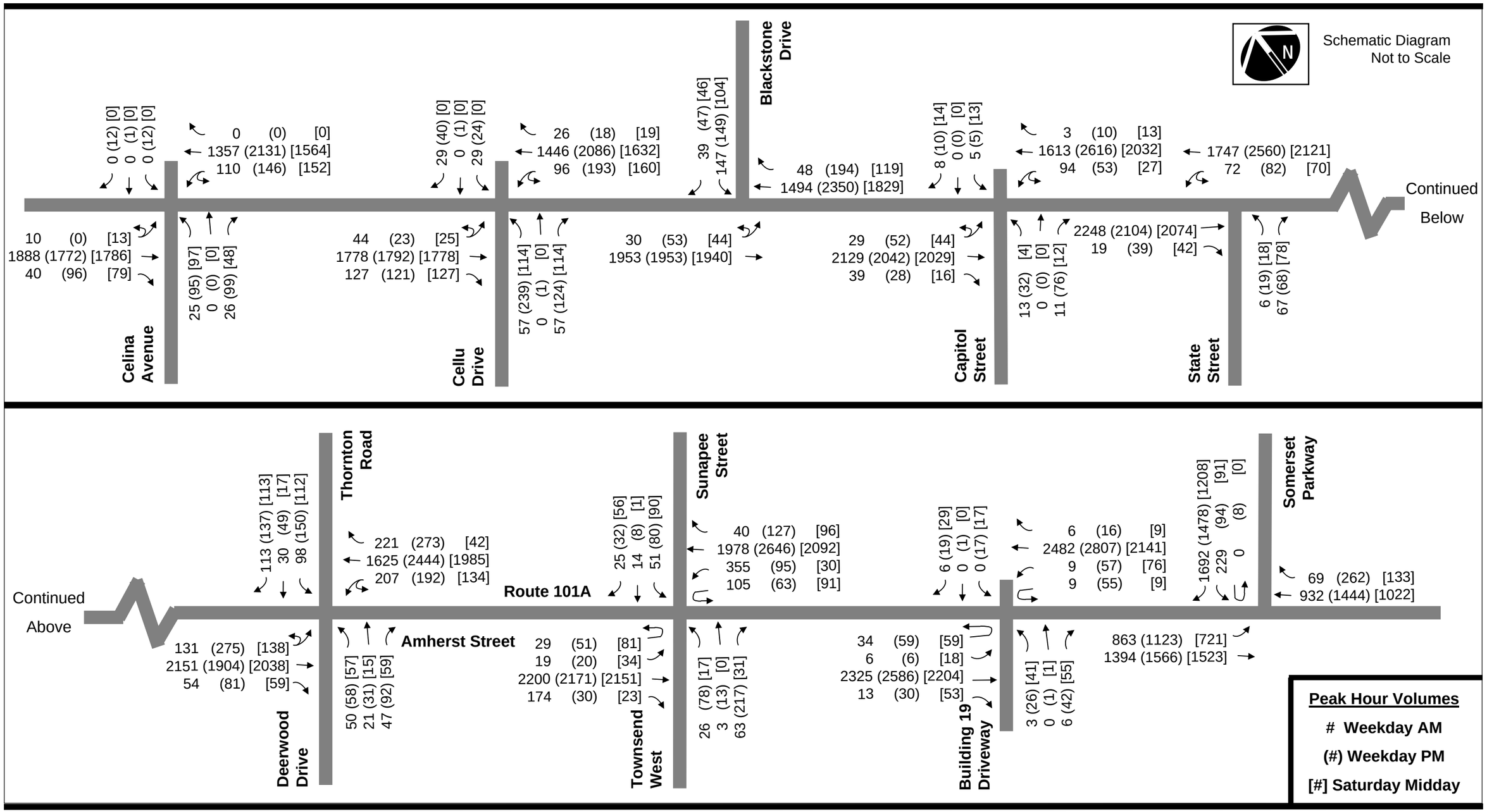
2017 No-Build
Peak Hour Traffic Volumes

Route 101A Widening and Improvements
City of Nashua, New Hampshire

Figure 2



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Route 101A Widening and Improvements
City of Nashua, New Hampshire

2027 No-Build
Peak Hour Traffic Volumes

Figure 3

3.2 Traffic Operations

Using the traffic volumes modeled for the 2017 and 2027 No-Build scenarios, Table 4 summarizes the traffic operations of the study-area intersections under No-Build conditions. The operations are measured in terms of volume-to-capacity (v/c) ratio, average delay in seconds per vehicle, and LOS. These results form the basis for comparison to operation measurements for the 2017 and 2027 Build conditions, and are shown in comparison to existing conditions.

TABLE 4 - Future No-Build Traffic Operations

	Existing			2017 No Build			2027 No-Build		
Weekday AM Peak Hour	v/c	Delay (s)	LOS	v/c	Delay (s)	LOS	v/c	Delay (s)	LOS
Signalized									
Celina Ave.	0.49	7.1	A	0.59	8.5	A	0.62	9.8	A
Cellu Dr./Nimcor Dr.	0.61	12.2	B	0.74	14.4	B	0.80	18.0	B
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Building 19	0.82	7.4	A	0.96	18.2	B	1.02	32.9	C
Somerset Pkwy.	0.78	19.0	B	0.94	30.0	C	1.04	49.8	D
Unsignalized									
Capitol St.	>2	>200	F	>2	>200	F	>2	>200	F
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Weekday PM Peak Hour									
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Celina Ave.	0.64	16.5	B	0.76	20.0	C	0.81	20.4	C
Cellu Dr./Nimcor Dr.	0.76	25.0	C	0.90	43.8	D	0.95	66.3	E
Blackstone Dr.	0.82	14.5	B	0.96	30.2	C	1.03	48.8	D
Thornton Rd./Deerwood Dr.	1.29	157.1	F	1.56	272.8	F	1.69	320.0	F
Sunapee St./Townsend West	0.97	33.6	C	1.14	71.6	E	1.23	102.5	F
Building 19	0.90	22.9	C	1.06	60.0	E	1.13	77.4	E
Somerset Pkwy.	0.75	16.0	B	0.88	20.3	C	0.97	26.8	C
Unsignalized									
Capitol St.	>2	>200	F	>2	>200	F	>2	>200	F
State St.	>2	>200	F	>2	>200	F	>2	>200	F
Saturday Midday Peak Hour									
Signalized									
Celina Ave.	0.50	10.7	B	0.58	12.2	B	0.62	13.8	B
Cellu Dr./Nimcor Dr.	0.63	11.4	B	0.75	15.0	B	0.80	16.4	B
Blackstone Dr.	0.62	5.9	A	0.73	6.4	A	0.78	6.8	A
Thornton Rd./Deerwood Dr.	0.84	21.3	C	1.00	47.7	D	1.07	75.0	E
Sunapee St./Townsend West	0.78	13.8	B	0.95	27.1	C	1.02	45.5	D
Building 19	0.78	15.3	B	0.91	27.5	C	0.97	41.3	D
Somerset Pkwy.	0.55	12.6	B	0.65	14.0	B	0.72	15.7	B
Unsignalized									
Capitol St.	>2	>200	F	>2	>200	F	>2	>200	F
State St.	>2	>200	F	>2	>200	F	>2	>200	F

The unsignalized intersections at Capitol Street and at State Street will continue to operate at unacceptable levels of service during all peak hours in the 2017 and 2027 No-Build conditions. In addition, the intersections at Thornton Road and Deerwood Drive, at Sunapee Street and Townsend West, and at the Building 19 driveway will operate at unacceptable levels of service during the PM peak hour in the 2017 and 2027 No-Build conditions.

4 FUTURE BUILD CONDITIONS

4.1 Proposed Roadway Cross-section Modifications

In general the cross section for all intersection approaches on Route 101A from the intersection at Celina Avenue to the intersection at the Building 19 driveway are proposed to consist of a left-turn bay, two through lanes, and a shared through/right-turn lane. At the three-legged intersections at Blackstone Drive and at Somerset Parkway, where there is no southerly leg to receive turning vehicles, the westbound left-turn bay would not be provided. In addition, the *Route 101A Corridor Master Plan and Improvements Program Final Report* (September 2002) recommends the signalization of the intersection with Capitol Street.

4.2 Traffic Operations with Corridor Study Recommendations

Using the future traffic volumes modeled for the 2017 and 2027 conditions, Table 5 summarizes the traffic operations of the study-area intersections under Build conditions as outlined in the *Route 101A Corridor Master Plan and Improvements Program Final Report*. The operations are measured in terms of volume-to-capacity (v/c) ratio, average delay in seconds per vehicle, and LOS.

Under future Build conditions, the unsignalized intersection at State Street will continue to operate at unacceptable levels of service during all peak hours in the 2017 and 2027 Build conditions. The corridor study results indicate that traffic operations at Capitol Street would be improved with the installation of a traffic signal. An evaluation of traffic signal warrants by NRPC, discussed in section 2.5, indicates that a traffic signal at Capitol Street is not warranted while a traffic signal at State Street is warranted. Both of these warrant analyses were performed based on existing conditions where the medians at both Capitol Street and State Street are open. It is reasonable to assume that a traffic signal would be required at Capitol Street if the median island were closed at State Street. Left-turning vehicles that currently turn into and out of State Street would be forced to use the Capitol Street intersection to make those movements. Consequently, the Capitol Street intersection would become much busier, requiring traffic signal control. Traffic analysis performed for this project also found that the intersection at Thornton Road and Deerwood Drive would operate at an unacceptable level of service during the PM peak hour in the 2027 Build condition.

TABLE 5 - Future Build Traffic Operations
(with Corridor Study Recommendations)

	2017 Build			2027 Build		
Weekday AM Peak Hour	v/c	Delay (s)	LOS	v/c	Delay (s)	LOS
Signalized						
Celina Ave.	0.59	8.6	A	0.62	9.0	A
Cellu Dr./Nimcor Dr.	0.54	9.7	A	0.59	7.1	A
Blackstone Dr.	0.55	4.7	A	0.58	5.1	A
Capitol St.	0.59	5.6	A	0.65	9.0	A
Thornton Rd./Deerwood Dr.	0.82	21.2	C	0.93	32.8	C
Sunapee St./Townsend West	0.93	19.2	B	0.98	16.0	B
Building 19	0.66	5.2	A	0.70	4.8	A
Somerset Pkwy.	0.95	24.5	C	1.04	41.9	D
Unsignalized						
State St.	0.69	73.8	F	>2	>200	F
Weekday PM Peak Hour						
Signalized						
Celina Ave.	0.64	6.5	A	0.67	6.3	A
Cellu Dr./Nimcor Dr.	0.68	8.6	A	0.71	11.7	B
Blackstone Dr.	0.66	7.9	A	0.70	5.6	A
Capitol St.	0.68	8.3	A	0.74	9.2	A
Thornton Rd./Deerwood Dr.	1.06	41.8	D	1.15	57.5	E
Sunapee St./Townsend West	0.79	13.2	B	0.85	14.0	B
Building 19	0.72	12.6	B	0.74	12.9	B
Somerset Pkwy.	0.88	22.3	C	0.97	28.9	C
Unsignalized						
State St.	0.83	90.9	F	0.92	117.1	F
Saturday Midday Peak Hour						
Signalized						
Celina Ave.	0.60	11.1	B	0.64	11.9	B
Cellu Dr./Nimcor Dr.	0.59	12.0	B	0.62	5.8	B
Blackstone Dr.	0.50	3.0	A	0.54	4.5	A
Capitol St.	0.51	2.5	A	0.55	4.0	A
Thornton Rd./Deerwood Dr.	0.71	15.3	B	0.82	19.7	B
Sunapee St./Townsend West	0.67	13.6	B	0.73	9.5	A
Building 19	0.63	7.6	A	0.67	9.7	A
Somerset Pkwy.	0.66	11.2	B	0.72	12.8	B
Unsignalized						
State St.	>2	>200	F	>2	>200	F

4.3 Build Alternatives Assessment

As was demonstrated in the previous section, implementation of the improvements recommended in the Master Plan is expected to result in acceptable traffic operating conditions in the corridor with the exception of the segment between Blackstone Drive and Thornton Road. In an effort to address this, a subnetwork of intersections in the study area, was identified for the purpose of investigating the effect of possible geometric and signalization treatments. A number of these treatments follow from previous studies conducted in the corridor, namely the *Route 101A Corridor Master Plan and Improvements Program Final Report*, and the Route 101A Signal Warrant Analysis previously discussed. These possible treatments are outlined below.

State Street

- Provide direct access to Route 101A for NHCTC by way of a driveway directly opposite State Street. This driveway would also provide access to the neighboring Amherst Park apartment complex, effectively replacing its existing driveway. The resulting four-leg intersection would be signal-controlled.
- Signalize the existing three-leg intersection, with no new access to NHCTC.
- Close the existing open median, with westbound entering and exiting access to businesses on the southerly side of Route 101A available at a signalized Capitol Street intersection, and eastbound entering access to businesses on the northerly side of Route 101A available via u-turns at Thornton Road.
- Maintain the existing open median unsignalized.

Capitol Street

- Signalize the existing intersection, incorporating the driveway to the businesses along the northerly side of Route 101A.
- Close the existing median, with westbound entering and exiting access to businesses on the southerly side of Route 101A, and eastbound entering access to businesses on the northerly side of Route 101A, available at a signalized State Street intersection; and eastbound exiting access to businesses on the northerly side of Route 101A provided via u-turns at Blackstone Drive.
- Maintain the existing open median unsignalized.

Blackstone Drive

- Only in conjunction with a closing of the Capitol Street median, provide a u-turn bay on Route 101A westbound.

Thornton Road/Deerwood Drive

- Provide a dual left-turn bay on Route 101A eastbound for traffic entering Thornton Road.
- Maintain the existing lane configuration on Route 101A eastbound.

TABLE 6 - 2027 Build Alternative Options

	Option			
	0	**1**	**2**	**3**
Thornton Rd./Deerwood Dr.	Single EB left-turn lane	Double EB left-turn lane	Single EB left-turn lane	Double EB left-turn lane
State St.	No change	Signalized three-leg	Signalized with NHCTC access	Closed median
Capitol St.	Signalized	Unsignalized	Closed median	Signalized
Blackstone Dr.	No change	No change	WB U-turn	No change

TABLE 7 - 2027 Build Traffic Operations

		Option											
		0			**1**			**2**			**3**		
Thornton Rd./Deerwood Dr.		Single EB left-turn lane			Double EB left-turn lane			Single EB left-turn lane			Double EB left-turn lane		
State St.		No change			Signalized three-leg			Signalized with NHCTC access			Closed median		
Capitol St.		Signalized			No change			Closed median			Signalized		
Blackstone Dr.		No change			No change			WB U-turn			No change		
Weekday AM Peak Hour		v/c	Delay (s)	LOS	v/c	Delay (s)	LOS	v/c	Delay (s)	LOS	v/c	Delay (s)	LOS
Thornton Rd./Deerwood Dr.		0.93	32.8	C	0.90	23.8	C	0.93	29.7	C	0.94	32.8	C
State St.	signalized	-	-	-	0.63	4.0	A	0.68	8.1	A	-	-	-
	unsignalized	>2	>200	F	-	-	-	-	-	-	0.14	11.4	B
Capitol St.	signalized	0.65	9.0	A	-	-	-	-	-	-	0.71	11.3	B
	unsignalized	-	-	-	>2	>200	F	0.03	10.7	B	-	-	-
Blackstone Dr.		0.58	5.1	A	0.58	7.3	A	0.64	5.7	A	0.58	4.8	A
Weekday PM Peak Hour													
Thornton Rd./Deerwood Dr.		1.15	57.5	E	1.06	40.5	D	1.09	35.0	D	1.00	40.4	D
State St.	signalized	-	-	-	0.60	3.5	A	0.83	14.2	B	-	-	-
	unsignalized	0.92	117.1	F	-	-	-	-	-	-	0.14	10.8	B
Capitol St.	signalized	0.74	9.2	A	-	-	-	-	-	-	0.76	10.4	B
	unsignalized	-	-	-	>2	>200	F	0.19	13.1	B	-	-	-
Blackstone Dr.		0.70	5.6	A	0.70	5.2	A	0.71	5.4	A	0.70	4.4	A
Saturday Midday Peak Hour													
Thornton Rd./Deerwood Dr.		0.82	19.7	B	0.81	15.6	B	0.84	19.9	B	0.81	15.8	B
State St.	signalized	-	-	-	0.58	4.7	A	0.63	6.1	A	-	-	-
	unsignalized	>2	>200	F	-	-	-	-	-	-	0.15	11.1	B
Capitol St.	signalized	0.55	4.0	A	-	-	-	-	-	-	0.54	4.9	A
	unsignalized	-	-	-	>2	>200	F	0.03	10.3	B	-	-	-
Blackstone Dr.		0.54	4.5	A	0.57	7.6	A	0.54	3.9	A	0.57	3.4	A

Four options employing combinations of the above-described treatments were identified for future capacity analysis in all peak periods. Table 6 provides a matrix summarizing the choice of potential treatment for each intersection in the subnetwork under the four options (option 0 presumes the implementation of geometric improvements proposed in the *Route 101A Corridor Master Plan and Improvements Program Final Report*, along with the Thornton Road lane reassignments). Table 7 summarizes the peak-hour traffic operations in the subnetwork of intersections for each 2027 Build treatment option.

Under Option 1, the addition of a second left-turn lane from Route 101A eastbound onto Thornton Road reduces overall delay to the point where the Thornton Road/Deerwood Drive intersection would operate at LOS "D". While the capacity problem for the eastbound left turn movement has been addressed such that it is no longer a critical movement in terms of the signal cycle, the overall v/c, while improved, is still over 1.0. Installation of a traffic signal at State Street provides the needed capacity for turning movements at that intersection such that they will operate at LOS "A". In contrast, turning movements entering Route 101A at Capitol Street will still experience high delays since minimal capacity is available for these movements in an unsignalized condition.

Option 2 reflects an alternative approach to improving traffic operations at Thornton Road/Deerwood Drive by reducing demand at the intersection with the provision of a second access point to the New Hampshire Community Technical College (NHCTC) at a signalized intersection with State Street. In support of the assessment of this alternative, NRPC conducted supplemental counts to identify volume and direction of vehicles entering and exiting the college. Reductions in traffic volumes at the Thornton Road intersection, due to traffic opting to enter and exit NHCTC at State Street, do result in a slight improvement in delay, but not to the point where there is expected to be a change in level of service compared with the addition of a second eastbound left turn lane as called for under Option 1. The lack of a more significant improvement in traffic operations could be attributed to what was a relatively small percentage of the total volume processed by the intersection in the PM peak hour that was found to be associated with the college.

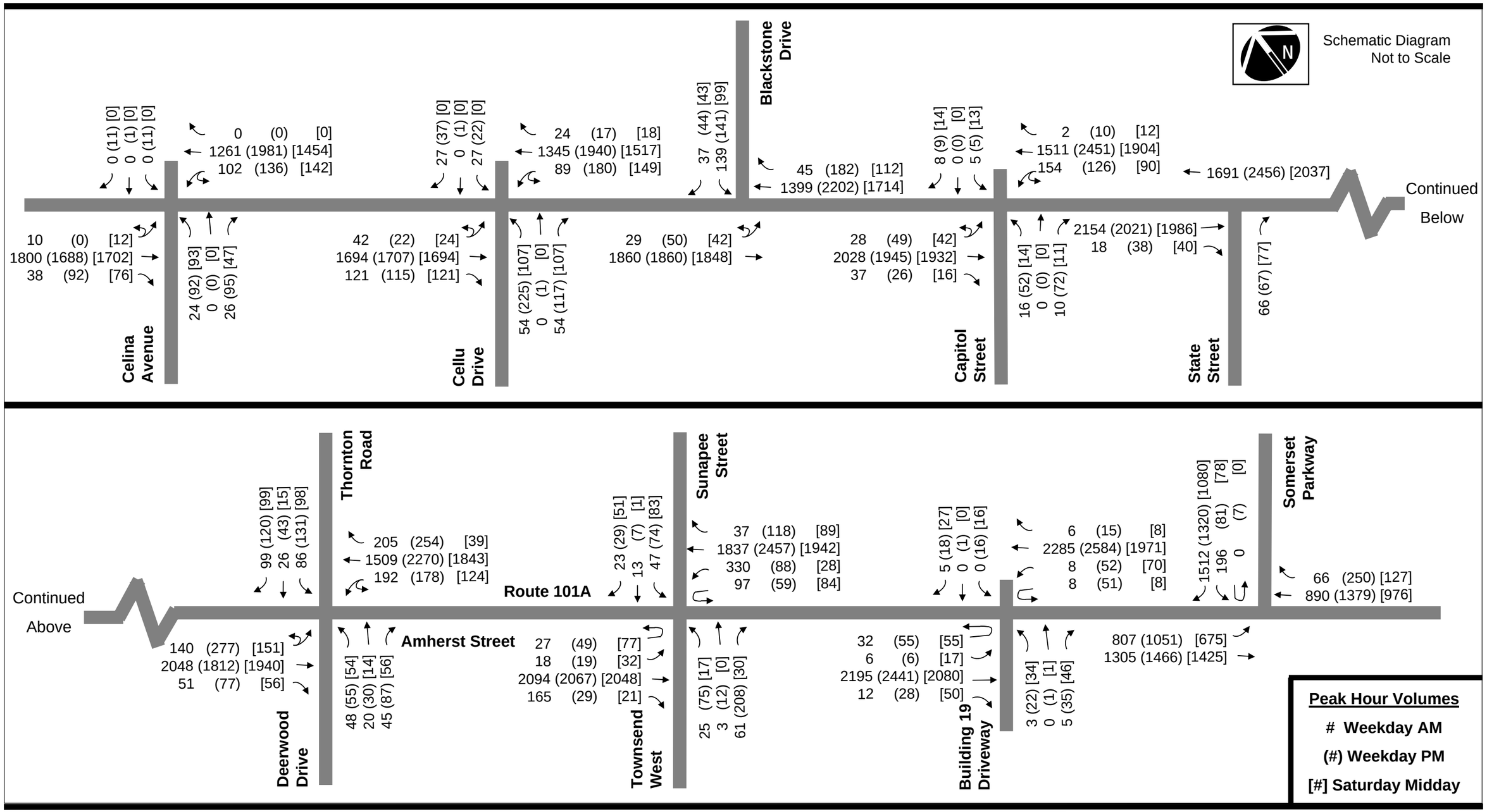
As a result of the median closure, left turns into and out of Capitol Street are anticipated to shift to the State Street intersection. Even with the additional traffic processed at State Street with the second school access, the State Street intersection will still operate at an acceptable LOS "B".

Option 3 calls for the installation of a traffic signal at Capitol Street rather than at State Street, as well as closing the median at State Street. It also includes providing the second left-turn lane from Route 101A eastbound to Thornton Road. As has been discussed previously, approach volumes on Capitol Street under existing conditions were not consistently high enough throughout the day for the intersection to satisfy traffic signal warrants. However, with the closure of the median at State it is anticipated that there will be an increase in the volume of traffic turning left from Capitol Street to Route 101A westbound. Since State and Capitol Street together serve as the only access point from commercial properties in this area to/from Route 101A, it is reasonable to expect a shift in demand when access is modified at one or both of these intersections. Recognizing that the existing approach volumes at each intersection are either

above or very close to satisfying signal warrants, the diversion of traffic from State Street is anticipated to be such that the approach volumes at Capitol Street will exceed warrant thresholds. Even with the shift in volumes from State Street to Capitol Street, this improvement alternative results in acceptable traffic operating conditions at all the intersections in the subarea. Option 3 would make use of a four-legged signalized intersection at Capitol Street versus a three-legged intersection at State Street under Option 2. Option 3 also provides a shorter trip for vehicles making a left turn onto Route 101A than Option 2 would. Besides the improvement in level of service compared to those associated with the recommendations of the corridor master plan, Option 3 is the alternative with the greatest improvement in the intersection v/c ratio. Considering that operations are improved at all locations and the signalization of the Capitol Street intersection is consistent with the *Route 101A Corridor Master Plan,* Option 3 was selected as the recommended alternative.

4.4 Traffic Operations with Recommended Improvements

Using the future traffic volumes modeled for the 2017 and 2027 conditions (shown in Figures 4 and 5, with volumes reassigned due to the State Street median closure), Table 8 summarizes the traffic operations of the study-area intersections under Build conditions. The operations reported for the 2017 and 2027 Build conditions reflect the improvements outlined previously in Build Alternative Option 3. It is shown that under these conditions with recommended improvements, all intersections can function at acceptable levels of service.



ENGINEERS
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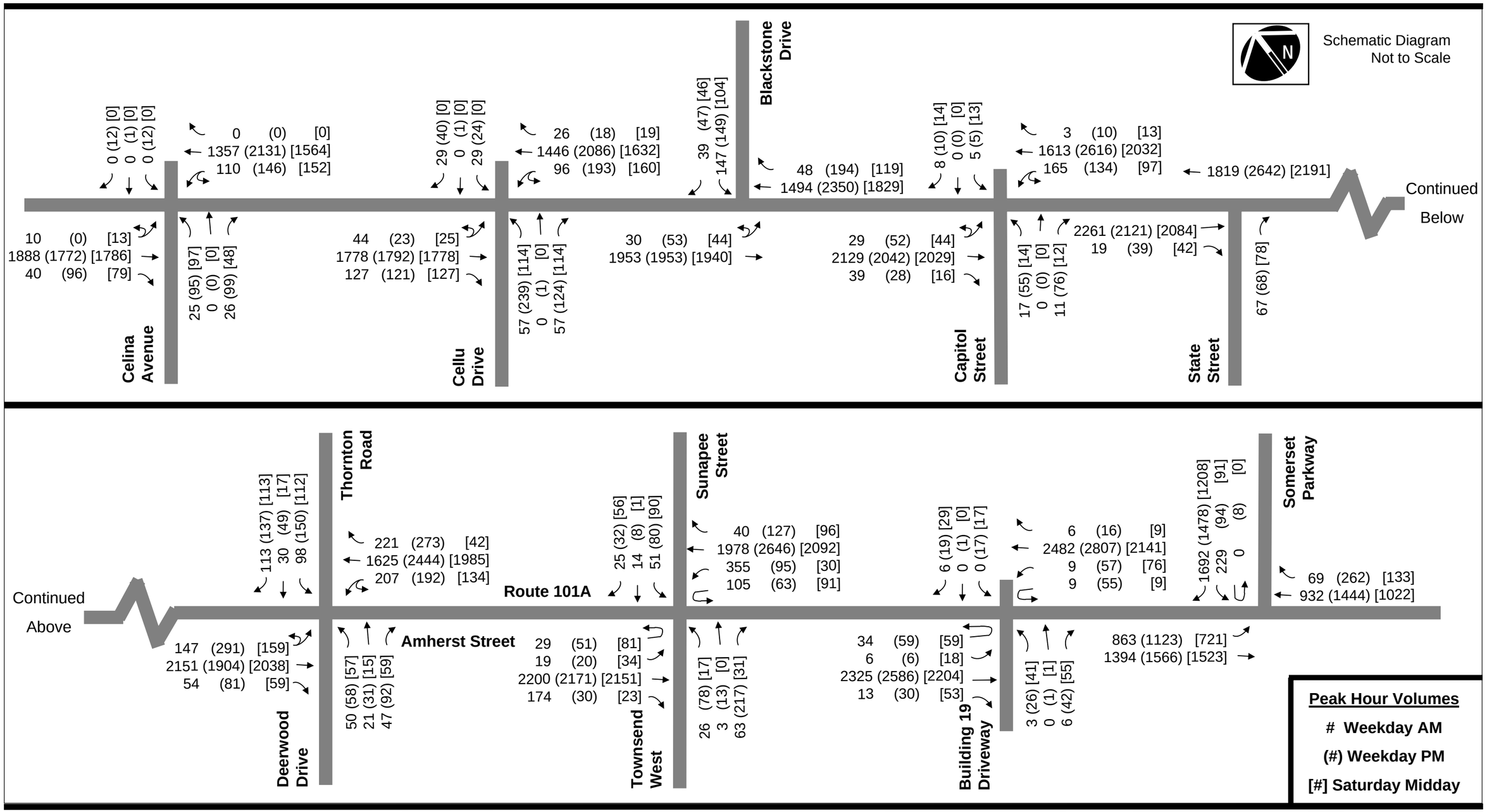
2017 Build
Peak Hour Traffic Volumes

Route 101A Widening and Improvements
City of Nashua, New Hampshire

Figure 4



ENGINEERS
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Route 101A Widening and Improvements
City of Nashua, New Hampshire

2027 Build
Peak Hour Traffic Volumes

Figure 5

TABLE 8 - Future Build Traffic Operations
(with Recommended Improvements)

	2017 Build			2027 Build		
Weekday AM Peak Hour	v/c	Delay (s)	LOS	v/c	Delay (s)	LOS
Signalized						
Celina Ave.	0.59	8.6	A	0.62	8.9	A
Cellu Dr./Nimcor Dr.	0.54	7.5	A	0.59	6.7	A
Blackstone Dr.	0.55	4.4	A	0.58	4.8	A
Capitol St.	0.68	8.2	A	0.71	11.3	B
Thornton Rd./Deerwood Dr.	0.79	19.1	B	0.94	32.8	C
Sunapee St./Townsend West	0.93	17.9	B	0.98	15.3	B
Building 19	0.68	4.9	A	0.70	4.8	A
Somerset Pkwy.	0.95	24.1	C	1.04	41.9	D
Unsignalized						
State St.	0.13	10.9	B	0.14	11.4	B
Weekday PM Peak Hour						
Signalized						
Celina Ave.	0.64	6.3	A	0.67	6.5	A
Cellu Dr./Nimcor Dr.	0.67	12.2	B	0.74	13.9	B
Blackstone Dr.	0.66	4.8	A	0.70	4.4	A
Capitol St.	0.74	11.5	B	0.76	10.4	B
Thornton Rd./Deerwood Dr.	0.99	40.9	D	1.00	40.4	D
Sunapee St./Townsend West	0.79	12.3	B	0.88	19.6	B
Building 19	0.71	10.3	B	0.81	8.9	A
Somerset Pkwy.	0.88	19.9	B	0.97	26.5	C
Unsignalized						
State St.	0.14	11.0	B	0.14	10.8	B
Saturday Midday Peak Hour						
Signalized						
Celina Ave.	0.60	11.2	B	0.64	12.0	B
Cellu Dr./Nimcor Dr.	0.59	11.8	B	0.62	10.7	B
Blackstone Dr.	0.50	3.0	A	0.57	3.4	A
Capitol St.	0.54	4.0	A	0.54	4.9	A
Thornton Rd./Deerwood Dr.	0.67	13.8	B	0.81	15.8	B
Sunapee St./Townsend West	0.67	13.1	B	0.75	15.4	B
Building 19	0.63	7.8	A	0.66	8.6	A
Somerset Pkwy.	0.66	11.3	B	0.72	12.5	B
Unsignalized						
State St.	0.16	11.6	B	0.15	11.1	B