

LITCHFIELD - HUDSON TRANSPORTATION STUDY

Prepared for:



Nashua Regional Planning Commission

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March 2003

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I. Introduction

Vollmer Associates LLP has been retained by the Nashua Regional Planning Commission (NRPC), under a contract between the NRPC and the NH Department of Transportation, to provide assistance in evaluating traffic conditions for the Towns of Litchfield and Hudson, New Hampshire. The project was conducted as a collaborative effort between the two towns, the NRPC and Vollmer Associates. The purpose of the project is to evaluate traffic conditions for a twenty-year future scenario and to consider improvements needed as a result of the Circumferential Highway and the Manchester Airport Access Road. The goal of the study is to identify needed improvements and to determine the costs of those projects for use by the Towns of Litchfield and Hudson and for the development of potential projects for state funding.

Thirty-eight intersections along three highway corridors (NH Route 3A, NH Route 102 and NH Route 111) were evaluated. The current levels of traffic congestion at these locations are expected to intensify over the next 20 years due to regional and local development pressures. Litchfield, Hudson and the NRPC through joint review identified the intersections selected as candidates for study.

The methodology employed for the project involves a straightforward approach and includes the following elements:

- 1. Comprehensive review of previous studies and information gathered to date;*
- 2. Identify location of constraints, issues and concerns (operational and geometric);*
- 3. Develop conceptual alternatives to address deficiencies identified; and*
- 4. Evaluation and screening of concepts based on geometric, right-of-way, operational, constructability and cost considerations.*

II. Traffic Study Review

The first task of the Litchfield-Hudson Transportation Study deals with the compilation and review of previous traffic studies that are available for the Towns of Litchfield and Hudson. This section of the report provides a summary listing of existing plans and proposals for roadway improvements for the Litchfield and Hudson study area.

Project Kick-off Meeting

The first opportunity to discuss previous design alternatives occurred at the project kick-off meeting held at the Litchfield Town Hall on February 20, 2002. The meeting provided a forum for the dissemination of information on previous

design alternatives within the study area as well as confirming study goals and objectives. Appendix A contains the minutes of the kick-off meeting.

Several planned roadway improvements were identified at the kick-off meeting. Perhaps the largest of these is the planned construction of the Nashua-Hudson Circumferential Highway. It was noted that the future year traffic forecasts for the Litchfield-Hudson Transportation Study should be based on the assumption that the Preferred Alternative of the Circumferential Highway would be built. This alternative consists of the construction of a limited access highway beginning with a new terminal interchange on the F. E. Everett Turnpike between Exit 8 and Exit 10. From there the highway runs easterly, crossing the Merrimack River, then follows the Litchfield/Hudson Town Line before heading southerly and ending at its eastern terminus at NH Route 111 in Hudson. Between the two termini, the Preferred Alternative calls for several intermediate interchanges along the highway at US Route 3 in Merrimack and NH Routes 3A and 102 in Litchfield.

Another major roadway improvement that is expected to impact future travel patterns in the Litchfield/Hudson study area is the planned construction of the Manchester Airport Access Road. This roadway extends across Bedford, Manchester and Londonderry connecting the Manchester Airport to the F. E. Everett Turnpike. Although this roadway is located north of the study area it is anticipated that traffic within the study area, particularly along NH Route 3A in Litchfield would be affected. Construction of the Airport Access Road was considered when developing the trip tables for the future year travel model.

Previous Traffic Studies and Other Documents

Previous traffic studies for Litchfield and Hudson were obtained and reviewed, both during and subsequent to the kick-off meeting. A document list showing all reports and studies obtained from the NRPC, Town of Litchfield and Town of Hudson is shown in Appendix B.

The *State of New Hampshire Ten Year Transportation Improvement Program 2001-2010*, prepared by the NHDOT contains New Hampshire's statewide program for intermodal transportation improvements. This program includes the following roadway improvements pertinent to the Litchfield-Hudson Transportation Study:

- Widen the intersection of NH Route 102/West Road in Hudson for turn lanes, signals and a truck lane. These improvements are scheduled for construction in 2004.
- Construction of the Circumferential Highway is scheduled to begin in 2008.
- Construct sidewalks along NH Route 3A in Hudson from Birch Street to Central Street. This improvement is scheduled for construction in 2002.

- Construction of a 0.3-mile segment of Albuquerque Avenue in Litchfield from April Drive to NH 3A is planned for 2007. Included in this construction are proposed intersection improvements at NH Route 3A/Albuquerque Avenue.
- Construction of intersection improvements at NH Route 3A/Hillcrest Road in Litchfield. This is a recently improved project under the State's Betterment program.

Recommended improvements obtained from the report, *Traffic Impact Assessment – Proposed Sawmill Brook Estates – Phase IV and V, Litchfield, NH* include the construction of a paved right-turn taper at the intersection of Hillcrest Road/Albuquerque Avenue for westbound vehicles turning right onto Albuquerque Avenue.

The *Traffic Study Review for the Proposed Litchfield High School, Litchfield, NH* report indicates a need for improving intersection sight distance at the NH Route 3A/Talent Road intersection. Suggestions are made for providing interim improvements until roadway geometry is improved. The report also recommends improvements to the Albuquerque Avenue/Page Road intersection by converting the intersection to three-way stop control.

A review of the Hudson Master Plan identifies several recommended roadway improvements that are applicable to the Litchfield-Hudson Transportation Study. Short-range recommended improvements include converting NH Route 111 between Hudson Park Drive and Lawrence Road to a three-lane cross section with the provision of a center turn lane. Other short-range improvements include prohibiting eastbound left turns from Ferry Street at the Derry Street/Ferry Street/Library Street Triangle. Improvements to enhance pedestrian amenities include the provision of a sidewalk along the east side of NH Route 102 between Grand Avenue and Phillips and providing crosswalks at the Derry Street/Highland Street intersection.

The Hudson Master Plan also identifies many long-range recommended improvements. Twenty-three separate projects are identified. Nine improvement projects are related to enhancing traffic flow on NH Route 3A, seven projects are identified for NH Route 102 improvements, four projects are recommended for NH Route 111 and three projects are recommended for local roadways in Hudson (Ferry Street/Derry Street/Central Street Triangle, Ferry Street between Library Street and Burnham Road and the Central Street/Burnham Road intersection).

Improvements to NH Route 3A include providing a three-lane cross section south of Sanders Drive and between Executive Drive and Central Street. The Master Plan calls for the provision of a five-lane cross section between Sanders Drive and Executive Drive. Capacity enhancements along NH Route 3A are recommended at the Wason Road, Executive Drive, Pelham Road and Birch Street intersections. Traffic signal installations are recommended for three intersections: NH Route

3A/Executive Drive, NH Route 3A/Pelham Road and NH Route 3A/Birch Street/Connector Road.

Recommended improvements to NH Route 102, as outlined in the Master Plan, include reconstruction of the roadway to a five-lane cross section between the Litchfield Town Line and the Londonderry Town Line. Capacity enhancements are also recommended at the McDonalds, Elm Street and Robinson Road intersections along with installation of traffic signals at McDonalds and Robinson Road.

The Master Plan recommends reconstruction of NH Route 111 to provide a three-lane cross section between Burnham Road and the Circumferential Highway interchange and a five-lane cross section between the Circumferential Highway interchange and the Town Line. Modifications are also recommended to the traffic signal at the Route 111/Greeley Street intersection.

Additional long-range improvements contained in the Master Plan include: the installation of traffic signals at the Central Street/Library Street and Central Street/Chase Street intersections, prohibiting left turns from Central Street onto Library Street, prohibiting the Ferry Street eastbound left turn at Library Street, converting Chase Street to one-way northbound between Ferry Street and School Street, and modifying the traffic signal at the Central Street/Burnham Road intersection.

A list of approved plans and new, large developments for the Town of Hudson was also reviewed as part of this study. Table II-1 shows the list of approved developments for Hudson for fiscal year 2001. In addition to the developments listed in Table II-1, several large developments are currently planned or under construction in Hudson. These include:

- Royal Oaks – 25 residential units with access via Greeley Street and Melba Drive.
- Shepherd’s Hill – 400 residential units with access via Kimball Hill Road east of Bush Hill Road (currently under construction).
- Thurston’s Landing – 148 residential lots with access via Bush Hill Road (currently under construction).
- Woodland Heights – 90 residential townhouse units with access via Melendy Road, east of Rickey Street.
- Sagamore Square II – 68,000 square feet retail development with access via Wason Road, east of Lowell Road.

**Table II-1
Town of Hudson, NH – Approved Development List**

Site Plan No.	Map/Lot No.	Name	Development
14-00	2/12	Stateline Park	Amend. of previous approval
15-00	37/52-2	Chase Welding	15,000 sf of industrial space
17-00	7/40	Digital Credit Union	4,000 sf Credit Union Bldg.
18-00	24 & 60/25	Lockwood Place	Changes to original site plan
19-00	48/11-1	Additive Services	4,800 sf addition
20-00	41/6-9	N.E. Gymnastics	Access to Londonderry Site
21-00	26/24-2	Khan Park Site Plan	15,000 sf light industrial
23-00	7/37	Vectron Amended Site Plan	1,320 sf addition
25-00	17/8	Woodland Heights	90 townhouse units
26-00	52/21	Hudson Memorial School	School addition
02-01	41/4-2	R & S Carpet	11,400 sf warehouse
03-01	7/73	Bandwidth Semiconductor	Amendments
04-01	10/10	199 Lowell Road	As Built
05-01	2/14-7	Security Drive Site	17,010 sf warehouse
08-01	32/35	Morgan Ceramics	26,350 sf 2-story addition
09-01	26/24-1	Poles Automotive Service	Auto Service Center
10-01	10/5-2	RAC Auto Services	4,005 sf auto service facility
12-01	10/14-5	APW Enclosure Systems	Warehouse/office

III. Existing Traffic Volumes

An evaluation of Existing Year (2002) traffic conditions was conducted in order to establish a baseline for analysis of the thirty-eight study area intersections. The thirty-eight intersections were selected by a steering committee made up of representatives from the Towns of Litchfield and Hudson and the NRPC. Table III-1 displays the study area intersections.

**Table III-1
Study Area Intersections**

Litchfield	Hudson
NH 3A/Corning Rd.	NH 102/Robinson Rd.
NH 3A/Colby Rd. (north)	NH 102/Page Rd. (Litchfield Line)
NH 3A/Colby R. (south)	NH 102/Old Derry Rd.
NH 3A/Robyn Ave.	NH 102/Elm Ave.
NH 3A/Hillcrest Rd.	NH 102/Highland St.
NH 3A/Pinecrest Rd.	NH 111/Library St.
NH 3A/Talent Rd.	NH 111/Chase St.
NH 3A/Page Rd.	Central St./Library St.
Albuquerque Ave./Hillcrest Rd.	NH 3A/Central St.
Albuquerque Ave./Meadowbrook	NH 3A/County Rd. (north)
Albuquerque Ave./Pinecrest Rd.	NH 3A/County Rd. (south)
Albuquerque Ave./Talent Rd.	NH 3A/Birch St.
Albuquerque Ave./Page Rd.	NH 3A/Executive Dr.
Hillcrest Rd./Pinecrest Rd.	NH 3A/Wason Rd.
NH 3A/Albuquerque Ave.	Belknap Rd./County Rd.
NH 3A/Industrial Drive	NH 111/Central St.
NH 3A/Sterling Rd.	Central St./Belknap Rd.
Hillcrest Rd./Meadowbrook Lane	Bush Hill Rd./Kimball Hill Rd.
	Wason Rd./Bush Hill Rd.
	NH 111/Greeley St./Kimball Hill Rd.

Typically, an evaluation of traffic conditions involves an assessment of traffic that occurs during the two peak travel periods of the day: the AM peak hour and the PM peak hour. An analysis of two peak hours, however, is beyond the scope of this project. In order to assess traffic conditions for the thirty-eight intersections, analysis is based on evaluating traffic during the heaviest travel period of the day. This provides for a conservative estimate of traffic conditions for the study area as

a whole. For the Litchfield-Hudson area, this period occurs during the PM peak hour.

Weekday PM peak hour turning movement counts for the study area intersections were collected by the NRPC during 2001 and 2002. Counts were collected between 4:00 PM and 6:00 PM and show that the system-wide peak hour generally occurs from 5:00 PM to 6:00 PM. Appendix C contains the traffic count data for the study area intersections.

Traffic volumes vary from month to month due to seasonal fluctuations in travel patterns. In order to account for this variation and to provide conservative traffic estimates, traffic counts need to be adjusted to reflect peak month conditions using historical traffic count data. To determine this seasonal variation of traffic volumes on study area roadways, historical traffic data from NHDOT's *Traffic Volume Report 2000* was reviewed. NHDOT maintains a permanent traffic recorder station on NH 111, west of Park Street in Hudson. Data from this location was used to develop peak month adjustment factors that were then applied to the raw turning movement counts. The adjustment factors are shown in Table III-2. To illustrate the use of the factors, if a count was obtained during a typically low travel month, say January, then that count would be adjusted upward by multiplying the count by 1.15 to more accurately reflect peak month conditions.

Table III-2
Traffic Volume Adjustment Factors
NHDOT Automatic Traffic Recorder Report (2000)

NH 111, west of Park Street, Hudson

Month	AWDT	Peak Month Adjustment Factor
January	15,416	1.15
February	15,898	1.11
March	16,481	1.07
April	16,731	1.06
May	16,892	1.05
June	17,702	1.00
July	16,434	1.08
August	17,304	1.02
September	16,961	1.04
October	17,163	1.03
November	16,426	1.08
December	15,875	1.12

Existing PM peak hour turning movement counts for the Town of Litchfield, adjusted for seasonal variation, are displayed in Figure III-1 through Figure III-3. Adjusted PM peak hour turning movement counts for the Town of Hudson are shown in Figure III-4 through Figure III-7.

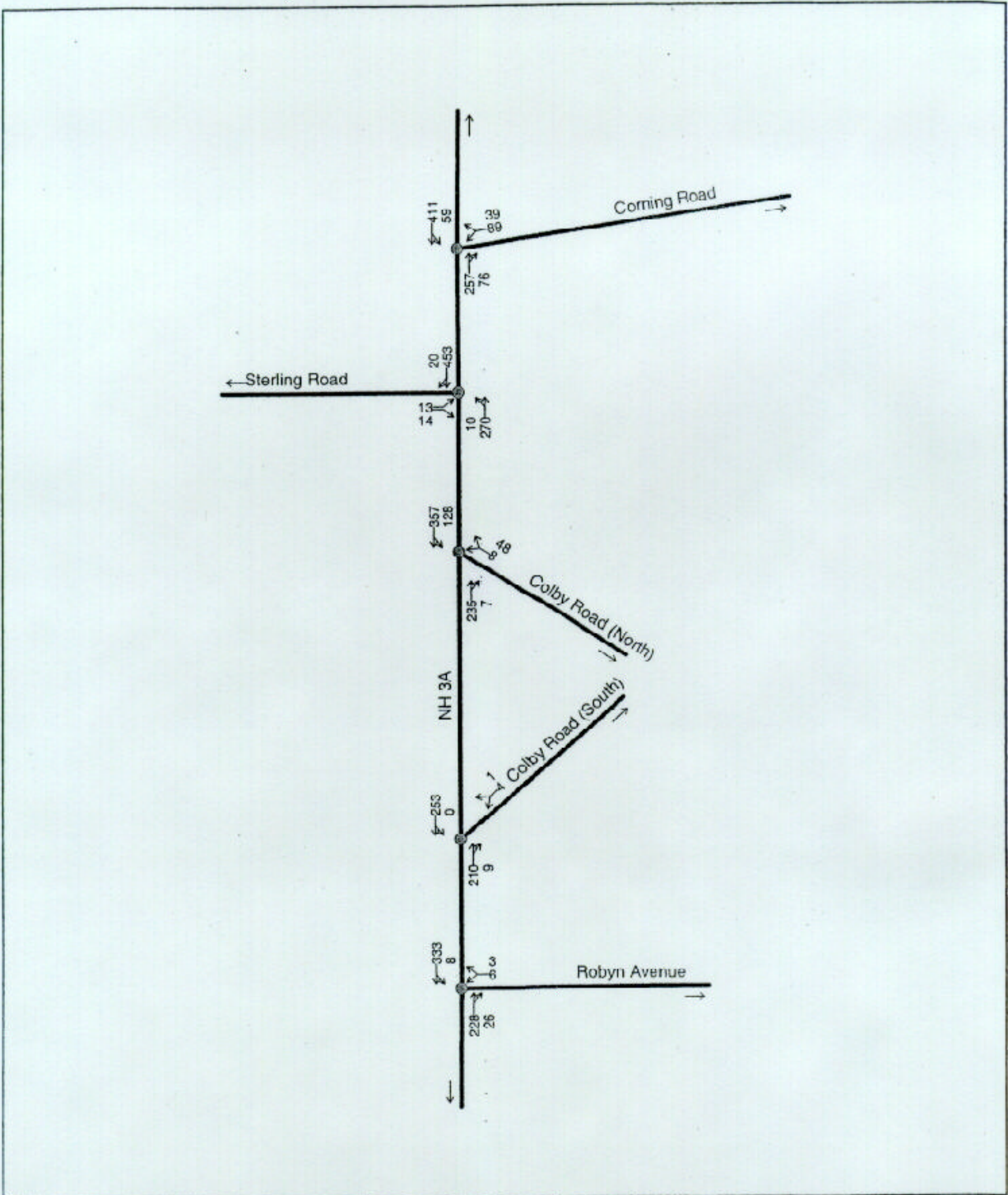
IV. Future Traffic Volumes

As noted earlier one of the main aims of this traffic study is to evaluate traffic conditions for a twenty-year future scenario. The NRPC maintains a travel model that reflects traffic projected to the year 2025 based on anticipated future land use patterns. According to the draft *Nashua Metropolitan Area Long-Range Transportation Plan 2003-2022 and Transportation Improvement Program 2003-2012*, “projected housing units, employment, and school enrollment are used to generate trip productions and attractions within the model. The projected growth in land use was made in consultation with local planners from the Nashua Region, and through a review of present and proposed zoning, physical constraints, and assumptions made regarding future area-wide growth rates”.

Included in the model are planned roadway infrastructure improvements anticipated to be completed by 2025. The primary roadway improvements that are included in the model and are expected to impact travel patterns in the Litchfield-Hudson study area include:

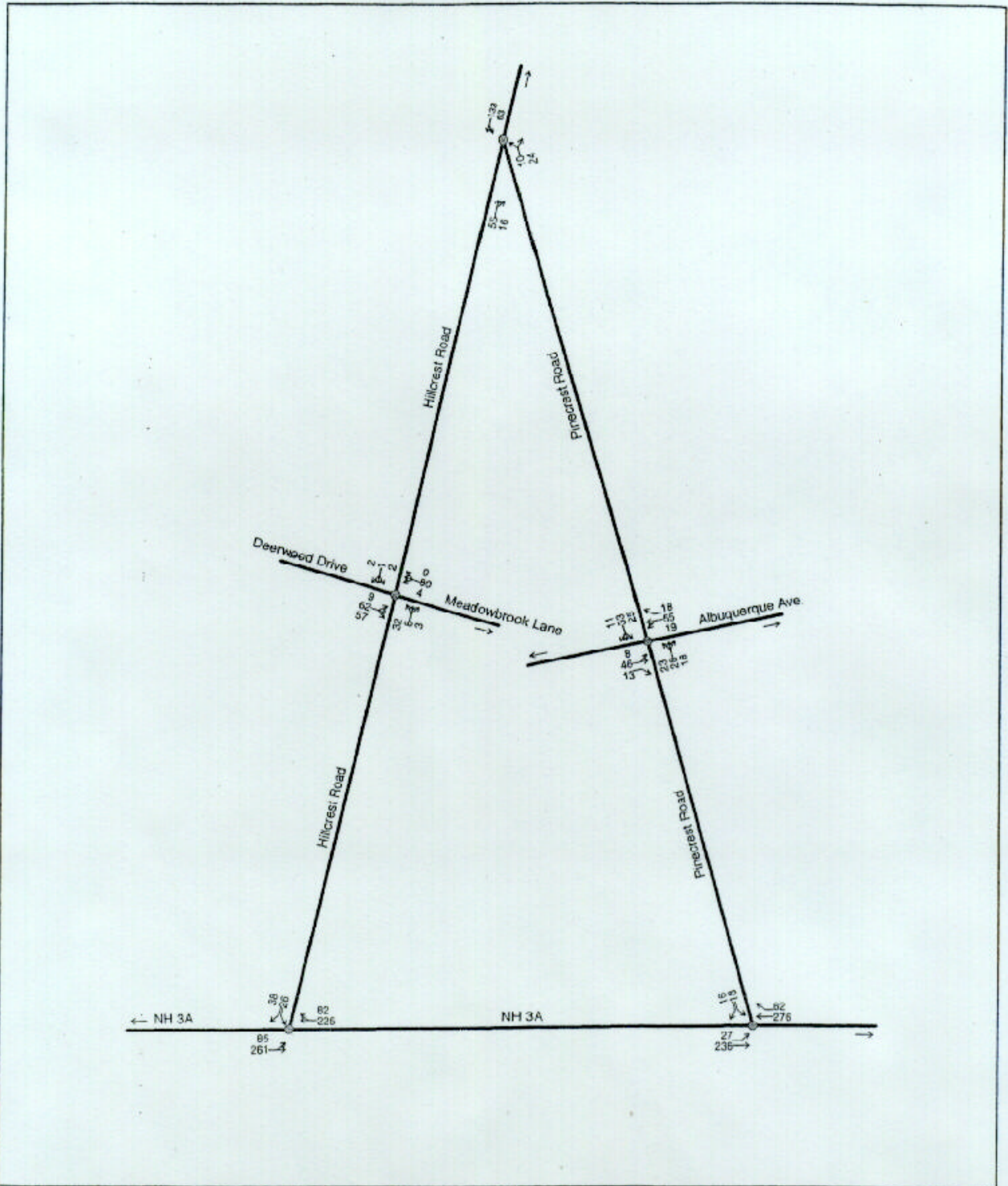
- Planned construction of the Preferred Alternative of the Nashua-Hudson Circumferential Highway;
- Planned construction of the Manchester Airport Access Road;
- Extension of Albuquerque Avenue in Litchfield;
- NH 102 widening in Hudson;
- NH 102/West Rd. intersection improvements in Hudson;
- NH 3A widening from Rena St. to Dracut Rd. in Hudson; and
- NH 3A widening from Wason Rd. to Executive Dr. in Hudson.

Currently, the NRPC maintains a 24-hour daily travel model for the region, but has not, to-date, developed a peak hour model. To determine future year peak hour forecasts, volumes were estimated by factoring the 24-hour model turning movement volumes to peak hour based on a review of available traffic counts in the Litchfield-Hudson area. The counts indicate that for Litchfield and Hudson as a whole 8.96 percent of the Average Weekday Daily Traffic (AWDT) occurs during the PM peak hour. Therefore, future year PM peak hour turning movement volumes were estimated by applying a factor of 8.96 percent to the 24-hour turning volumes obtained from the regional model. The traffic count data used to develop the peak factor is contained in Appendix D.



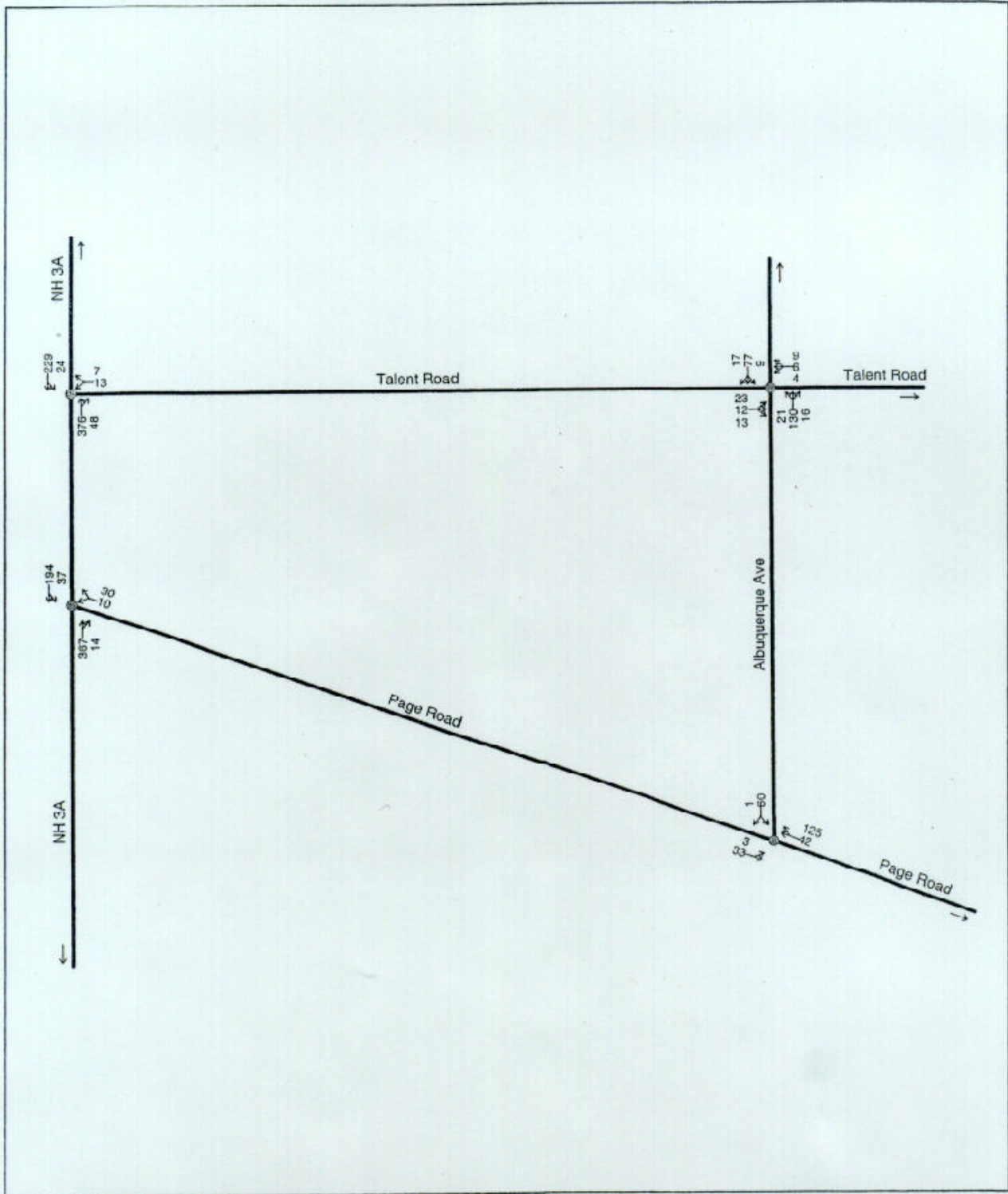
2002 Existing Conditions - Litchfield
 Vollmer Associates

Figure III-1
 Not to Scale



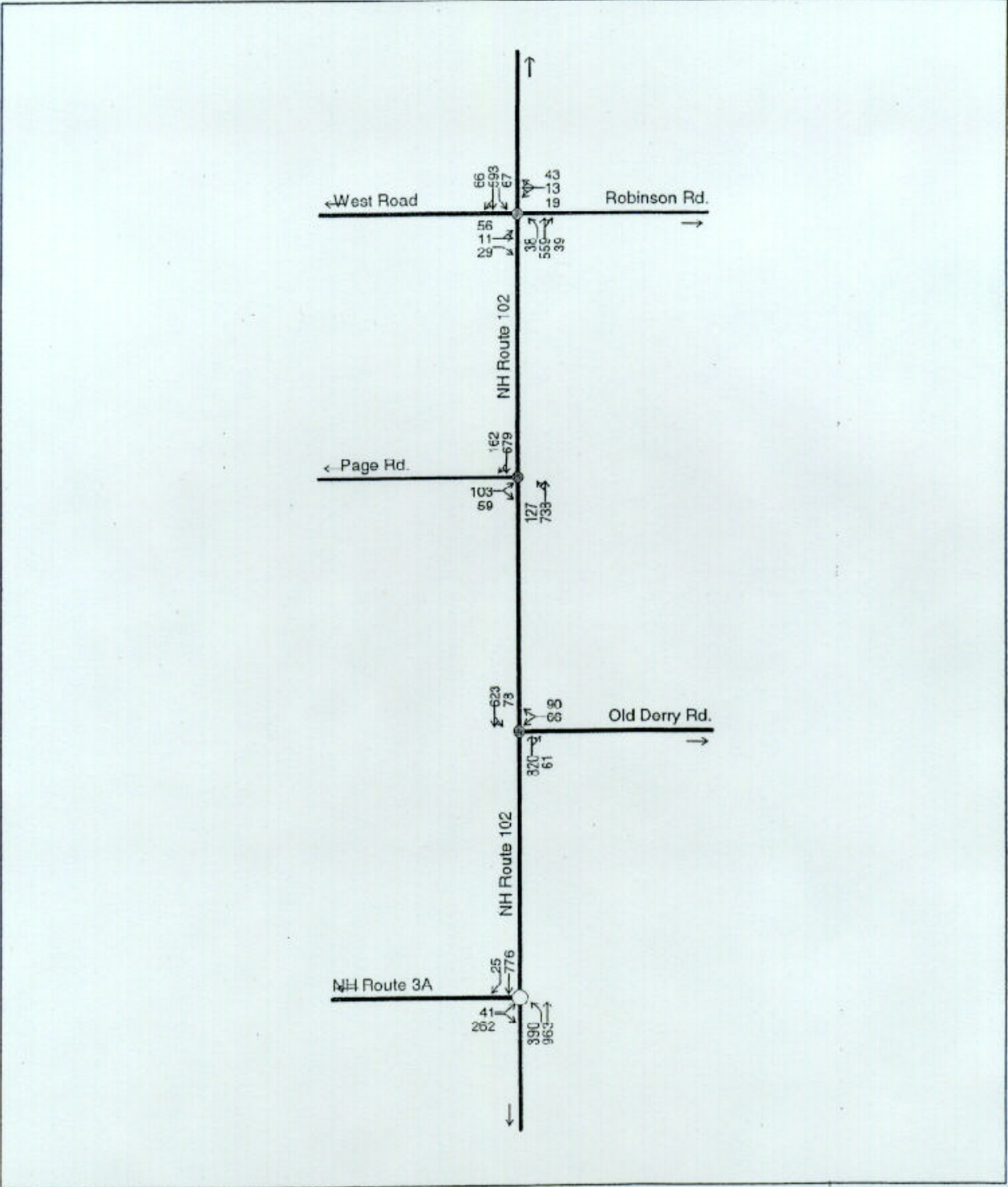
2002 Existing Conditions - Litchfield
 Vollmer Associates

Figure III-2
 Not to Scale



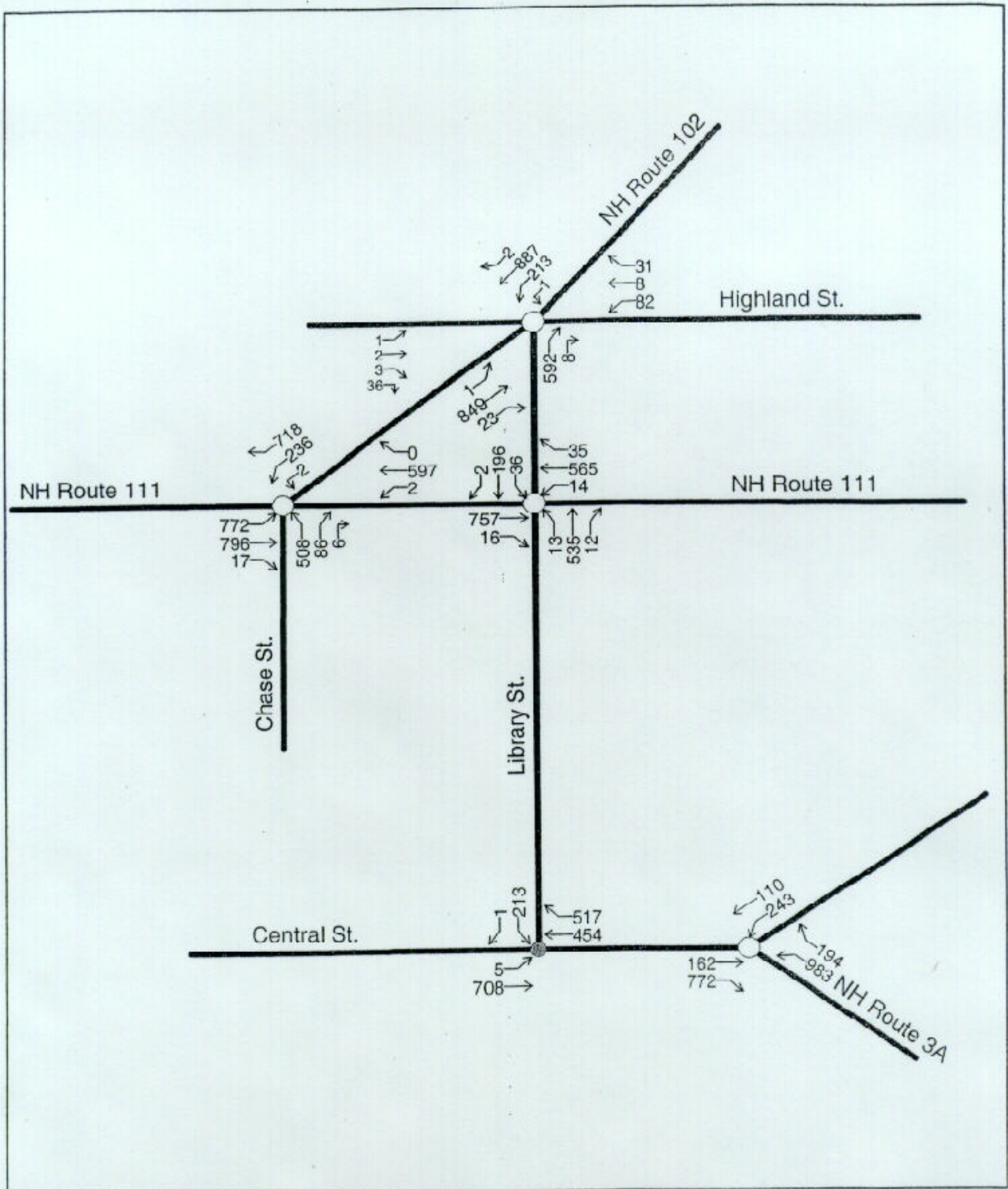
2002 Existing Conditions - Litchfield
 Vollmer Associates

Figure III-3
 Not to Scale



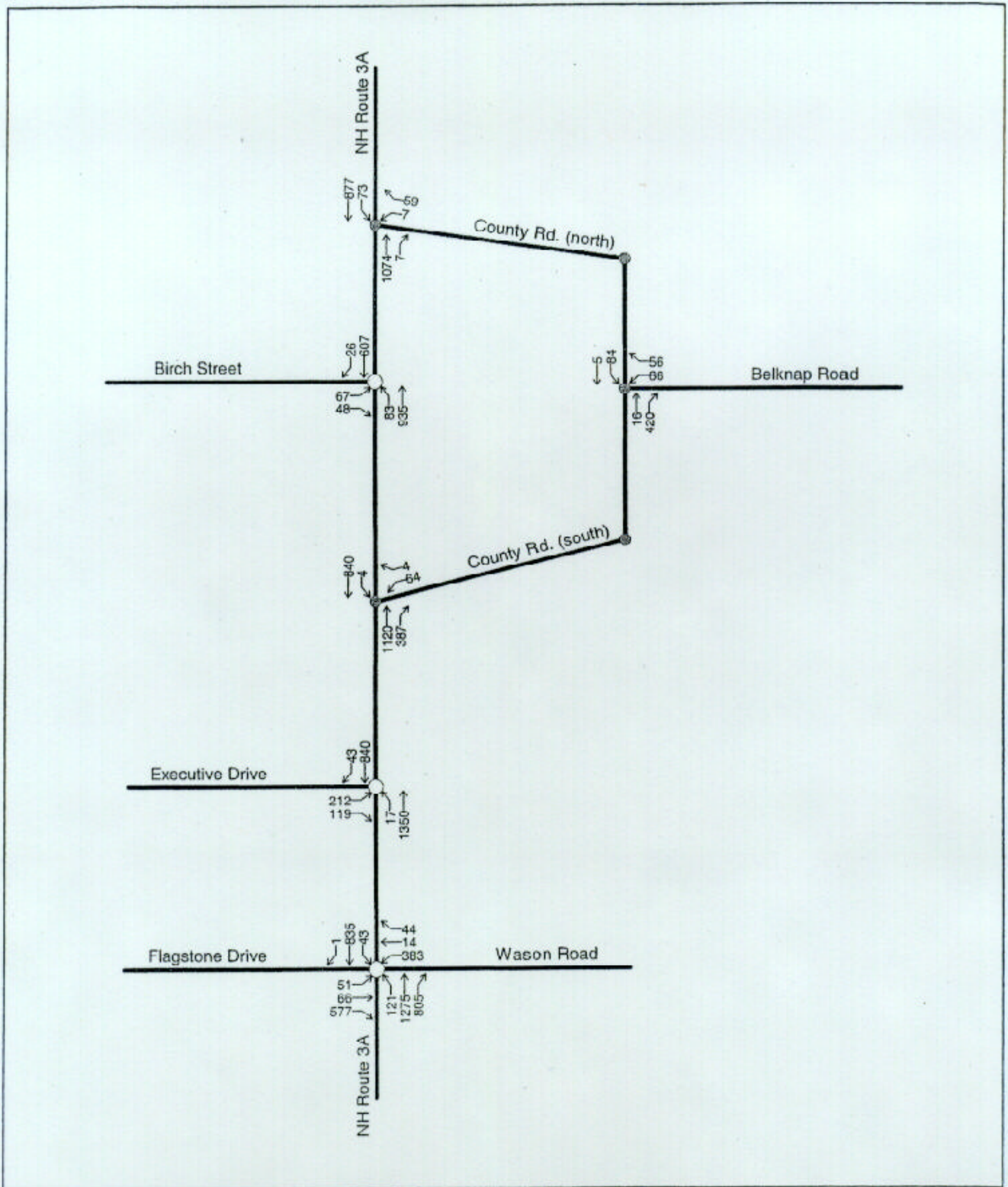
2002 Existing Conditions - Hudson
 Vollmer Associates

Figure III-4
 Not to Scale



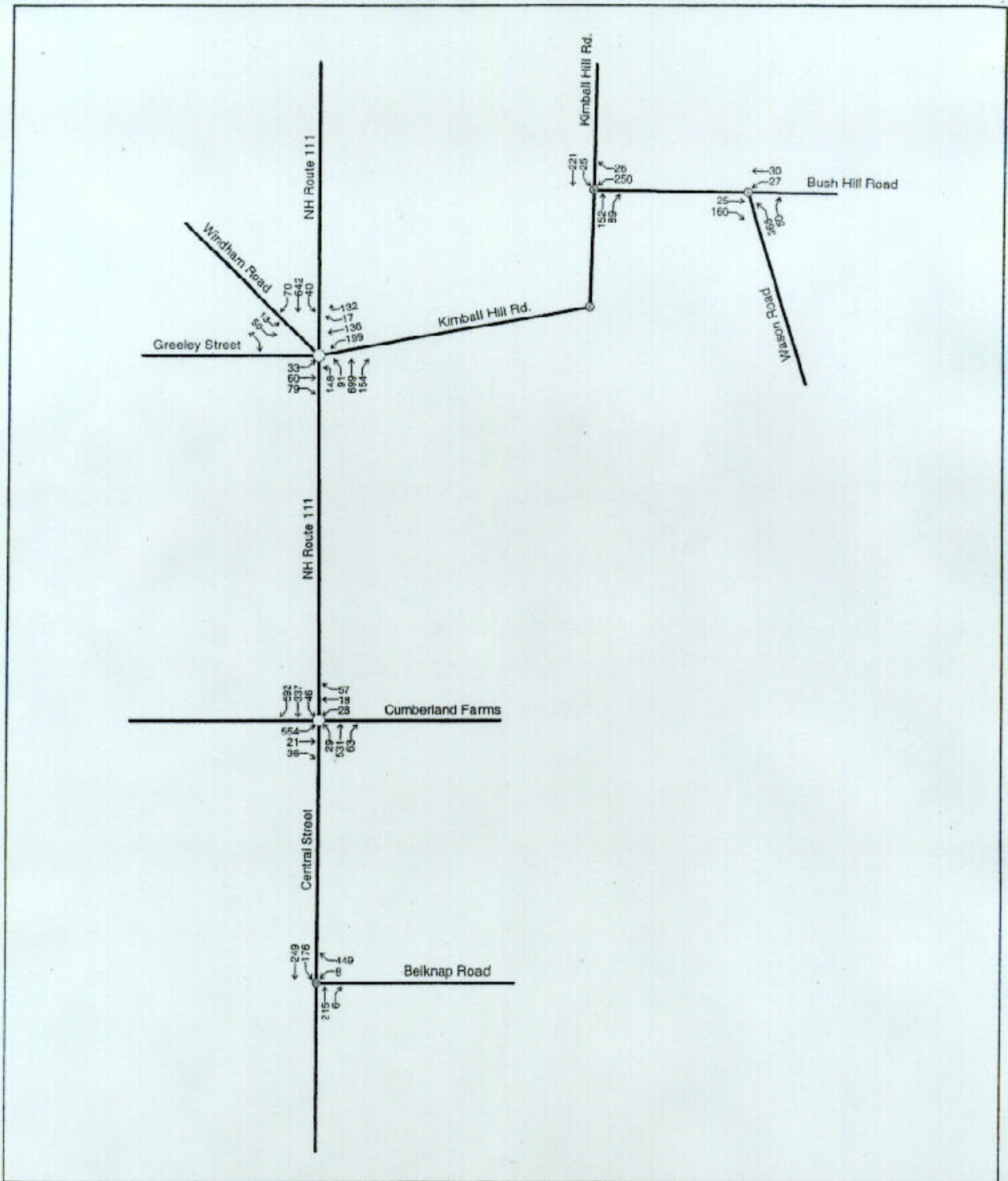
2002 Existing Conditions - Hudson
 Vollmer Associates

Figure III-5
 Not to Scale



2002 Existing Conditions - Hudson
 Vollmer Associates

Figure III-6
 Not to Scale



2002 Existing Conditions - Hudson
 Vollmer Associates

Figure III-7
 Not to Scale

Future year PM peak hour turning movement volumes for the Town of Litchfield, are displayed in Figure IV-1 through Figure IV-3. Future year PM peak hour turning movement volumes for the Town of Hudson are shown in Figure IV-4 through Figure IV-7.

V. Traffic Operations

Capacity analyses were conducted for the thirty-eight project intersections. The capacity analysis methodology is based on the concepts and procedures contained in the *2000 Highway Capacity Manual* (HCM). The primary result of capacity analysis is the assignment of Levels of Service (LOS) to traffic facilities under various traffic flow conditions. LOS is a qualitative measure describing operational conditions within a traffic stream and their perception by motorists and/or passengers. A LOS definition provides an index to quality of traffic flow in terms of such factors as speed, travel time, freedom to maneuver, traffic interruptions, comfort, convenience, and safety.

There are six Levels of Service defined for each type of facility. They are given letter designations from A to F. LOS A represents the best operating conditions and LOS F the worst. Since the LOS of a traffic facility is a function of the traffic flows placed upon it, the LOS of a facility may vary greatly, depending on the time of day, day of week, or period of year. LOS for signalized intersections is calculated using the operational analysis methodology of the HCM.

LOS for signalized intersections is defined in terms of average control delay, which is a measure of driver discomfort, frustration, fuel consumption, and lost travel time. The LOS criteria for traffic signals are stated in terms of average control delay per vehicle. The control delay includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. Control delay under signalized control is a complex measure and is dependent on a number of variables, including the quality of progression, the cycle length, the green ratio, and the volume-to-capacity ratio for the lane group in question. Table V-1 provides the LOS criteria of signalized intersections.

Unsignalized intersection procedures are currently provided for two-way stop controlled (TWSC) and all-way stop controlled (AWSC) intersections. The level-of-service for a TWSC and AWSC intersection is based on control delay (initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay) and is defined for each minor street movement. The level-of-service is not defined for the intersection as a whole. The level-of-service criteria for unsignalized intersections are also provided in Table V-1. Both TWSC and AWSC level-of-service criteria are the same.

**Table V-1
Level of Service Criteria**

Level of Service	Unsignalized Intersection Criteria Average Total Delay (Seconds per Vehicle)	Signalized Intersection Criteria Average Stopped Delay (Seconds per Vehicle)
A	□10	□10
B	10.1 to 15.0	10.1 to 20.0
C	15.1 to 25.0	20.1 to 35.0
D	25.1 to 35.0	35.1 to 55.0
E	35.1 to 50.0	55.1 to 80.0
F	>50.0	>80.0

Source: *Highway Capacity Manual*, Special Report 209, Third Edition; Transportation Research Board; Washington, D.C.; 1998. Pages 9-7 and 10-25.

Capacity analyses were performed at each intersection for both existing and future year conditions utilizing traffic control, roadway geometry, lane configurations and traffic conditions. The capacity analyses were performed using Synchro 5.0, a computer application that is based on the methodology of the HCM 2000. The results of the operational analysis for intersections within the Towns of Litchfield and Hudson, including LOS, vehicle delay and 95th percentile queue, are summarized in Table V-2 and Table V-3, respectively, and are described briefly below. The capacity analysis computer printouts are included in Appendix E. A brief discussion of the capacity analyses for the project intersections follows.

Intersection operations analyses were performed for eighteen intersections within the Town of Litchfield. From a traffic operations standpoint, these intersections generally operate fairly well under existing conditions. These intersections currently operate at LOS B or better and experience relatively minor delay. This is primarily due to relatively low volumes on the minor street approaches to the intersections. All Litchfield intersections analyzed as part of this study are currently stop sign or yield controlled.

Under future year (2025) conditions several factors come into play that affect traffic along Litchfield roadways. Primary among these are the planned construction of the Circumferential Highway, the Airport Access Road and the Albuquerque Ave extension. The traffic volume forecasts developed by the NRPC show that these improvement projects are expected to benefit traffic operations, particularly along NH 3A.

All intersections are expected to operate at LOS C or better under 2025 conditions, with two exceptions. The southbound approach to the intersection of Albuquerque Ave and Page Road (Albuquerque Ave. SB) is expected to operate at LOS D in 2025. All other movements at this intersection are expected to operate at LOS C or better. This intersection is slated for reconstruction to accommodate the Albuquerque Ave extension south of Page Road. It is recommended that a southbound left-turn lane be constructed to accommodate the

high volume of left-turns projected for the Albuquerque Ave southbound approach. Construction of a southbound left-turn lane would result in an improved LOS from LOS D to LOS C.

The other exception involves the westbound approach to the intersection of NH 3A and Industrial Drive (Industrial Drive WB), which is expected to operate at LOS F in 2025. Furthermore, it is anticipated that the Industrial Drive approach will experience substantial queues if constructed as a stop controlled intersection. The NH 3A approaches to this intersection would both be expected to operate at LOS A. It is recommended that this intersection be signalized to accommodate forecasted traffic volumes. It is anticipated that installation of a traffic signal would allow the intersection to operate at an overall LOS B under 2025 future year conditions.

Intersection operations analyses were conducted for twenty intersections within the Town of Hudson. Operational conditions vary widely among these intersections, depending on location, from LOS A to LOS F. A discussion of the capacity analyses at the Hudson intersections follows.

Traffic operations at the unsignalized *NH 102/Robinson Road* intersection operate at LOS B or better under existing conditions and are expected to operate at LOS C or better in the future year. However, safety at this intersection is a concern for the Town and NHDOT and several improvements are programmed in the NHDOT's Ten Year Transportation Improvement Plan to mitigate safety issues. These planned improvements include widening the intersection for turn lanes, signals and a truck acceleration lane. These improvements are scheduled for construction in 2004. A capacity analysis, conducted for 2025 conditions with these improvements in place, indicates that the intersection is expected to operate at an overall LOS B. The northbound left-turn movement (left-turns from NH 102 onto West Road) is expected to operate at LOS D primarily due to opposing volume on NH 102. All other movements are anticipated to operate at LOS C or better.

Analysis for the unsignalized *NH 102/Page Road* intersection shows that the eastbound movements (from Page Road onto NH 102) currently operate at LOS F and are expected to operate at LOS C in 2025. It is anticipated that the planned Nashua-Hudson Circumferential Highway will divert traffic away from this intersection, thereby improving intersection operations.

The unsignalized *NH 102/Old Derry Road* intersection operates at LOS B or better under existing conditions and is anticipated to operate at LOS A under future year conditions. Construction of the Nashua-Hudson Circumferential Highway is expected to benefit this intersection in the future year.

The signalized intersection of *NH 102/NH 3A (Elm Avenue)* currently operates at LOS D. The northbound through and northbound left-turn movements (from NH 102) operate at LOS E and LOS F, respectively. Traffic operations in the future

year are expected to improve, primarily due to construction of the Nashua-Hudson Circumferential Highway. The intersection is anticipated to operate at LOS B in 2025, with individual movements operating at LOS C or better.

The intersection of *NH 102/Highland Street* operates at LOS D under both 2002 and 2025 conditions. Some individual movements (right-turns from Library Street onto Highland Street and westbound movements from Highland Street) operate at LOS E or LOS F due to limited capacity at the intersection. Capacity improvements to mitigate the intersection, (e.g., additional left-turn lanes) would provide some benefit to these individual movements, however, it is anticipated that the costs of obtaining right-of-way would be prohibitively high.

Capacity analysis indicates that the *NH 111/Library Street* signalized intersection operates at LOS B under both 2002 and 2025 conditions. Operations for individual movements are at LOS C or better under both analysis years.

The intersection of *NH 111/Chase Street* operates at LOS F under existing and future year conditions. The analysis indicates that the intersection can be improved to operate at an overall LOS D in the future year by adding a second northbound left-turn lane on Chase Street. The LOS for all individual movements will improve with the improvement, with the exception of the northbound right-turns from Chase Street (which will remain the same at LOS C). The northbound left-turns will improve from LOS F to LOS E with the additional lane. Furthermore, the anticipated queues for the northbound left-turn movement will be reduced from 901 feet to 375 feet. The southbound left-turn/right-turn lane group will improve from LOS F without the improvement to LOS D with the improvement. The southbound right-turn movement will improve from LOS D to LOS B. The eastbound left-turn (from Ferry Street to Derry Street) will improve from LOS E to LOS D and the eastbound through/right-turn and westbound through movement will improve from LOS F to LOS E, respectively.

The unsignalized intersection of *Central Street/Library Street* currently operates at LOS C or better in 2002. The intersection degrades to LOS F by 2025. Installation of a traffic signal will improve operations at this intersection and allow the intersection to operate at LOS D in the 2025 planning horizon year. A traffic signal will allow a more efficient flow of traffic to travel through the intersection. Installation of a signal is also expected to substantially reduce vehicle queues approaching the intersection from Library Street southbound from 3635 feet to 602 feet. Furthermore, although beyond the scope of this project, one consideration for future study is to investigate the benefit of installing a traffic signal at the intersection of Central Street/Gillis Street and coordinating that signal with the intersections of Central Street/Library Street and Central Street/Lowell Road. The potential benefit of this improvement would be, among others, to provide adequate gaps in the traffic stream approaching the Central Street /Library Street intersection.

The signalized intersection of *NH 3A/Central Street* operates at LOS D under existing conditions and LOS F in 2025. The addition of a second eastbound through lane on Central Street will improve operations from LOS F to LOS D. Furthermore, significant reductions in queue lengths can be observed, particularly for the northbound left-turns on NH 3A (from 1206 feet to 833 feet) and for the eastbound right-turns on Central Street (from 1412 feet to 522 feet).

Capacity analysis for the *NH 3A/County Road (north)* intersection indicate that the intersection operates at LOS C or better under existing conditions and LOS B or better in 2025.

Westbound movements at the *NH 3A/County Road (south)* intersection operate at LOS F under both 2002 and 2025 conditions. All other movements operate at LOS C or better. The capacity analysis indicates that installation of a traffic signal and constructing a northbound right-turn lane on Lowell Road would improve overall intersection performance to LOS B. Individual movements would operate at LOS C or better. It is recommended that signal installation at the NH Route 3A/County Road (south) intersection be coordinated with the existing signal at NH Route 3A/Birch Street.

Signalized intersection analysis for *NH 3A/Birch Street* intersection indicates that the intersection operates at LOS A in 2002 and LOS B in 2025. Individual movements operate at LOS C or better under both years.

The *NH 3A/Executive Drive* intersection operates at LOS D under existing conditions and is anticipated to operate at LOS C in 2025. The eastbound left-turns from Executive Drive operate at poor levels of service due to the high traffic volumes on NH 3A. A second left-turn lane on Executive Drive would help to mitigate the eastbound left-turn delay. However, this improvement would not appear to be cost effective since it would, for the most part, benefit only the eastbound left-turn movement. All other movements operate at good levels of service (LOS C or better).

Capacity analysis of the *NH 3A/Wason Road* intersection shows that the intersection operates at LOS E in both 2002 and 2025. Recommended improvements at this intersection include the addition of a westbound left-turn lane on Wason Road and traffic signal modifications. This would improve overall intersection operations to LOS D in 2025. The Town of Hudson recently approved a retail development on the southeast corner of the intersection and has required the developer to provide mitigation for the intersection. Additional improvements beyond those would require substantial cost primarily due to acquisition of right-of-way.

Intersection analysis at *Belknap Road/County Road* indicates that the westbound approach (from Belknap Road) level of service is expected to degrade from LOS A in 2002 to LOS F in 2025. Installation of a traffic signal would allow the overall intersection to operate at LOS C in 2025. Furthermore, the westbound

approach would improve from LOS F to LOS D and westbound queues would significantly be reduced. Another possible alternative for this intersection that would minimize the impact of a signal and keep more in line with the residential character of the neighborhood would be to construct a roundabout instead of a traffic signal. The conceptual improvement diagrams shown in Section VII of this report contain a concept drawing depicting a proposed roundabout at the Belknap Road/County Road intersection.

Discussions with Town of Hudson and NRPC officials have identified another improvement alternative for the Belknap Road/County Road intersection to be considered for further study. The Hudson Highway Safety Committee's preferred recommendation for congestion mitigation at NH Route 3A/County Road (south) and Belknap Road/County Road is a proposed extension of Belknap Road westerly from its intersection at County Road to NH Route 3A at Birch Street. Under this improvement, left turns from Belknap Road onto County Road (south) would be prohibited. These trips would continue onto Belknap Road extension and turn left at the existing signalized NH Route 3A/Birch Street intersection. This movement further reduces the left turns at the NH Route 3A/County Road (south) intersection, helping to alleviate the need for a signal at 3A/County Road. This improvement will require the acquisition of right-of-way which is included in the cost estimates shown in Section VIII of this report.

Signalized intersection analysis for *NH 111/Central Street* intersection indicates that the intersection operates at LOS D in 2002 and LOS C in 2025. This is another intersection that benefits from planned highway improvements in the region, such as the Nashua-Hudson Circumferential Highway. The southbound through/left-turn movement improves from LOS E in 2002 to LOS D in 2025. The eastbound through/right-turn movement improves from LOS E in 2002 to LOS C in 2025.

Capacity analyses for the *Central Street/Belknap Road* intersection indicate that the intersection operates at LOS B or better under both existing and 2025 conditions.

Capacity analyses for the *Bush Hill Road/Kimball Hill Road* intersection indicate that the intersection operates at LOS B or better under both existing and 2025 conditions.

Capacity analyses for the *Wason Road/Bush Hill Road* intersection indicate that the intersection operates at LOS B or better under both existing and 2025 conditions.

Capacity analyses for the *NH 111/Greeley Street/Kimball Hill Road* intersection indicate that the intersection operates at LOS F in both 2002 and 2025. Recommended improvements for this intersection is to construct additional eastbound and westbound left-turn lanes on NH 111, a northbound left-turn lane on Kimball Hill Road and provide separation of left and right turn movements on

Greeley Street southbound. It is anticipated that these improvements would improve intersection operations to LOS D in 2025. Additional improvements to the intersection would require substantial costs for right-of-way acquisitions.

VI. Sight Distance Evaluation

As part of the evaluation of the intersections designated for study, Vollmer Associates performed a sight distance review of all the intersections in the study. Sight distance is provided at intersections to allow drivers to perceive the presence of potentially conflicting vehicles. This should occur in sufficient time for a motorist to stop or adjust their speed to avoid a collision.

The evaluation of sight distance at the intersections was performed to determine if the sight distance is adequate and whether additional safety improvements are required beyond that necessary to improve the traffic flow at a particular intersection.

The criteria used to evaluate the sight distance are found in the 2001 AASHTO Design Manual for intersection sight distance. We assumed the condition as a stopped passenger car turning left onto a two-lane road. Based on Exhibit 9-55, on page 665 of the ASHTTO Manual, a sight distance requirement of 390 feet was used to evaluate the intersections. A driver's eye height of 3.5 feet and an object height of 4.35 feet were used as the criteria to determine if adequate line of sight exists at the intersections.

The Town of Hudson provided their aerial maps to Vollmer. These aerial maps were used to generate an individual sight distance profile, in each direction, at all the intersections. Based on our use of the aerial maps and two-foot contour relief shown on the map, we determined that all the intersections, in Hudson, designated for study, currently have adequate sight distance.

Subsequent to preparing the sight distance profiles, Vollmer Associates, visited each intersection in the field to ensure that tree growth, fences, utility poles, etc. did not obscure the sight distance. All of the intersections were found to have adequate sight distance.

The Town of Litchfield does not have aerial mapping and the Nashua Regional Planning Commission does not possess mapping of a quality suitable for preparing sight distance profiles. To check the sight distance of the designated intersections in Litchfield, Vollmer Associates visited all the intersections to perform a visual check of the existing sight distance.

There are three intersections in Litchfield where the sight distance is inadequate and improvements should be made to improve the sight distance at these locations. The intersections are as follows:

<u>No.</u>	<u>Intersection</u>
7	NH3A/Talent Road
8	NH3A/Page Road
13	Albuquerque Avenue/Page Road

Figures VI-1 and VI-2 contain information on existing sight distances at all the designated intersections. Since the Litchfield intersections do not require improvements from a traffic flow standpoint, the town should consider constructing the recommended improvements to improve safety at these locations. The intersections at NH 3A will require coordination with the NHDOT District 5 Maintenance Division as they have jurisdiction over NH 3A.

VII. Recommended Improvements

Section V of this report explains the capacity analysis and assumptions used to evaluate the Year 2025 PM Peak Hour capacity of the designated intersections. If the overall capacity of an intersection was projected to be below Level of Service (LOS) “D”, then Vollmer Associates evaluated the intersection and recommended improvements to bring the overall level of service of the intersection to LOS D or better. The following intersections, located in Hudson, were identified as requiring improvement to improve the level of service with the exception of NH 102 and Robinson Road that was studied due to the high accident rate at this location.

<u>No.</u>	<u>Intersection</u>
18	NH 102/Robinson Road
24	NH111/Chase Street
25	Central Street/Library Street
26	NH 3A/Central Street
28	NH 3A/County Road (south)
31	NH 3A/Wason Road
32	Belknap Rd./County Road
37	NH 111/Greeley Street/Kimball Hill Road

The following intersections in Litchfield were identified as requiring improvements to increase the sight distance as a safety improvement only. None of the designated intersections require improvements to increase the traffic capacity of the intersection.

<u>No.</u>	<u>Intersection</u>
7	NH3A/Talent Road
8	NH3A/Page Road
13	Albuquerque Avenue/Page Road

The 11” x 17” Exhibits illustrate conceptual design improvements proposed by Vollmer Associates to improve the traffic level of services of the Hudson intersections and improve the sight distance of the Litchfield intersection. The associated costs of the improvements are contained in Section VIII of this report.

VIII. Engineer's Opinion of Conceptual Construction Cost

The following table provides an opinion of construction cost for the recommended improvements at each intersection. It is important to understand that the improvement drawings are conceptual only and as a result, the cost shown in this report provide an understanding of the magnitude of the improvement cost. Only an actual engineering design that considers actual surveyed conditions, the vertical aspect of the improvements, current construction prices and associated right of way cost that are based on current land appraisals can provide a more definitive estimate of the cost.

Hudson Intersections

<u>No.</u>	<u>Intersection</u>	<u>Construction & Design</u>	<u>Right of Way Acquisition</u>	<u>Total Cost</u>
18	NH 102/Robinson Road	\$335,000	\$0	*\$335,000
24	NH111/Chase Street	\$120,000	\$50,000	\$170,000
25	Central Street/Library Street	\$385,000	\$100,000	\$485,000
26	NH 3A/Central Street	\$200,000	\$100,000	\$300,000
28	NH 3A/County Road (south)	\$162,000	\$25,000	\$187,000
31	NH 3A/Wason Road	\$110,000	\$0	*\$110,000
32	Belknap Rd./County Road (Traffic Signal or Roundabout Option)	\$142,000	\$50,000	\$192,000
32	Belknap Rd./County Road (extend Belknap Road to NH 3A)	\$350,000	\$200,000	\$550,000
37	NH 111/Greeley Street/Kimball Hill Road	\$400,000	\$100,000	\$500,000

*Private Development is proposed at the corner of each of these intersections. In each case the developer will bear the cost of improvements to the intersections. The improvements proposed will increase the level of service at each intersection and are similar to those originally proposed by Vollmer Associates.

It should be assumed that eminent domain proceedings will be required for all the intersections since no discussions with abutting land owners have occurred and the willingness to negotiate with the Towns is unknown at this time

Litchfield Intersections

<u>No.</u>	<u>Intersection</u>	<u>Conceptual Cost</u>
7	NH3A/Talent Road	\$35,000
8	NH3A/Page Road	\$35,000
13	Albuquerque Avenue/Page Road	\$45,000

IX. Potential Funding Sources for Recommended Improvements

There are a number of federal and state funding programs in which the Towns of Hudson and Litchfield can utilize to complete the recommended improvements. Some of these programs may require that the town contribute a local funding match. The application process is facilitated through the NRPC, and funding, both at the state and federal level is acquired through the NHDOT. It is recommended that town officials work with both the NRPC and NHDOT to facilitate the funding and implementation of recommended projects.

The following describes potential funding sources:

- The Surface Transportation Program (STP) under the federal aid (TEA-21) statute: The STP targets the funding of projects on roads with a higher functionality than a local road or rural minor collector. The flexibility of STP allows for funding at the discretion of states and localities. Funding is based upon an 80 percent federal and 20 percent state or local share. There are four subcategories of STP funds as described below:
 1. STP < 200,000 – This category of STP exists to fund projects in small urban areas with a population under 200,000. There are statewide and municipal apportionments.
 2. STP Any Area – This category of STP funds may be used in urban or rural areas.
 3. STP Transportation Enhancements – This category funds projects submitted by municipalities and chosen through a statewide selection process. Eligible projects include bicycle and pedestrian facilities scenic improvements, and preservation of abandoned railroad corridors, historic preservation, rehabilitation of historic transportation facilities and mitigation of water pollution from highway runoff.
 4. STP Hazard Elimination – These funds are earmarked for minor projects designed to eliminate hazardous roadway or traffic conditions.
- State Betterment Funding (2/3 state funds, 1/3 local match required) – Includes roads on the State Highway System.
- State Betterment for Small-Scale Improvements (100 percent state funds, no local match required). – Includes roads on the State Highway System.
- State Turnpike (100 percent State Turnpike Funds) – Includes highways on the State Turnpike System.

Funding of Improvements in Litchfield

The improvements recommended for the Albuquerque Ave./Page Road intersection in Litchfield would most likely be eligible for the STP program. These roads are of a higher

functionality than local or minor rural collectors, are not on the state highway system, and would therefore not be eligible for the State Betterment program.

The improvements recommended at the NH Route 3A/Talent Road intersection and at the NH Route 3A/Page Road intersection would be eligible under State Betterment with a 1/3 local match and State Betterment for Small-Scale Improvements, with no local match required.

The State's Ten-Year Transportation Plan includes the construction of Industrial Drive under the Turnpike program in concert with the construction of the Circumferential Highway. Both projects are expected to be completed utilizing State Turnpike funds. The Town should communicate the need for signalization of the Industrial Drive/NH Route 3A intersection during the public hearing phase of the environmental assessment process for the Circumferential Highway, which is likely to take place in early 2003, and also thereafter during the design phase of the project.

Funding of Improvements in Hudson

The intersections cited for improvements in Hudson fall within the STP category. The Town has also included use of private funds for improvements as developments occur. The Town should continue to leverage these sources of funds to mitigate traffic impacts as they have for the improvements of the NH Route 102/Robinson Road intersection and the NH Route 3A/Wason Road intersection.

Application Process Schedule for Federal Funding

The following describes the process schedule for programming new projects in the State of New Hampshire's Transportation Improvement Program (TIP):

October 1, 2002	TIP Development Begins, Regional Planning Commissions (RPC) solicit projects from municipalities
April 1, 2003	RPC Submit Draft TIP to NHDOT
July 1, 2003	NHDOT Submits Draft 10 Year Plan to Governor's Advisory Council on Intermodal Transportation (GACIT)
December 1, 2003	GACIT Submits Draft 10 Year Plan to Governor
January 15, 2004	Governor Submits 10 Year Plan to Legislature
June 1, 2004	Legislature Approves 10 Year Plan
June 14, 2004	NHDOT Submits 1 Year Plan to RPC
July 30, 2004	RPC Approves 3 year TIP's
September 1, 2004	NHDOT Submits 3 Year STIP to FHWA/FTA for Approval
October 1, 2004	Approved 3 Year STIP and 10 Year Plan