

Vinal Square Traffic and Safety Study



Prepared by: Northern Middlesex Council
of Governments

VINAL SQUARE TRAFFIC AND SAFETY STUDY

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Vinal Square Traffic and Safety Study

I. Introduction

The Northern Middlesex Council of Governments (NMCOG) has undertaken a comprehensive Traffic Operations and Safety Study of the Vinal Square area in Chelmsford, Massachusetts. The purpose of this study was to examine existing traffic operation and safety conditions, develop solutions to address any identified deficiencies, and project future travel conditions within the study area. The findings of the study will assist local decision-makers in addressing future transportation and land use policy issues affecting the North Chelmsford area.

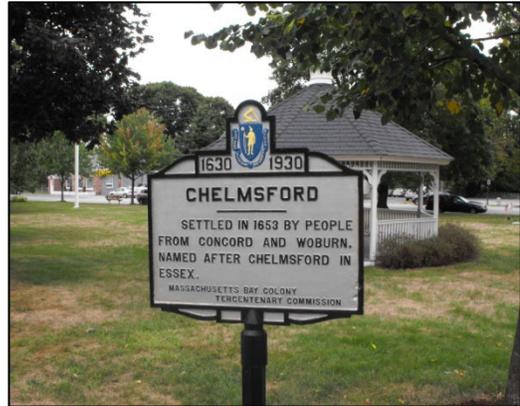


Photo 1: North Common located in Vinal Square

A. Background

Vinal Square is located approximately 1.5 miles north of U.S. Route 3 at the convergence of several arterials: Route 40, Route 3A, Dunstable Road, and Middlesex Street, which meet at three intersections within the study area, as shown on Map 1. Vinal Square is home to a variety of neighborhood retail and service businesses. Renovated historic mill complexes are located just south of the Square, and scattered pockets of retail development can be found along Route 3A north of the Square.

In 1996, in response to growing traffic and safety concerns raised by the Town, MassDOT upgraded the traffic control signals and made minor geometric modifications, including the addition of pedestrian phasing and channelization at the Vinal Square intersections. In 2000, signal timing improvements were made to separate the Route 40 and Wotton Street signal phases, eliminating conflicts on each leg. Resurfacing projects were also completed in the area in 1998 and 2009.

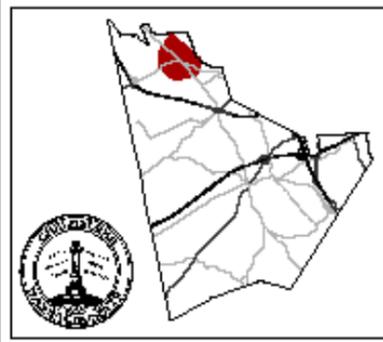
North Chelmsford has been identified as a possible site for a new commuter rail station, as part of the proposed extension of the Massachusetts Bay Transportation Authority's (MBTA) Lowell commuter rail line into New Hampshire. In fact, an area of Vinal Square was identified as the preferred location for a new commuter rail station, which would be accessed from Wotton Street. Additional information regarding the commuter rail extension project can be found in later sections of this report.

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B. Study Approach

Public policy makers, citizens and the business community have a stake in understanding and responding to demands on the transportation system. A properly developed traffic study can provide the factual basis for good decision-making and facilitate the timely implementation of necessary improvements. This study summarizes the existing key traffic issues impacting the study area, identifies any traffic constraints or facilities which need to be improved, and characterizes traffic operating conditions in terms of level of service.

The Vinal Square study began with the collection and analysis of land use, traffic, and crash data in order to assess the existing operating conditions in the study area. Existing traffic operations were evaluated and a safety analysis was performed to determine high crash locations. The potential impact of developing a new commuter rail station was also analyzed. As part of this study, alternative transportation modes, such as bicycling, walking, and public transit, were inventoried and studied. Operating conditions and level of service were projected for all major intersections and roadway segments within the Vinal Square study area. Capacity and safety deficiencies within the transportation network were identified, and appropriate improvement measures and planning strategies were recommended.



Existing Conditions

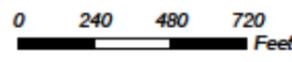
Map: 1 Vinal Square Transportation Study Area

Data provided by the Executive Office of Energy & Environmental Affairs through MassGIS, MassDOT, The Northern Middlesex Council of Governments and the Town of Chelmsford.

The data depicted by this map is for planning purposes only. The data is not of sufficient detail to allow either boundary determination or regulatory interpretation.

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- Legend**
- Town Boundary
 - Vinal Square Study Area
 - Rail Lines
 - Property Parcels
 - Lakes, rivers, streams



Vinal Square Traffic and Safety Study

II. Existing Conditions

A. The Vinal Square Neighborhood

Vinal Square is located at the confluence of several state and local roadways in North Chelmsford. State Routes 3A and 40 converge with Wotton Street and Adams Street, to form the center of Vinal Square. Route 3A is owned by MassDOT, while the Town of Chelmsford has jurisdiction over Route 40 and the other roadways converging at Vinal Square. The neighborhood consists of a variety of businesses including convenience stores, restaurants, offices, a used car dealership, bank, and hardware store. Chelmsford's North Town Hall, the McKay branch of the Chelmsford Public Library, Varney Playground, Ayotte Field, Southwell Park, and the North Chelmsford Common are all located in the Vinal Square area. It is essential that these locations be connected to the surrounding residential area.

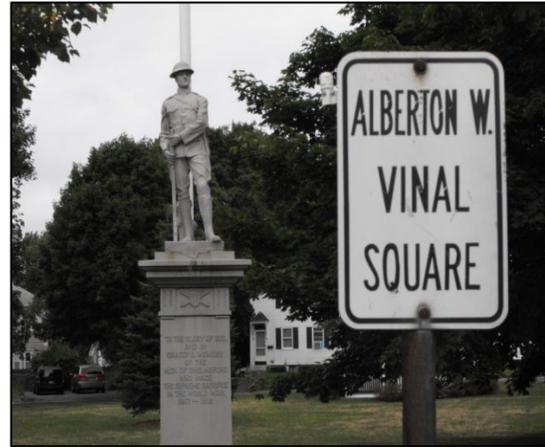


Photo 2: Vinal Square and World War II Memorial



Photo 3: Gazebo in North Common

The North Chelmsford Common is a half-acre park bounded by Middlesex Street, Princeton Street, and Wright Street. It is home to Chelmsford's World War I monument, erected in 1922, and the North Chelmsford Vietnam War Memorial, erected in 2006. Sidewalks are located around the edge of the Common, with midblock crosswalks on both Middlesex Street and Princeton Street providing pedestrian access to the Common. There are two benches located in the park, as well as a gazebo, which serves as the focal point for activities on the Common.

The North Town Hall was recently renovated and restored. In 2004, the Chelmsford Community Preservation Committee initiated the North Town Hall stabilization project for \$28,247. Town Meeting then approved a plan to create a Community Center at the Old North Town Hall, which included a mini-museum with historical exhibits that conveys the story of the mill village. Construction funding to implement this plan was appropriated at the 2010 Spring Town Meeting.

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Providing better access to the Anna C. MacKay Memorial Library from Vinal Square and the North Common was suggested by residents during the development of the 2010 Master Plan. The library has many programs for both children and adults and provides a gathering place for the residents of North Chelmsford. While bicycle parking is available at the library, the sidewalk system is incomplete. Residents believe that the library would be better utilized if it were open at more convenient hours and if accessibility for bicyclists and pedestrians were improved.



Photo 4: The Anna C. MacKay Memorial Library

Two town parks, Varney Playground and Southwell Park, are also located in the Vinal Square area. Varney Playground, established in 1948, is a multipurpose recreational area south of Vinal Square, where Adams Street meets Freeman Lake. The facility includes a large children's playground, baseball field, basketball court, tennis courts, and a beach area on the lake. However, the area does not meet the American with Disabilities Act (ADA) standards for accessibility.



Photo 5: Varney Playground Entrance in North Chelmsford

more visitors to the recreation areas.

Southwell Park is located along the bank of the Merrimack River off Wotton Street. The Park includes two baseball fields, a small playground, restroom facilities, and a boat ramp. The Park's parking area is unpaved and not well maintained. There is no signage on Route 3A, Route 40, or Middlesex Street identifying the Playground or Park. The addition of signage at these locations would help direct

B. Land Use and Zoning

Vinal Square represents a classic mill village that grew as a result of the area's industrial heritage. The immediate area adjacent to the roadway within Vinal Square is zoned General Commercial (CD). Just south of Vinal Square, the area around the mill complexes is zoned Limited Industrial (IA). North of Vinal Square, along Tyngsborough Road, is zoned Roadside Commercial (CB) and Residential Multifamily (RM). The area along Route 40 north of the Square is zoned Residential A (RA) and Residential B (RB). The area on Wotton Street occupied by the mill is zoned Limited Industrial (IA). Most of the businesses within the Square serve the nearby neighborhood.

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Vinal Square and the adjacent mill district contain numerous significant economic development opportunities, including the revitalization of the former Southwell Combing Company Mill, and the historic mills located at 51 and 61 Middlesex Street and at 70 Princeton Street. The Town's Master Plan recommends the establishment of a Mill Reuse Overlay District to encourage additional uses not addressed under the current base zoning. This would provide greater flexibility in redeveloping or reusing existing structures, and in developing vacant parcels. It would also increase potential property values for current owners. In addition, the mill reuse overlay district would accomplish the following:

- Protect the neighborhood from: the loss of historic buildings, new construction not in character with the neighborhood, or alterations to existing buildings that would lessen their architectural significance;
- Facilitate and encourage the reuse of the historic mill buildings should a vacancy occur;
- Promote diverse housing choices within the community; and
- Provide greater flexibility in meeting the town's housing and economic development goals.

The Town's 2010 Master Plan recommends that the Town's zoning bylaw be amended to accommodate mixed use, allowing residential development over retail uses within the Vinal Square area. This would lead to additional foot traffic, creating a more vibrant village community. The Master Plan also recommends that a District Revitalization Program be created for the Vinal Square area. Funding opportunities for such an initiative may be available through the Business Improvement District (BID), District Improvement Financing (DIF), MassWorks, and the Community Development Block Grant (CDBG) programs.

C. Roadway Characteristics

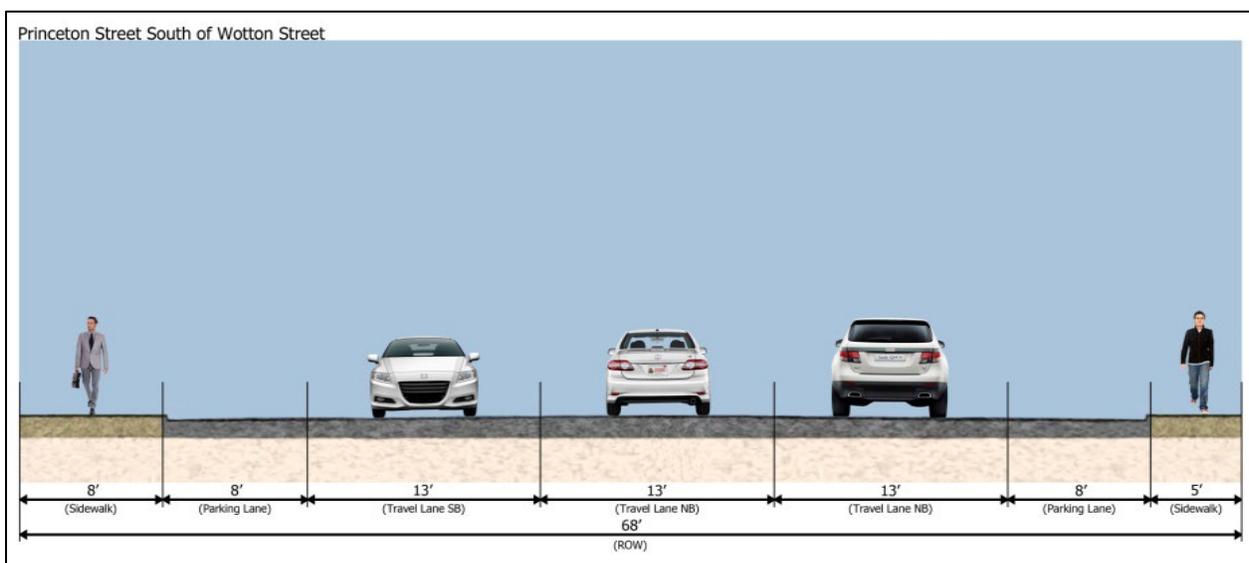
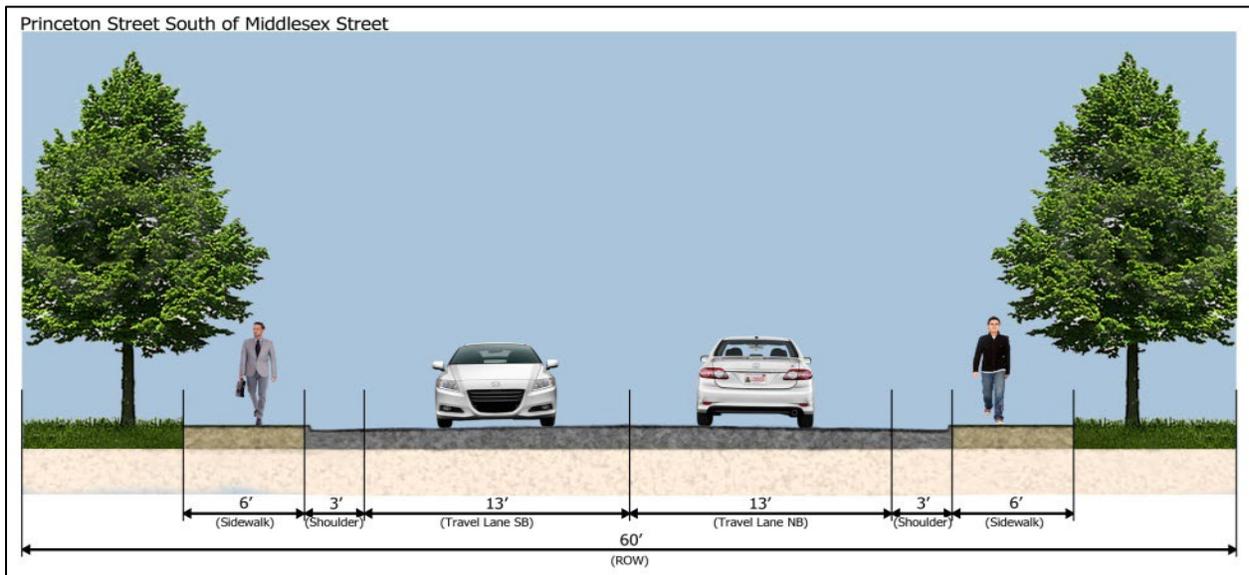
There are several arterial roadways that converge in Vinal Square, as outlined below. The six-legged intersection carries high volumes of traffic and experiences congestion during peak periods of the day. The main roadways intersecting Vinal Square include:

- Route 3A (Princeton Street/Tyngsborough Road) – owned by MassDOT
- Route 40 (Groton Road) – owned by the Town of Chelmsford
- Dunstable Road – owned by the Town of Chelmsford
- Middlesex Street – owned by the Town of Chelmsford
- Wotton Street – owned by the Town of Chelmsford
- Adams Street – owned by the Town of Chelmsford

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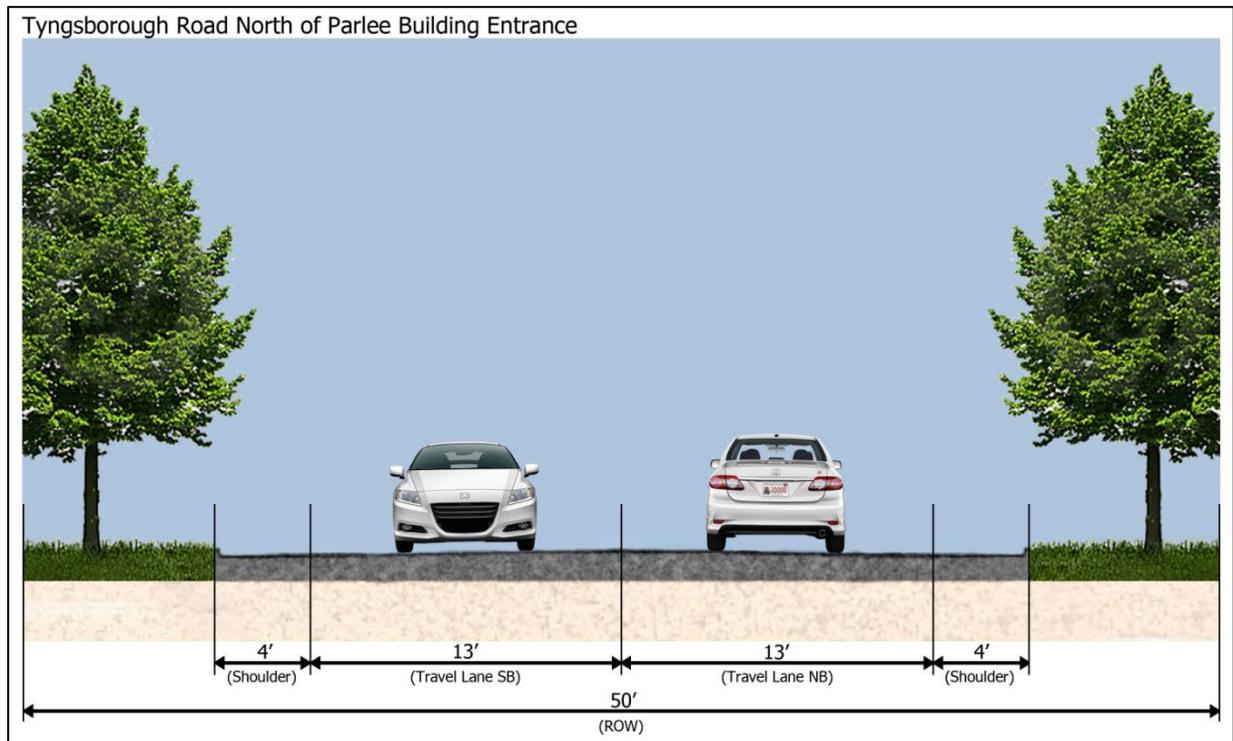
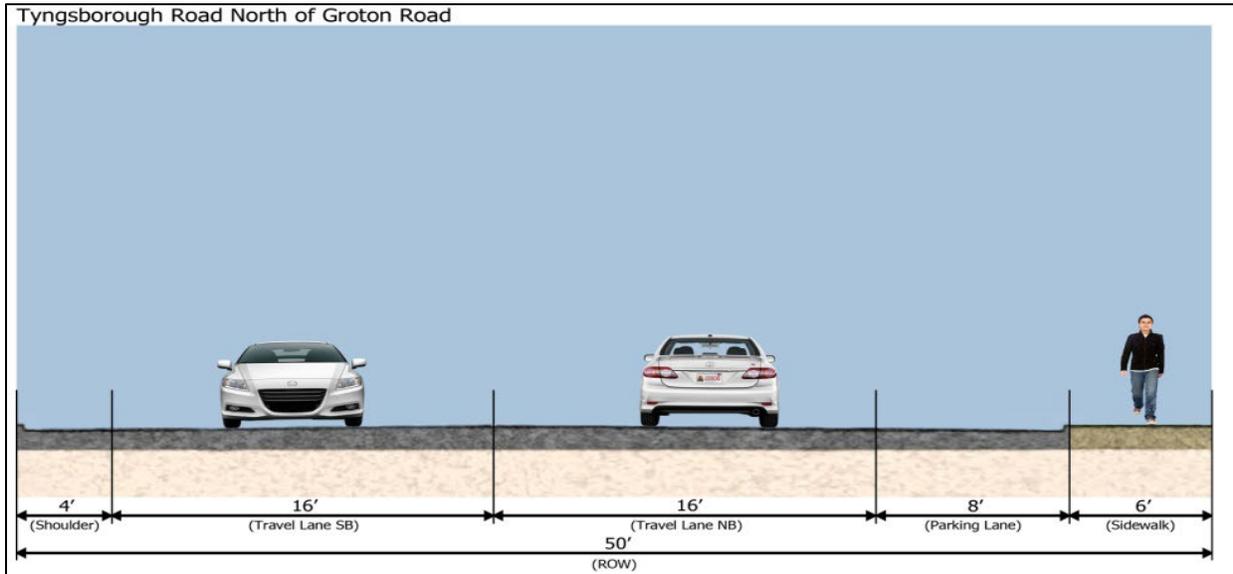
The characteristics of the various roadways are described in the following section. Typical cross sections are shown for each roadway with the Square.

Route 3A (Princeton Street/Tyngsborough Road) is owned by MassDOT and classified as an urban minor arterial. The road runs in a general north/south direction through Vinal Square, and provides access to the Town of Tyngsborough to the north, and Route 3 and the City of Lowell to the south. Princeton Street is generally 32-feet wide south of Middlesex Street, widening as it enters the heart of Vinal Square to allow for a left-turn lane and parking. Route 3A cross sections change depending on the location along the corridor. Sidewalks run along Princeton Street to its intersection with Groton Road. Currently, there are no bicycle facilities along Route 3A.



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Tyngsborough Road is designated as State Route 3A north of the intersection with Groton Road. While the Square has a general speed limit of 30 miles per hour (mph), just to the north the speed limit increases to 40 mph. The sidewalk on the north side of the road ends at the Parlee Building parking lot entrance, while a desire line is worn into the grass shoulder northerly to Wellman Avenue. No bicycle facilities currently exist along Tyngsborough Road.



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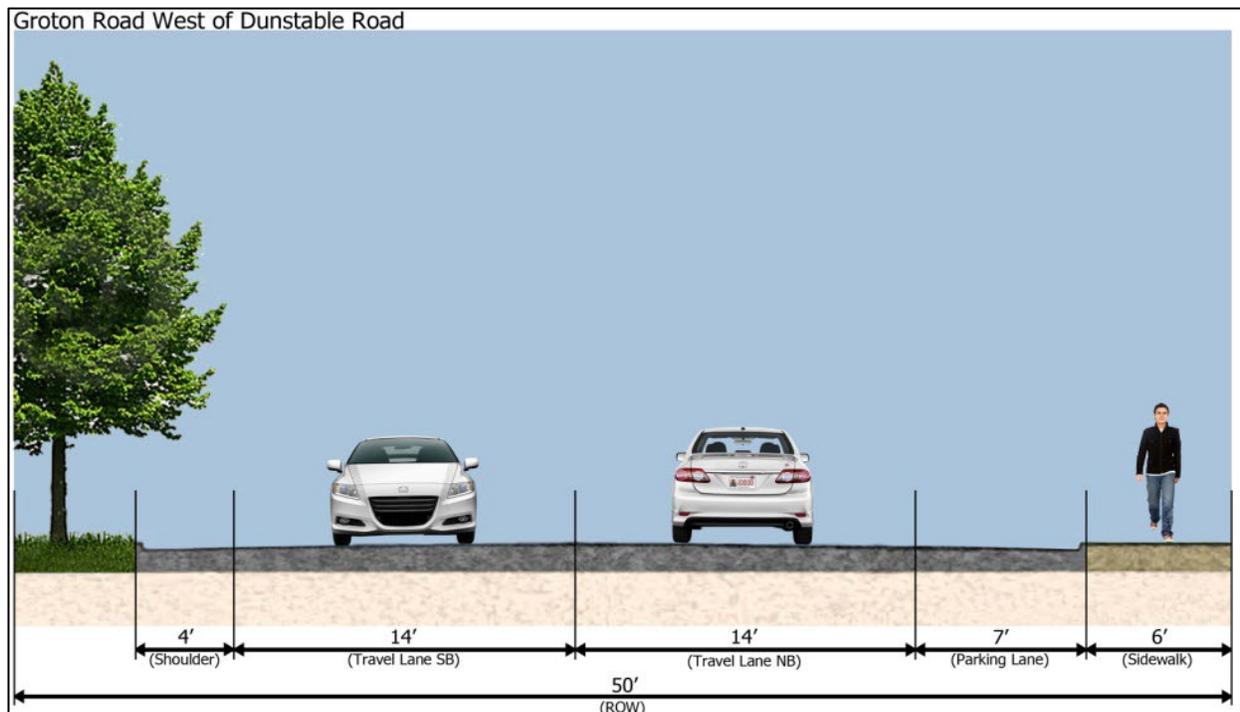
Route 40 (Groton Road) is a Town-owned urban minor arterial, providing access from Route 3 and Westford west of the study area, and terminating at the intersection with Route 3A. The Chelmsford Senior Center is located on Route 40, just west of the study area. There is a mix of residential uses and commercial properties within and around Vinal Square. The residential neighborhood can also be accessed to the south of Vinal Square along Route 40. Within Vinal Square, the roadway is 38-40 feet wide with a parking lane on the west side. In the westbound travel direction, a four-foot shoulder is often used as on-street parking for residents of an apartment building and for consignment shop patrons. A six-foot sidewalk, which was upgraded in 2009, runs along the opposite side of Groton Road.



Photo 6: Groton Road looking West



Photo 7: Groton Road looking East



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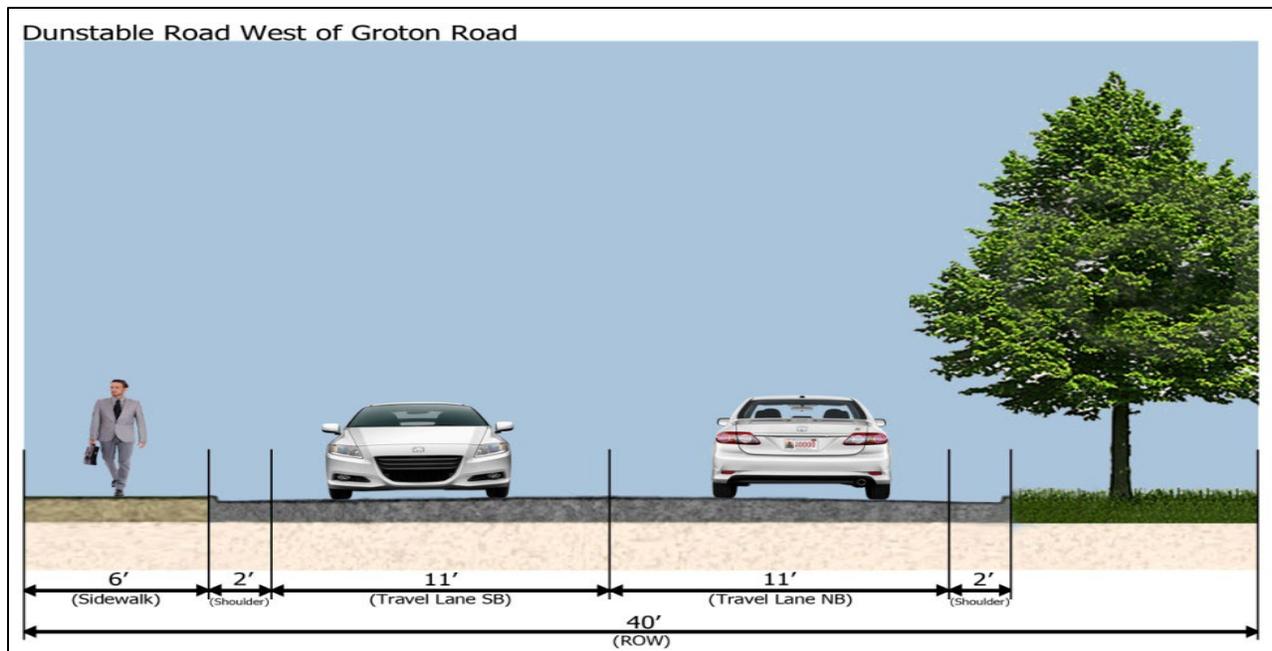
Dunstable Road is functionally classified as an urban collector and is a Town-owned roadway. The roadway runs in a general northwest/southeast direction, beginning just north of the main Vinal Square intersection and eventually ending in the Town of Dunstable at Route 113. In general, the roadway is 26-30 feet wide with a six-foot sidewalk running alongside the eastbound travel lane. The Town right-of-way is 40 feet, leaving room for expansion if needed. However, commercial structures immediately abut the roadway within Vinal Square.



Photo 8: Dunstable Road looking southeast



Photo 9: Dunstable Road looking northwest



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Middlesex Street is town-owned and classified as an urban minor arterial. The roadway extends in a general east/west direction, connecting Vinal Square to the City of Lowell. In general, the roadway is 38-feet wide with 7-foot shoulders on both sides near the Square. Though not marked, on-street parking for businesses and the North Common is allowed along Middlesex Street, west of the Cottage Row intersection. In addition, the Town of Chelmsford has installed an electric vehicle charging station at the North Common, which is located at the intersection of Middlesex Street and Princeton Street. East of Cottage Row, the road narrows to 32 feet with 4-foot shoulders on both sides. There are no bicycle markings along the roadway. Six-foot wide sidewalks line both sides of the streets. Starting at Quigley Avenue, the roadway contains a mix of residential and commercial land uses. The Pan Am rail line crosses Middlesex Street at the eastern end of the study area, near Quigley Avenue. Pavement conditions have deteriorated significantly at the crossing.



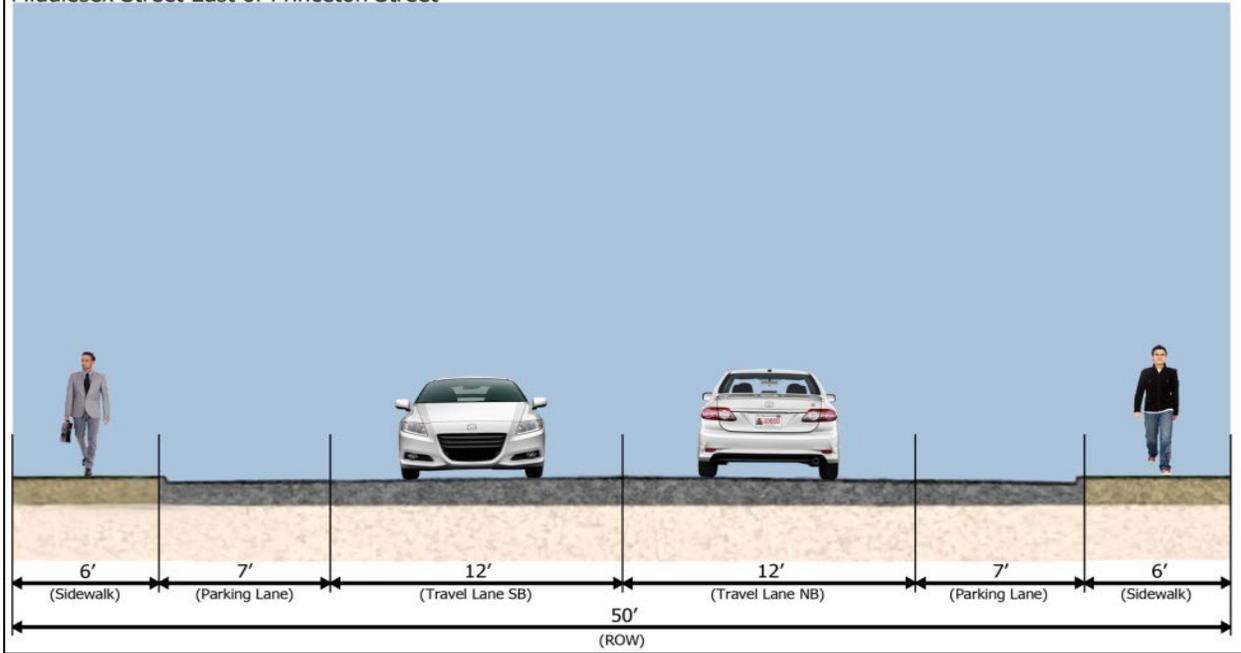
Photo 10: Middlesex Road at Princeton Street



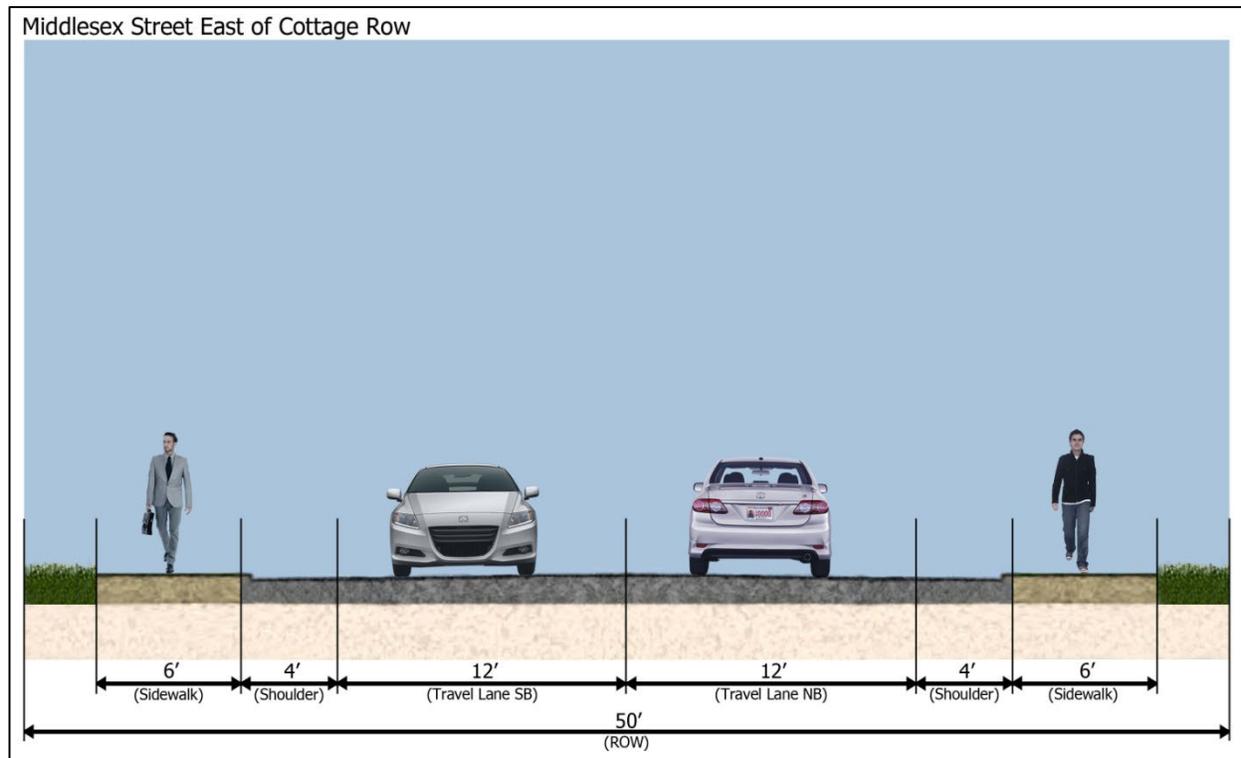
Photo 11: Middlesex Road at Rail Crossing

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Middlesex Street East of Princeton Street



Middlesex Street East of Cottage Row



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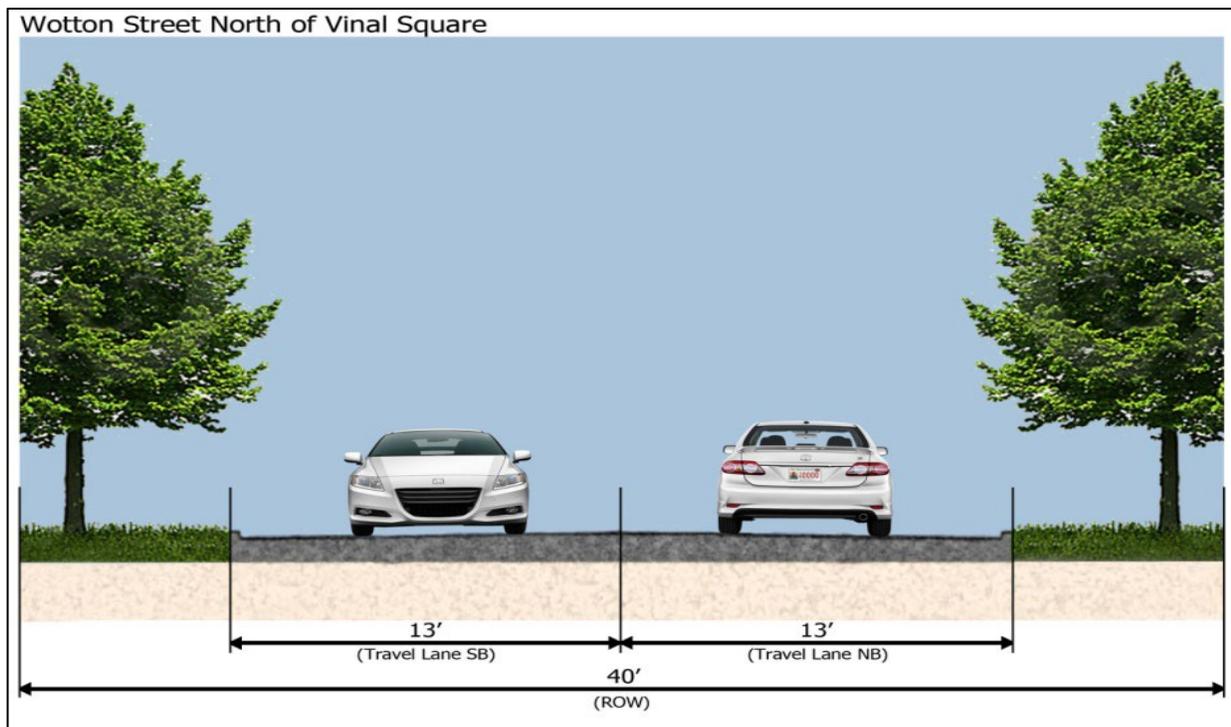
Wotton Street is a Town-owned local road which provides access from Vinal Square to parking areas for the Parlee Building and other nearby businesses. Southwell Park located along the Merrimack River is also accessed via Wotton Street. In general, the roadway is 26-feet wide, but narrows near the railroad crossing to 24 feet. The right-of-way (40 feet) is sufficient for widening and/or installation of sidewalks, but wetlands and floodplain surround the roadway in the vicinity of the rail line. In the future, an entrance to the proposed North Chelmsford commuter rail station could be accessed via Wotton Street. A community garden is also proposed along Wotton Street north of Route 3A.



Photo 12: Wotton Street looking south



Photo 13: Southwell Park on Wotton Street



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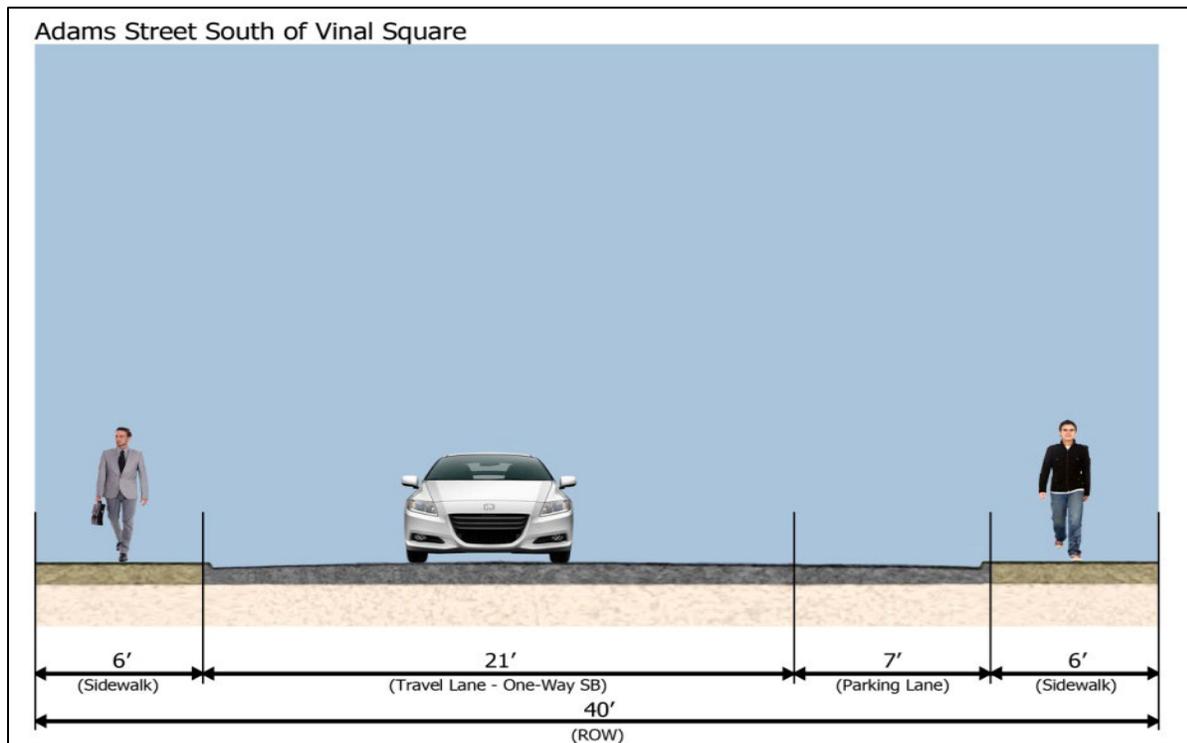
Adams Street is a one-way (southbound) Town-owned local road intersecting with Route 3A, Route 40, and Wotton Street in Vinal Square. The one-way section of the roadway is 28-feet wide, with a 7-foot parking lane on the east side. Currently, a six-foot wide asphalt sidewalk runs along the east side of Adams Street for approximately fifty (50) feet. The west side of the roadway has a 6-foot sidewalk running for approximately 330 feet, with large gaps for driveways interspersed. There are currently no bicycle amenities along Adams Street. The roadway leads into residential areas and ends at the Varney Playground and beach area. Neighborhood residents were observed walking or bicycling in the street.



Photo 14: Adams Street looking North



Photo 15: Adams Street looking South



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D. Intersection Characteristics

Vinal Square is located at the junction of Route 3A, Route 40, Dunstable Road, Wotton Street, and Adams Street, forming a six-legged signalized intersection. Dunstable Road forms an adjacent stop-controlled intersection with Route 40, just west of the main intersection. Adams Street is one-way leaving the intersection, while the Route 3A and Route 40 signal controls the major traffic movements within this section of the Square. This traffic signal is under MassDOT ownership and control.



Photo 16: Vinal Square in North Chelmsford



Photo 17: Intersection of Princeton Street and Middlesex Street

The statutory speed limit throughout Vinal Square is 30 mph. At the eastern end of the Square, the intersection of Route 3A (Princeton Street) and Middlesex Street converges into a T-intersection, with stop control for movements from Middlesex Street. Princeton Street runs in a northeast/southwest direction, providing a connection between Route 3 and the North Chelmsford neighborhoods. Princeton Street, in the southbound direction, contains a through travel lane and an exclusive left turn lane. In the northbound direction, Princeton Street consists of one general purpose travel lane. Middlesex Street is an urban collector running in a general east/west direction at the intersection. The intersection at Middlesex Street widens to form both a right turn and left turn lane, separated by a raised median. The posted speed limit along Middlesex Street is 35 mph.

To the east on Middlesex Street, the Pan Am owned double-tracked rail line crosses the study area. At this crossing, pavement conditions have deteriorated considerably. Therefore, vehicles and bicycles using Middlesex Street must take precautions when crossing the tracks. In Massachusetts, the Department of Public Utilities (DPU) has responsibility and regulatory authority for grade crossing safety at all public highway-railroad grade crossings. Federal funds are available under Section 130 of federal surface transportation law to assist in eliminating or mitigating hazards at public highway-railroad grade crossings. The MassDOT Highway Division administers these funds and works with the railroads and communities to identify and construct priority projects.

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The MassDOT Grade Crossing Program focuses on improving safety at existing highway railroad grade crossings primarily through the installation of warning devices. Such devices include: standard signs and pavement markings; installation or replacement of active warning devices (flashers and gates); upgrading active warning devices, including track circuitry improvements and interconnections with highway traffic signals; crossing illumination; crossing surface improvements; and general site improvements.

The following observations were also made during site visits conducted as part of the study process:

- Vehicles traveling on Route 3A northbound routinely queue beyond the Princeton Street/Middlesex Street intersection to the south. This situation creates greater delays for vehicles turning from Middlesex Street.
- Route 40 eastbound queues beyond the Dunstable Road intersection, causing delays for vehicles on Dunstable Road. Vehicles on Route 40 were observed allowing turning vehicles from Dunstable Road to move into the line of traffic.
- The Route 3A northbound traffic signal head is missing a back plate. This should be repaired to ensure proper motorist vision of the traffic control signal.
- Pedestrian signals should be upgraded to newer LED signals. The “countdown hand” for all pedestrian signals does not function properly and should be repaired. The push button for pedestrians crossing Route 3A toward Wotton Street is also in need of repair. The pedestrian signal head in front of the Taaza Market is not properly aligned and should be realigned so that pedestrians can see walk signal when illuminated. Audible cues should be also added to the pedestrian signal system for visually impaired pedestrians.
- There are two “Do Not Block Intersection” signs on Route 3A northbound in Vinal Square; however, vehicles cannot see the sign until they are already in the intersection. These signs should be moved further south, providing advance information to the driver before arriving at the intersection.

E. Traffic Volumes and Turning Movements

Automatic traffic recorder (ATR) counts were performed at key locations in and around Vinal Square. These counts provide insight into traffic volumes moving through the area. Table 1 on the following page shows the Average Daily Traffic (ADT) at locations within the study area. The highest volumes are found on Route 3A north and south of Vinal Square, with volumes

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ranging from 10,900 vehicles per day to 12,100 vehicles per day. Route 40 and Middlesex Street also carry significant volumes of traffic, with ADTs of 6,100 and 8,900 vehicles per day respectively.

Table 1: Average Daily Traffic Volumes

Location	Year Counted	Average Daily Traffic (ADT) vehicles per day (vpd)
Adams Street South of Vinal Square	2009	320
Wotton Street North of Route 3A	2009	420
Route 3A (Tyngsborough Rd) North of Vinal Square	2010	10,900
Route 40 (Groton Rd) West of Vinal Square	2009	6,100
Dunstable Road West of Route 40 (Groton Rd)	2009	2,200
Middlesex Street East of Route 3A (Princeton St)	2009	8,900
Route 3A (Princeton St) North of Richardson Road	2009	12,100

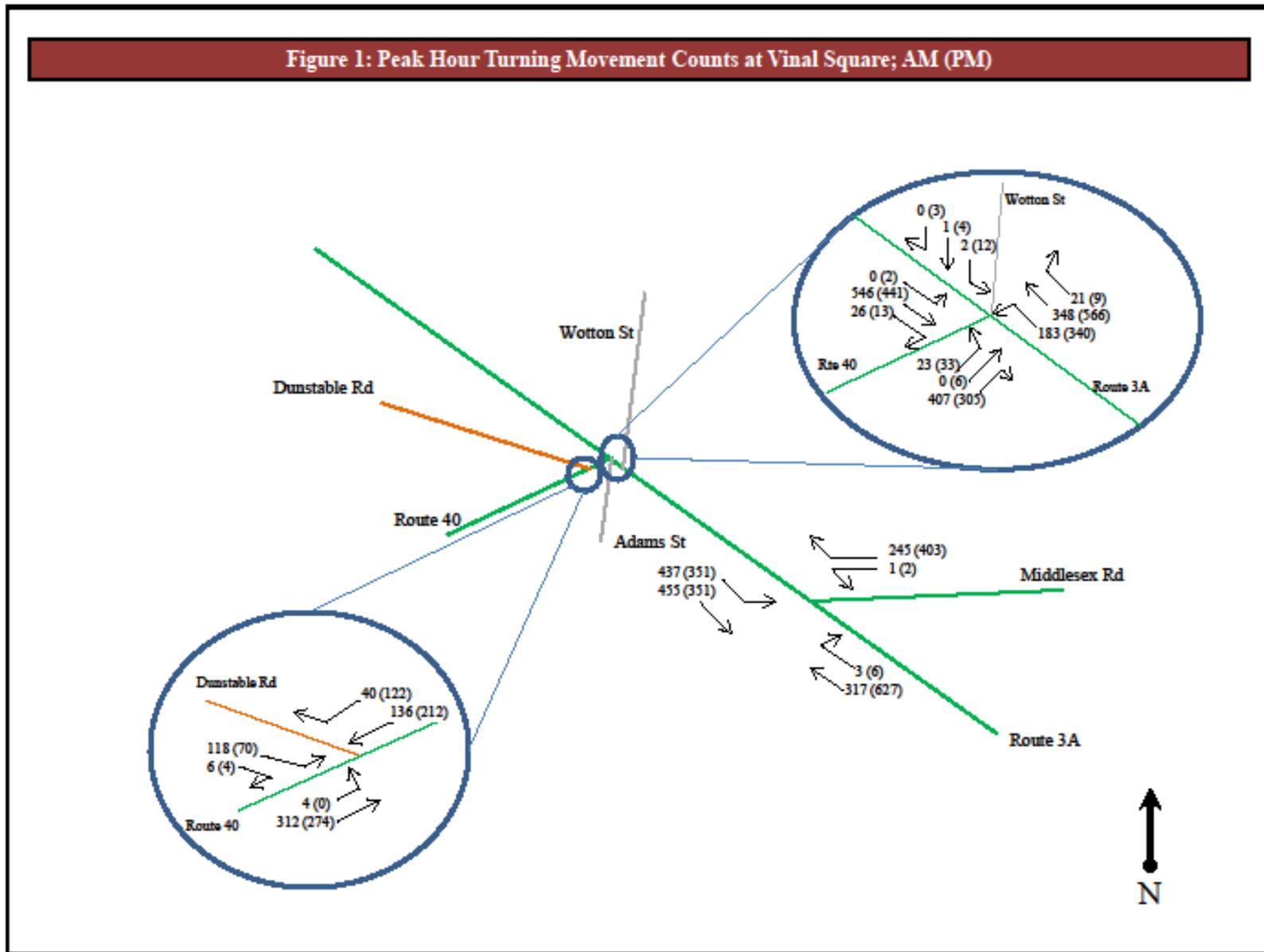
Turning Movement Counts (TMCs) were collected on Tuesday, November 3, 2009 and October 29, 2009, during peak periods of the day (7:00-9:00 A.M. and 4:00-6:00 P.M.). Figure 1 on the following page summarizes the turning movement count data. For purposes of analysis, Vinal Square was addressed as three distinct intersections: (1) Route 40 and Dunstable Road; (2) Route 3A, Wotton Street, and Adams Street; and (3) Route 3A and Middlesex Street. Table 2 below shows the number of vehicles passing through each of these intersections during the A.M. and P.M. peak travel periods.

Table 2: Intersection Turning Movement Volume Totals (A.M. and P.M. Peak Periods)

Intersection	Number of Vehicles Processed through Intersection	
	A.M. Peak Period	P.M. Peak Period
Route 40 and Dunstable Road	616	682
Route 3A, Wotton Street and Adams Street	1,557	1,734
Route 3A (Princeton Street) and Middlesex Street	1,458	1,740

The intersection of Route 40 and Dunstable Road processed 616 vehicles during the A.M. peak travel period and 682 vehicles during the P.M. peak. The intersection of Route 3A, Wotton Street and Adams Street processed 1,557 vehicles during the A.M. peak period and 1,734 vehicles during the P.M. peak period. Similarly, the intersection of Route 3A and Middlesex Street processed 1,458 vehicles during the A.M. peak period and 1,740 vehicles during the P.M. peak period. As is common in most locations, travel demand in the Vinal Square area is higher during the evening peak travel period than during the morning peak.

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F. Pedestrian and Bicycle Facilities

Communities that promote walking and other forms of non-motorized transportation can reap significant social, environmental and health benefits that are not often available in automobile dominated places. Safe, convenient and comfortable sidewalks and walkways provide opportunities for exercise, help people meet and socialize, and give children and others who do not drive mobility options. With the option to walk and bike available to residents, shoppers and workers, communities can decrease the number of vehicles on the roadway, helping to reduce congestion, air pollution, and the need for large parking facilities. When considering improvements to pedestrian and bicycle facilities, it is important to take into account the needs of all users, including those with disabilities or physical impairments. Sidewalks should be wide enough to safely accommodate wheelchairs, and wheelchair ramps at crosswalks should meet ADA standards. Pedestrian-actuated signals at crosswalks should include an audible indicator for those with visual impairments.

Children are often users of the bicycle and sidewalk network when walking to and from school. In Chelmsford, children who live less than two miles from an elementary or middle school must pay for school bus transportation. All high school aged children must pay the bus fee as well, if they choose to ride the bus. Students residing in parts of Vinal Square are within in the two-mile distance, with Harrington Elementary and Chelmsford High School being less than 2 miles away. A program such as Safe Routes to Schools has been designed to promote physical activity for school children, increase safety, reduce traffic congestion and improve air quality. The program is aimed at providing information to elementary school children, parents, and the general public relative to the benefits of walking, bicycling, carpooling, utilizing public transportation, and riding the school bus to and from school. Chelmsford already supports this program with all elementary schools in town participating. While the Safe Routes to School program is geared toward elementary schools, the Middle School and High School should consider implementing similar educational programs to encourage more of their students to walk to school.



Photo 18: Snow and ice covered sidewalks make walking difficult

Chelmsford prepared its first pedestrian plan in 1981, which largely focused on the areas adjacent to schools, commercial districts and recreation areas.¹ The Plan established design parameters for pedestrian construction projects, prioritized locations for improvements, and

¹ Pedestrian Safety Study, Chelmsford, Massachusetts, Edward McCann Associates, June 1981.

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developed cost estimates for implementation. The pedestrian plan was updated in 1996. The 2010 Master Plan recommends that the town develop an overall bicycle and pedestrian plan to address the community's needs based on existing conditions. While it may not be practical to provide sidewalks on every street, a lack of accessible sidewalks in critical areas has been a topic of discussion in Chelmsford for some time, as indicated during the public input process for the Master Plan. In addition, deficiencies in sidewalk maintenance and the need to improve sidewalk snow and ice removal during the winter months have been identified by residents as a concern. A review of the pedestrian and bicycle accommodations in Vinal Square included an inventory of sidewalk conditions, crosswalks and pedestrian signals, and bicycle facilities.

Sidewalks are located on the northeast and southwest sides of Vinal Square, and are in fair condition structurally, but do not meet ADA standards. There are telephone poles, street signs and street lights within the sidewalk layouts, making passage difficult, especially for those using wheelchairs. There should be truncated domes at the end of the sidewalks and on the approach of large curb cuts and parking lots, to alert visually-impaired pedestrians of the change in grade. Over the course of the winter months, snow and ice accumulation on the sidewalks was noted throughout much of Vinal Square. Observations showed that the areas where crosswalks meet sidewalks were sometimes completely obstructed. In addition, large cracks appeared between the brick sidewalk located in front of the Parlee Building and some brick pieces were dislodged or missing entirely.



Photo 19: Princeton Street with vehicle stopped in crosswalk.

The neighborhood abutting the southern end of the Square has limited pedestrian accommodations. There are some sidewalks interspersed throughout the neighborhood, but they are in poor condition. Many parts of the neighborhood have no sidewalks, and residents were observed walking in the street. Improving the walkability of the neighborhood with a complete sidewalk network would be beneficial to those accessing the Vinal Square business area, the Varney Playground, and the MacKay Library.

Vinal Square has four striped crosswalks at the main signalized intersection. Two are located at the main traffic control signal, and accommodate pedestrians crossing at Route 3A and Wotton Street. A third crosswalk is located on Adams Street, on the northern end of Vinal Square. The fourth crosswalk is located across Route 40 and Dunstable Road, connecting Adams Street to the North Chelmsford True Value Hardware store. The surfaces of all the crosswalks are in good condition and have been repainted as part of the Vinal Square resurfacing project completed in 2009. However, the pedestrian signals are in poor working condition. The signal buttons for crossing Route 3A are not operational and there is no exclusive pedestrian phase available for

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crossing the busiest portion of the roadway. The Adams Street crossing does not have a pedestrian signal, however, volumes are low (<1,000 vpd) and the crossing is short enough (15 ft) that it is not warranted. The Groton Road crossing is operational, but the signal heads are turned at an angle, making it very difficult to see the pedestrian signal when illuminated. Additionally, the pedestrian signals are not equipped with audible cues for the visually impaired or with LED lenses which improve visibility.

The Chelmsford Bicycle and Pedestrian Advisory Committee (BPAC) has made suggestions for bicycle and pedestrian improvements in Vinal Square, including the following:

- Improve pedestrian access/crosswalks/sidewalks;
- Improve bicycle access;
- Improve the Lowell Regional Transit Authority (LRTA) access;
- Implement traffic calming measures; and
- Improve parking access.

Such improvements, along with additional recommendations outlined in this study, will help make Vinal Square a more vibrant and sustainable neighborhood.

The Vinal Square area lacks bicycle accommodations. There are no designated bicycle lanes or “share the road” signs. With on-street parking and limited shoulders, the roadways through Vinal square inhibit safe bicycle use. If the Town wants to consider the removal of on-street parking and narrowing of travel lanes, bicycle lanes could be accommodated on Groton Street, Princeton Street, and Middlesex Street. Tyngsborough Road narrows to a point where “share the road” signage and pavement markings would be more appropriate. Wotton Street and Dunstable Road could accommodate “Share the Road” signage and pavement markings as well.

Currently, the MacKay Library is the only location in the Vinal Square neighborhood with a bicycle rack, although it is in poor condition. Within the Square itself, there is no designated bicycle parking. The installation of additional bicycle racks would be a short-term, low-cost improvement to encourage the use of bicycles as an alternative form of transportation.

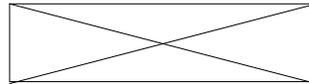
Pedestrian amenities, such as street furniture and pedestrian-scale lighting, improve pedestrian conditions and encourage pedestrian activity. Objects specifically for pedestrians foster a sense that the area is a comfortable place for pedestrians to be. Pedestrian amenities also signal to other users of the transportation network that pedestrians are likely to be present. The design of future transportation projects within Vinal Square should incorporate improvements to the pedestrian realm such as public seating, trash and recycling receptacles, lighting and street trees.

It is important to note that pedestrian amenities should never reduce the width of the pedestrian travel area below the minimum three feet required under ADA standards and MassDOT design

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guidelines. In fact, the MassDOT Design Guidebook recommends a five-foot sidewalk, to ensure a continuous minimum 36-inch clear width which is free of obstructions (utility poles, signs, fire hydrants, etc). In addition, the location of pedestrian amenities should be focused at specific locations that have or are expected to have significant pedestrian traffic such as transit stops, major building entrances, retail buildings, public buildings (library, post office, North Town Hall) and restaurants. Many communities identify these locations as part of a larger streetscape plan. Seating incorporated into building form or landscape features, such as seat walls, is an alternative to freestanding benches and could be considered as part of any building renovation or new construction proposed within the Square. Street furnishing design and location should consider car overhang area and door swing. When placed near the curb, furnishings should be located at the ends of on-street parking stalls rather than at the center. Furnishings should never obstruct curb ramps or be placed near intersections such that they interfere with visibility of pedestrians by motorists.

In the current fiscal climate, providing amenities and accommodations for pedestrians and cyclists can be challenging. As outlined in the 2010 Master Plan, progress in this area could be achieved by asking developers to provide sidewalks and streetscape amenities through the project permitting and approval process.



1. Middlesex Street Bicycle and Pedestrian Assessment

The Middlesex Street segment starts at the intersection with Princeton Street and continues east to the intersection with Quigley Avenue. A six-foot wide sidewalk parallels the northern and southern sides of Middlesex Street for the majority of this roadway segment. There is a break in the sidewalk where the railroad tracks cross at the Quigley Avenue intersection. This section of sidewalk is in good condition with the majority of the sidewalk free from any root upheaval or large cracking. However, the sidewalk is not ADA compliant. On the northern side of Middlesex Street, fourteen (14) utility poles have been placed along this 0.33 mile length of sidewalk, while on the south side of Middlesex Street the sidewalk is free of utility poles. There are no truncated domes on the sidewalk ramps on either side of Middlesex Street.



Photo 20: Middlesex Street at crosswalk to North Common

On the North Common, there are two benches which are the only designated places to sit within Vinal Square. Additional benches in and around the Square would make the area more inviting and pedestrian friendly.

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The crosswalks on Middlesex Street do not have pedestrian signals. The crosswalk located in the vicinity of 28 Middlesex Street is visible and identified by a “yield to pedestrians in the crosswalk” sign, but the crosswalk paint is starting to fade and should be reapplied in the near future to ensure that it is clearly visible to motorists. A second, less prominent crosswalk is located where Edwards Place forms a T-intersection with Middlesex Street. The pavement marking on the crosswalk has faded and is barely visible. During the winter months, snow and ice accumulation was observed to be blocking some of the sidewalks on Middlesex Street.

There are currently no designated bicycle facilities on Middlesex Street. However, the wide shoulders and roadway width provides an ideal scenario for a bike lane leading into Vinal Square from the east. There are some issues with on-street parking that may inhibit the installation of bike lanes near Princeton Street and the North Common. Closer to the Square, a share the road designation may be a more reasonable alternative, assuming that the Town wishes to maintain on-street parking in this area.

2. Tyngsborough Road (Route 3A) Bicycle and Pedestrian Assessment



Photo 21: Tyngsborough Road looking north

The study area segment for Tyngsborough Road extends from the intersection of Tyngsborough Road and Groton Road northerly to the Tyngsborough Road/ Wellman Avenue intersection. The sidewalk system that runs along the northbound side of Middlesex Street continues along Tyngsborough Road for a short distance to the north and abruptly stops. There are no sidewalks on either side of Tyngsborough Road north of Vinal Square, essentially eliminating pedestrian access to Vinal Square from this residential area. The existing sidewalk within the Square is six-foot wide with stairs separating various levels. The sidewalk in front of 2 Tyngsborough Road is in good condition and is free of obstructions, but the parking lot at the northern end of the plaza has stair access only. The presence of stairs in the sidewalk and no ramp access to the parking lot behind the plaza makes traveling between the parking lot and the front of the plaza difficult for the disabled. Part of the sidewalk in front of the Schezuan Chef Restaurant is comprised of brick pavers that have recently been repaired.

No bicycle facilities exist along Tyngsborough Road at this time. However, the road is 30 feet wide with a 50-foot right-of-way, leaving room for expansion. Without expansion of the paved surface, pavement markings could be altered to allow for two 11-foot travel lanes and a 4-foot bike lane on each side of the roadway. In the Square, the roadway widens to 46 feet with an eight-foot parking lane and 16-foot travel lanes. Narrowing the travel lanes to 12 feet would provide the necessary width to include a bike lane.

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3. Princeton Street (Route 3A) Bicycle and Pedestrian Assessment

The study area for the Princeton Street section of Vinal Square extends from the Princeton Street/Middlesex Street intersection southwest to the Princeton Street/Foundry Street intersection. Six-foot wide sidewalks are found on both sides of Princeton Street within the study area. The sidewalks are in good condition with minimal obstructions. As with the majority of the sidewalks in the Vinal Square study area, the Princeton Street sidewalks are missing truncated domes to warn pedestrians with visual impairments that they are approaching driveways or curb cuts. Like other locations within the study area, snow and ice buildup was found to be a major obstacle for pedestrians during the winter months.



Photo 22: Princeton Street at North Common

Princeton Street has two midblock crosswalks. The first is found at approximately 12 Princeton Street, and is in good condition with striping still visible to motorists. A second crosswalk is found at approximately 36 Princeton Street. This crosswalk is well-striped and visible to vehicles approaching from either direction. There are no pedestrian signals at either crosswalk on this section of Princeton Street.

Princeton Street currently has no designated bicycle facilities. When considering bicycle accommodations on Princeton Street south of Middlesex Street, there is available roadway width for a bicycle lane. In the Square itself, share the road markings are more reasonable due to the presence of on-street parking and turning lanes.

4. Groton Road (Route 40) Bicycle and Pedestrian Assessment

Groton Road intersects Vinal Square from the west and serves as a link between North Chelmsford and Route 3, Westford, the Chelmsford Senior Center, and Freeman Lake. The limits of the study area on Groton Road extend from Vinal Square to 20 Groton Road. On the eastbound side of Groton Road, a six-foot sidewalk runs the entire length of the study area. The westbound side of Groton Road contains a sidewalk that begins outside of the study area, after 20 Groton Road. Both sidewalks are in good condition and were recently reconstructed.

Currently, there are no bicycle accommodations along Groton Road approaching Vinal Square. The presence of on-street parking on both sides of the road inhibits the installation of a bike lane. Share the road markings and signage would be a recommended alternative for promoting bicycling on this roadway.

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5. Wotton Street Bicycle and Pedestrian Assessment

Currently there are no sidewalks along Wotton Street. Parking is not allowed due to the limited width of the roadway. The roadway is in fair condition but upgrades would be needed if higher volumes of traffic were present.

There are no bicycle accommodations evident along Wotton Street as well. The roadway leads to a park along the Merrimack River, and if a commuter rail station opens, additional traffic will be drawn to the area. The roadway will require significant improvements and upgrades in order to provide bicycle accommodations.

6. Adams Street Bicycle and Pedestrian Assessment

Currently, a six-foot wide asphalt sidewalk runs along the north side of Adams Street for approximately fifty (50) feet. The south side of the roadway has a 6-8 foot (mix of asphalt and concrete) sidewalk running for approximately 330 feet with large gaps for driveways interspersed. The roadway leads into a residential area and ends at the Varney Playground and beach. Neighborhood residents were observed walking or bicycling in the street.

Currently, there are no designated bicycle facilities along Adams Street. Installation of signage designating this road as a bike route between Varney Playground, residential areas, and the Vinal Square businesses would encourage bicycle use. This road could be the gateway for bicyclists and pedestrians in the neighborhood to the business district. Providing additional bike racks in Vinal Square will accentuate the promotion of bicycling in the area.

G. Crash Data

Crash data was provided to NMCOG staff by MassDOT using the state's accident report database. The data included traffic crashes that occurred within the study area over a three-year period between 2006 and 2008. A crash data summary is provided in Table 3 below. The crash summary includes the type of crash, severity, time of day, and surface conditions. Also included are the equivalent property damage only (EPDO) scores for each intersection. EPDO is used to rank high crash locations based on number and severity of each incident. The EPDO number for an intersection is a summation of the EPDO score for individual crashes. The EPDO number for each intersection below falls outside of the NMCOG's Regional Top 100 List, meaning that these locations are not considered high hazard intersections based on the ranking system in place currently.

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Table 3: Vinal Square Crash Summary

Major Street	Rte 3A	Rte 3A	Rte 40
Minor Street	Middlesex St	Rte 40/ Wotton St	Dunstable Rd
Year			
2006	1	8	5
2007	2	3	3
2008	3	3	1
Total	6	14	9
MassDOT District 4 Crash Rate	0.58	0.78	0.58
Calculated Crash Rate	0.31	0.74	1.21
Higher than expected?	No	No	Yes
EPDO	14	26	17
Type			
Angle	2	6	2
Rear-End	2	5	3
Run off road	0	0	0
Other	2	3	4
Time of Day			
AM Peak	0	1	0
PM Peak	0	1	0
Other	6	12	9
Pavement Conditions			
Dry	5	8	6
Wet	0	4	1
Snow/Ice	1	2	0
Other	0	0	2
Severity			
Property Damage Only	4	11	7
Personal Injury	2	3	2
Fatal	0	0	0

Results of the crash data analysis at the three intersections in and around Vinal Square show the following:

- The intersection of Route 40 and Dunstable Road experiences a higher than expected crash rate with 1.21 crashes per million entering vehicles, compared to the MassDOT District 4 crash rate of 0.58.
- The numbers of crashes at the other two study area intersections are relatively low when compared to average intersection crash rates within the MassDOT District 4 region.
- At the intersection of Route 3A and Middlesex Street, a total of six (6) crashes were reported over three years, for an average of two crashes per year. The incidents mainly

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occurred under dry conditions at off-peak times of the day. The types of crashes were evenly split between angle and rear end crashes. Only two crashes involved injuries and no fatalities occurred.

- There were fourteen (14) reported crashes at the intersection of Route 3A and Route 40/Wotton Street/Adams Street. Of those, eleven (11) were reported as property damage only crashes, and no fatalities were reported. Angle and rear-end type incidents were evenly split, with the majority occurring during off-peak hours and under dry roadway conditions. Two crashes were reported during snow and ice conditions.
- There were nine (9) crashes reported at the intersection of Dunstable Road and Route 40 reported during the three-year study period. All incidents occurred during off-peak hours of the day, with 67% occurring under dry roadway conditions. Two injuries and no fatalities were reported at this intersection.
- A review of the 2006-2008 MassDOT crash data found that there were no reported pedestrian or bicycle related crashes reported during the three year period.

H. Pavement Conditions

A survey of existing pavement conditions was conducted to determine if any road segments in the study area are in need of pavement maintenance. Table 4 on the following page shows the results of the survey using Pavement Condition Index (PCI) values calculated through the use of RSMS pavement management software. Also included in the table are repair recommendations based on the PCI values calculated.



Photo 23: Pavement conditions on Middlesex Street

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Table 4: Pavement Conditions on Roadways in Vinal Square Study Area

Location	PCI Rating	Roadway Condition	Recommended Repair Category
Adams Street	72	Fair	Preventive Maintenance
Dunstable Road	91	Excellent	None
Middlesex Street	88	Good	Routine Maintenance
Route 40 (Groton Road)	100	Excellent	None
Route 3A (Princeton Street)	98	Excellent	None
Route 3A (Tyngsborough Road)	57	Poor	Rehabilitation
Wotton Street	54	Poor	Rehabilitation/Reconstruction

It should be noted that a resurfacing effort by MassDOT was undertaken on Route 3A in the fall of 2009. The Route 3A project included the paving of Princeton Street from Foundry Street to Groton Road. Therefore, no repairs are needed along this segment of Route 3A at this time.

In the summer of 2011, Route 40 (Groton Road) was repaved as part of the town’s annual roadway and sidewalk improvement plan. The limits of the project extended from Coolidge Street to Route 3A. Therefore, the pavement condition is excellent and no improvements are needed at this time.

Middlesex Street could benefit from routine maintenance, such as crack sealing or patching. Adams Street needs some routine maintenance to improve its overall condition. These improvements may include crack sealing, chip sealing, and/or an overlay less than 2 inches thick. Roadways with poor pavement condition include Wotton Street and the Tyngsborough Road section of Route 3A, which are in need of some rehabilitation, if not total reconstruction. Such rehabilitation could include full and partial depth patching, joint and crack sealing, grouting and under-sealing, and grinding and milling in conjunction with overlays over two inches.

I. Public Transportation

The Lowell Regional Transit Authority (LRTA) operates daily fixed route bus service through Vinal Square and North Chelmsford between 6:00 A.M. and 6:00 P.M. All fixed route buses currently have bicycle racks mounted on the front for passengers with bicycles. The #17 North Chelmsford Bus enters Chelmsford at Wood Street, stops at the Wal-Mart Plaza, departs the plaza by following Drum Hill Road to Technology Drive, past the Lowell General Hospital Out Patient Center, turns onto North Road, then onto Princeton Street. The bus then proceeds along Princeton Street, passing through Vinal Square and veers left onto Groton Rd. (Rte 40), passing the Chelmsford Senior Center. The bus then turns left on Lynn Avenue and terminates on Main Street at the Triangle Store. Departing the Triangle Store on the inbound route, the bus turns onto Sheila Avenue, turns into the senior housing complex behind the Senior Center, and proceeds along Marinel Avenue turning left onto Dunstable Road. Bearing right onto Mission

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Road, the bus turns right onto Wood Street (Tyngsborough), then turns south onto Tyngsborough Road (Route 3A). At Vinal Square, the bus bears left onto Middlesex Street and turns right onto Brouillette Street. At the end of Brouillette Street, the bus turns right onto Princeton Street and rejoins the outbound route at the intersection of Princeton Street and North Road.

The LRTA also operates paratransit service within the region in three distinct programs, all under the title “Road Runner”. The greatest numbers of passengers are carried under the Road Runner senior service (60 plus). The second service operated under the Road Runner program is the Americans with Disabilities Act (ADA) complementary service, and the third is the Council on Aging service, which is operated by each community’s COA, with funds provided by the LRTA.

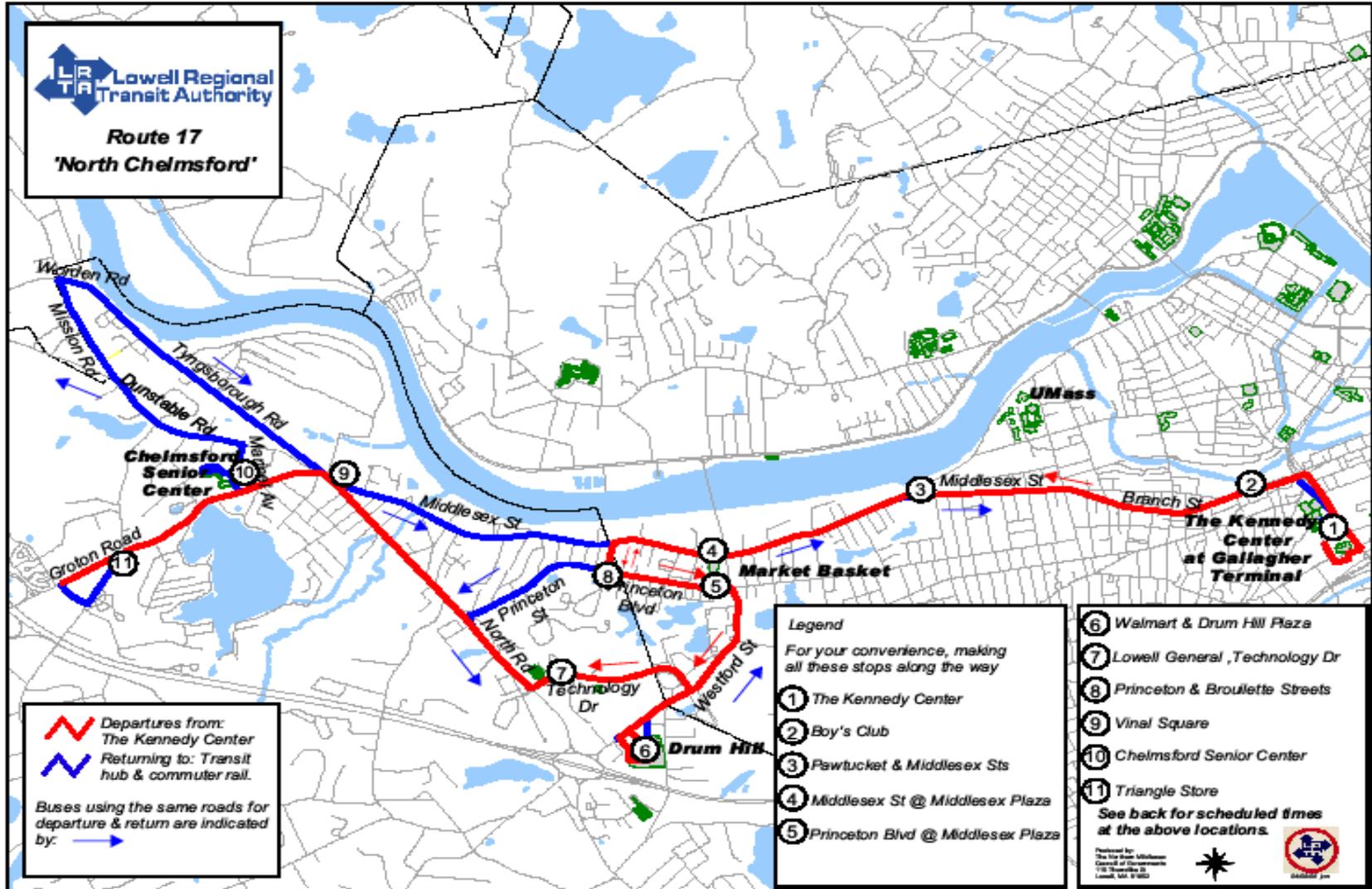
In Chelmsford, the Road Runner senior service consists of one wheelchair lift-equipped minibus operating within the Town, and between Chelmsford and Lowell. The service is provided from 8:00 A.M. to 4:00 P.M., Monday through Friday, and requires a two-day (48-hour) advanced booking. In Fiscal Year 2011, 5,147 passenger trips were handled by LRTA’s Chelmsford Road Runner.

The Road Runner ADA service consists of two or more (depending upon the daily demand) wheelchair lift-equipped minibuses, operating throughout the LRTA fixed route ADA service area, Monday through Friday, from 6:00 A.M. to 6:00 P.M. (7:30 A.M. to 6:00 P.M. on Saturdays). Trips can be scheduled one-day in advance by calling the Road Runner office in Lowell. These trips are reserved for disabled passengers who are not able to access a fixed route bus. In general, the ADA complementary service area is defined as a three-quarter mile radius surrounding existing fixed routes. The ADA service area is smaller on Saturdays, as several bus routes do not operate. In Fiscal Year 2011, 2,863 ADA passenger trips were generated by Chelmsford residents.

The Road Runner Council on Aging service consists of one wheelchair lift-equipped minibus which operates Monday through Friday, from 8:00 A.M. to 4:00 P.M. The LRTA owns the minibus, leases it to the Town, and provides funds for vehicle operation. Residents schedule trips by calling the Chelmsford Senior Center at least one day in advance. Senior Center staff schedule, dispatch and drive the minibus. The Road Runner COA van reported 6,060 passenger trips in Fiscal Year 2011.

The 2010 Master Plan calls for the establishment of clearly marked bus stops with shelters, posted route maps and schedules along all bus routes. In addition, the Plan recommends extending transit service into the evening hours, providing enhanced service between the town’s larger neighborhoods and its major retail and business areas, and providing additional transit access between the Senior Center and the town’s elderly housing complexes.

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J. Commuter Rail Expansion

The New Hampshire Transit Authority (NHTA), along with the New Hampshire Department of Transportation (NHDOT), has proposed to extend the existing Massachusetts Bay Transportation Authority (MBTA) commuter rail Lowell Line into New Hampshire with stops in Manchester NH (at the Manchester-Boston Regional Airport), Nashua, NH (near the Pheasant Lane Mall) and Chelmsford (Vinal Square). In response, the Chelmsford Board of Selectmen voted to pursue the development of a new station in the North Chelmsford area, if the New Hampshire-initiated project moves forward.

In addition to the New Hampshire initiated project, the Central Transportation Planning Staff (CTPS) conducted a North Chelmsford Commuter Rail Feasibility Study for the MBTA in 2002, which identified two preferred locations for such a station and assessed the potential demand for each location. The locations included the North Chelmsford Auto Parts site north of Vinal Square and the industrial complex at the end of Wotton Street. The site off Wotton Street was recommended as the most feasible location for a future new station. The estimated construction cost ranged from \$3.7 million for a 400-vehicle lot facility to \$4.9 million for a 725-vehicle lot. A new access road connecting to Route 3A north of Vinal Square was also recommended as part of any new rail station in this location.

Ridership forecasts to 2025 showed that approximately 1,000 riders per day would use the Chelmsford commuter rail station². These figures were updated in a 2008 report for the Southern New Hampshire Planning Commission (SNHPC). Ridership forecasts were estimated for 2030 to be between 920 and 1,080 passenger trips per day³.

The added traffic from a new commuter rail station near Vinal Square would have an impact on the peak hour traffic operations in that an additional 500 vehicles would travel to the station between 6:00 A.M. and 8:00 A.M. and 600 vehicles between 6:00 P.M. and 7:00 P.M. The morning peak hour occurs between 7:45 and 8:45 A.M. and will be affected by the additional vehicles. The evening peak occurs from 5:00 to 6:00 P.M. The peak period for the commuter rail station would occur later than the peak for the existing roadway traffic. In addition, the proposed additional access road would serve as a bypass of Vinal Square for those passengers heading north to and from Tyngsborough on Route 3A. The impact of a commuter rail station on traffic operations within Vinal Square is outlined in the Section III of this report.

² North Chelmsford Commuter Rail Station Feasibility Study, CTPS, September 2002.

³ Ridership forecasts from Ridership Estimates for Capital Corridor Passenger Rail Service Study, SNHPC, October 2008

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K. Parking

Through the public process for the development of the town’s Master Plan, parking in Vinal Square was identified as both a transportation-related challenge and an economic development issue. There are approximately 240 parking spaces available in Vinal Square, including private lots. There are thirty-five (35) marked on-street parking spaces with signage on the north side of Route 3A with a one-hour parking limit. An additional twelve (12) to fifteen (15) spaces are located on Dunstable Road. These spaces are not striped, but there are signs posted indicating a thirty-minute parking limit. The north side of Groton Road has limited on-street parking between 14 and 16 Groton Road, including one space reserved for handicapped parking. The south side of Groton Road has on-street parking between 12 and 18 Groton Road. On-street parking can also be found on the northbound side of Middlesex Street from Edwards Place to Vinal Square. In addition, there are five on-street parking spaces, located in front of the Picken Insurance Agency. On-street parking is not allowed on Princeton Street until reaching the center of Vinal Square. There are two parking spaces in front of the Chargepoint electric car charging station on Middlesex Street, which have a four-hour time limit.



Photo 24: Electric car charging station on Middlesex Street

As shown in Table 5 below, there is one municipal parking lot, located on the north end of the Square, which provides forty-four (44) spaces with a one-hour time limit. A privately-owned lot is located off Wotton Street which contains 73 spaces, including seven (7) handicapped spaces, designated for patrons of the Parlee Building. An additional privately-owned lot is located where Princeton Street enters the Square. This lot contains thirty (30) spaces.

Table 5: Parking Lot Characteristics in Vinal Square

Parking Lot Location	Number of Handicapped Parking Spaces	Number of Time Restricted Parking Spaces	Total Number of Parking Spaces	Occupancy (%)	
				Daily Average	Average P.M. Peak Hour
Municipal Parking Lot	2	3	44	44%	64%
Parking Lot off Wotton Street	7	0	73	40%	60%
Parking Lot (Located at 54 Vinal Square)	0	0	30	53%	73%

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At present, there does not appear to be a need for additional parking in Vinal Square. Observations made during site visits found that parking was always available. Parking occupancy averaged 50% over the course of the day, with occupancy levels reaching 70% during evening peak traffic hours. It should be noted that there are significant commercial vacancies within the Square. Should additional businesses reoccupy these spaces or if the proposed commuter rail station becomes a reality, there could be a significant increase in the demand for parking. The Town of Chelmsford should closely monitor business development in Vinal Square. Depending on future development activity, there may be a need to re-evaluate parking demand and utilization.

Traffic Operations Analysis

Traffic operations within the Vinal Square study area are assessed from the study of the un-signalized intersections at Route 3A and Middlesex Street and at Route 40 at Dunstable Road, as well as the signalized intersection at Route 3A and Route 40/Wotton Road/Adams Street. Level of Service (LOS), as defined within in the *Highway Capacity Manual (HCM 2000 Edition)*, is used to measure traffic operating conditions along a traffic facility based on average delay at each of the intersections within the roadway network.

Capacity analysis results in the assignment of levels of service to traffic facilities under various traffic conditions. Level of service (LOS) is a qualitative measure of traffic conditions ranging from free flow to major congestion. There are six levels of service ranging from A (free flow conditions) to F (highly delayed conditions). LOS accounts for various factors including traffic volume, roadway capacity, speed, roadway grade, traffic control devices, roadway types and geometry, and roadway delays. LOS A through D is considered acceptable in an urbanized area, while LOS E and F indicate delays and congestion that warrant mitigation.

A. Signalized Intersections

Signalized intersection level of service quantifies the overall operating condition of the intersection in terms of control delay. Control delay involves initial deceleration, move up time in the queue, stopped time, and re-acceleration for vehicles entering an intersection. The *2000 Highway Capacity Manual* (Exhibit 16-2), as outlined in Table 6 on the following page, shows various degrees of delay and its affect on level of service.

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Table 6: LOS Criteria for Signalized Intersections

LOS	Control Delay per Vehicle (s/veh)
A	≤ 10
B	> 10-20
C	> 20-35
D	> 35-55
E	> 55-80
F	> 80

B. Unsignalized Intersections

The Vinal Square study area includes two unsignalized intersections. Traffic operations at unsignalized intersections are somewhat different from signalized intersections in that LOS is only calculated for conflicted movements generally from the minor street. Through movements on the mainline generally do not have to yield the right-of-way and LOS usually is not determined for this movement. Thus, an overall intersection LOS will not be determined for an unsignalized intersection.

Stop controlled intersections use control delay as the performance measure for operational level of service analysis. Control delay at an unsignalized intersection is a quantitative result of motorist delay associated with the traffic control device. Control delay includes initial deceleration delay, stopped delay, queue move up time, and final acceleration delay. The LOS criteria are presented in the *2000 Highway Capacity Manual* and are provided in Table 7 below.

Table 7: Level of Service Criteria for Unsignalized Intersections*

LOS	Control Delay per Vehicle (s/veh)
A	≤ 10
B	> 10-15
C	> 15-25
D	> 25-35
E	> 35-50
F	> 50

**Highway capacity Manual*; Transportation Research Board; Washington DC; 2000; p 17-2.

C. Results of the Intersection Analysis

Table 8 below summarizes the results of the LOS analysis for the MassDOT-owned and controlled signalized intersection in Vinal Square. The Route 40 approach experiences unacceptable delays during both the A.M. and P.M. peak periods of the day. Both Wotton Street and Route 3A southbound experience longer delays during the evening peak hour and are

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operating at unacceptable levels of service (E). Because of the longer delay on Route 40, the overall intersection experiences a LOS E during the morning peak hour and LOS F during the P.M. peak hour.

Table 8: Intersection Capacity Analysis for Vinal Square in Chelmsford (Signalized)

Approach Movement	AM Peak Hour		PM Peak Hour	
	LOS ¹	Delay (sec) ²	LOS ¹	Delay (sec) ²
Route 40 EB	F	136.0	F	90.1
Wotton St SB	D	41.9	E	62.3
Route 3A NB Left	C	22.6	C	33.8
Route 3A NB	B	13.8	C	22.8
Route 3A SB	D	38.7	E	75.1
Overall Intersection	E	57.8	D	52.5

¹ LOS = Level of Service

² Delay = control delay measured in seconds per vehicle

Analysis of the unsignalized intersection of Route 3A (Princeton Street) and Middlesex Street is summarized in Table 9. Left turns from Middlesex Street onto Princeton Street experience the greatest delay due to insufficient gaps in traffic on the mainline. Right turns from Middlesex Street encounter unacceptable delays due to congestion on Princeton Street during the P.M. peak hour. Overall, this intersection operates at an unacceptable level of service during the A.M. peak hour.

Table 9: Intersection Capacity Analysis for Princeton Street at Middlesex Street (Stop Control for Middlesex Street)

Approach Movement	AM Peak Hour		PM Peak Hour	
	LOS ¹	Delay (sec) ²	LOS ¹	Delay (sec) ²
Route 3A SB Left	A	9.6	B	11.4
Middlesex St WB Left	F	65.0	F	71.7
Middlesex St WB Right	B	12.9	F	52.7

¹ LOS = Level of Service

² Delay = control delay measured in seconds per vehicle

Analysis conducted for the intersection of Route 40 (Groton Road) and Dunstable Road shows acceptable operations during peak periods of the day. The analysis is summarized in Table 10 on the following page. Delays on Dunstable Road are directly related to the main Vinal Square signalized intersection due to the proximity of the two intersections.

Table 10: Intersection Capacity Analysis for Groton Road at Dunstable Road (Stop Control for Dunstable Road)

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Approach Movement	AM Peak Hour		PM Peak Hour	
	LOS ¹	Delay (sec) ²	LOS ¹	Delay (sec) ²
Rte 40 EB	A	7.6	A	7.9
Dunstable Rd SB	B	13.3	B	13.2

¹ LOS = Level of Service

² Delay = control delay measured in seconds per vehicle

D. Traffic Impacts of New Commuter Rail Station at Vinal Square

Using existing train schedules for the Lowell Line of the MBTA Commuter Rail System, the following trains would most likely stop at the new Chelmsford station during peak hours of the day, assuming the existing schedule remains and the line is extended to New Hampshire.

A.M.:

- # 308 inbound train leaves Lowell for North Station at 7:18 A.M.; assume approximate departure time from North Chelmsford would be 7:12 A.M.
- #310 inbound train leaves Lowell for North Station at 7:46 A.M.; assume approximate departure time from North Chelmsford would be 7:40 A.M.

P.M.:

- #327 outbound train arrives in Lowell at 4:58 P.M.; assume approximate arrival time in North Chelmsford would be 5:04 P.M.
- #329 outbound train arrives in Lowell at 5:31 PM; assume approximate arrival time in North Chelmsford would be 5:37 P.M.

The other peak hour trains on the Lowell Line would not enter/exit the North Chelmsford station during the A.M. and P.M. peak traffic hours, based on the current train schedule. Other schedule alternatives have been discussed, with frequency of service ranging from a low of three (3) peak period trains to a high of six (6) peak period trains. Various options for the frequency of stops have also been discussed should the concept of establishing express trains be adopted. The evening peak trains will result in approximately six-hundred (600) vehicles exiting the station between 6:00 P.M. and 7:00 P.M., which is after the existing peak hour for traffic in Vinal Square. This will serve to extend the peak hour conditions in the Square. During the existing P.M. peak hour, approximately one-hundred (100) vehicles will be added to the traffic network in 2025.

Ridership estimates show by 2025, approximately 1,000 daily passenger trips will board at the North Chelmsford station. Approximately 80% of the passengers arriving at the station will come by automobile (80%) and park at the station. Another 10% will arrive by auto and be dropped off, and the remaining 10% will walk or bike to the station.

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Based on existing Lowell boarding data, it is assumed that the most heavily used train would attract approximately 250 passengers and 200 vehicles to the Vinal Square area. The size of the parking area at the North Chelmsford station would also impact the number of vehicles accessing the site. Figure 2 on the following page shows estimated turning movements in the study area with added trips from the commuter rail station integrated into 2025 traffic conditions.

Wotton Street would be impacted by the new station. Currently, Wotton Street is a local road carrying approximately 420 vehicles per day. The additional 1,000 vehicles per day accessing the station by 2025 would be distributed between Wotton Street and the proposed new access road located north of Vinal Square on Route 3A. In general, the roadway network can handle the added traffic volume, but during the peak periods, delays would rise throughout the study area. During the existing P.M. peak hour, the Wotton Street approach to Vinal Square operates at LOS E. Given that 90% of traffic at the new station is vehicle-related, it is estimated that 100 more vehicles would be added in the peak fifteen-minute period within the afternoon peak hour. This would degrade the level of service for the Wotton Street approach from LOS E to LOS F which would require mitigation.

Table 11 on the following page summarizes the results of the LOS analysis for the signalized intersection in Vinal Square under future conditions. Both the Route 40 and the Route 3A southbound approaches experience unacceptable delays during each peak period of the day. Wotton Street also experiences longer delays due to increased traffic from the commuter rail station. The overall intersection will operate at LOS F assuming mitigation is not put in place by 2025. Figure 2 on page 39 shows the peak hour turning movements that are projected for the analysis year 2025.

Table 11: Intersection Capacity Analysis for Vinal Square in Chelmsford, 2025 Conditions

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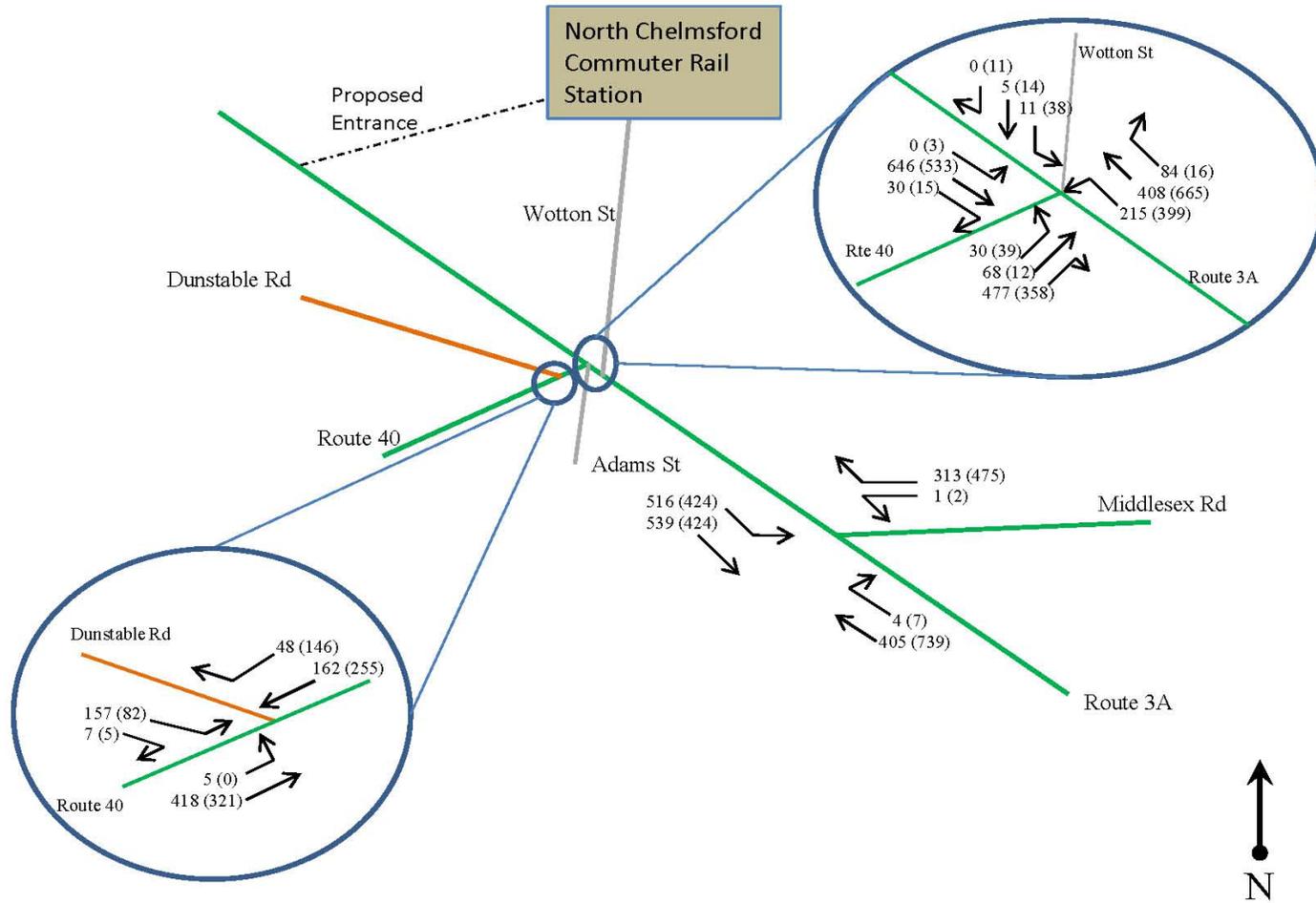
Approach Movement	AM Peak Hour		PM Peak Hour	
	LOS ¹	Delay (sec) ²	LOS ¹	Delay (sec) ²
Route 40 EB	F	336.0	F	145.8
Wotton St SB	E	62.1	E	72.6
Route 3A NB Left	C	34.0	E	74.2
Route 3A NB	B	18.8	C	28.0
Route 3A SB	F	241.3	F	137.9
Overall Intersection	F	194.5	F	89.8

¹ LOS = Level of Service

² Delay = control delay measured in seconds per vehicle

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Figure 2: Peak Hour Turning Movement Counts with North Chelmsford Commuter Rail Station, 2025; AM (PM)



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Analysis of the unsignalized intersection of Route 3A (Princeton Street) and Middlesex Street is summarized in Table 12. Vehicles turning from Middlesex Street experience unacceptable delays due to congestion on Princeton Street and lack of acceptable gaps for minor street movements during the P.M. peak hour.

Table 12: Intersection Capacity Analysis for Princeton Street at Middlesex Street, 2025 Conditions

Approach Movement	AM Peak Hour		PM Peak Hour	
	LOS ¹	Delay (sec) ²	LOS ¹	Delay (sec) ²
Route 3A SB Left	B	11.0	B	14.0
Middlesex St WB Left	F	125.0	F	154.7
Middlesex St WB Right	C	16.8	F	162.3

¹ LOS = Level of Service

² Delay = control delay measured in seconds per vehicle

Analysis conducted for the intersection of Route 40 (Groton Road) and Dunstable Road shows continued acceptable operations during peak periods of the day under future traffic conditions. The results of the analysis are summarized in Table 13 below. Delays on Dunstable Road are directly related to the Vinal Square signalized intersection due to the proximity of the two intersections.

Table 13: Intersection Capacity Analysis for Groton Road at Dunstable Road, 2025 Conditions

Approach Movement	AM Peak Hour		PM Peak Hour	
	LOS ¹	Delay (sec) ²	LOS ¹	Delay (sec) ²
Rte 40 EB	A	7.6	A	8.1
Dunstable Rd SB	C	16.9	B	15.0

¹ LOS = Level of Service

² Delay = control delay measured in seconds per vehicle

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III. Recommendations

There are several amenities that draw residents and visitors to the Vinal Square area. These include the North Common, Varney Playground, the MacKay Library, Southwell Park, and the Square's many businesses and restaurants. Under existing conditions, Vinal Square experiences congestion during peak periods of the day. Analysis has shown that there are some comparatively minor traffic improvements that could improve traffic operating conditions.

Enhancing the walkability of the area would serve to make the Square more appealing to visitors, customers and workers. It is possible to better accommodate bicyclists, however, some of the potential improvements would impact the availability of on-street parking within the Square, as discussed in previous sections of this report and reiterated below.

It should be noted that there are several vacant commercial properties in the immediate vicinity of the Square presently. The addition of a commuter rail station would benefit the economic and business climate in Vinal Square by creating a larger market of potential customers. However, there are traffic improvements that would be needed to accommodate the traffic generated through the siting of a commuter rail station off Wotton Street.

The following measures are recommended to improve the transportation network within the Square under both existing and future conditions. It should be noted that Route 3A is a state-owned facility and that the signals within Vinal Square are state-owned and controlled. The implementation of these recommendations will require collaboration between the Town and MassDOT.

A. Recommendations for Roadway Improvements

Middlesex Street

- A portion of Middlesex Street, from Highland Avenue to Princeton Street, is listed on the MassDOT Roadway Inventory File as unaccepted. To ensure that the Town receives full Chapter 90 funding from the State, this oversight should be remedied by submitting appropriate documentation to MassDOT.
- Coordinate with Pan Am Railroad and MassDOT to repair poor pavement at-grade crossing and develop a maintenance plan to ensure adequate pavement conditions are maintained;
- Upgrade the sidewalk system along Middlesex Street to comply with ADA standards. The handicapped access ramps at crosswalks and median openings need truncated domes for visually impaired users of the system.
- Relocate utility poles in the sidewalk on the westbound side of the street which presently obstruct travelers and do not comply with ADA requirements.

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- Add additional pedestrian benches on the North Common.
- Install a sprinkler system on the North Common to improve maintenance. This need was identified by the DPW Department. Similar systems have already been installed at other public spaces in Town.
- Improve maintenance of the existing sidewalk network, including timely snow and ice removal, in order to enhance pedestrian safety.

Route 3A (Princeton Street)

- Upgrade the existing sidewalks to meet ADA standards.
- Maintain existing sidewalks, and improve snow and ice removal.
- Trim trees that are currently obstructing directional and way finding signs.

Route 3A (Tyngsborough Road)

- Extend the existing sidewalk to Wellman Avenue (approximately 0.5 mile) to improve pedestrian access to Vinal Square.
- Upgrade existing sidewalk to meet ADA standards. Remove the stairs in the sidewalk and reconstruct with a system that complies with ADA requirements.
- Maintain existing sidewalk and improve snow and ice removal.
- Pavement is in poor condition with a PCI of 57. Pavement rehabilitation is needed.

Route 40 (Groton Road)

- Add a second stop line on Groton Road just west of the Dunstable Road intersection to provide additional storage for vehicles turning left from Dunstable Road.
- Add truncated domes at all sidewalk ramps to meet ADA standards.

Wotton Street

- Provide way finding signage and improve pedestrian access to Southwell Park.
- Construct a sidewalk where sufficient right-of-way can be secured.
- Pavement is in poor condition with a PCI of 54. Roadway resurfacing is needed.

Adams Street

- Extend the sidewalk through the neighborhood to connect Vinal Square to Varney Playground, the MacKay Library, and the residences.
- Pavement is in fair condition with a PCI of 72. Attention should be paid to preventive maintenance to preserve the life of the roadway surface.

B. Recommendations for Intersection Improvements

Route 3A (Princeton Street) at Middlesex Street

The crash rate for this intersection is well below the MassDOT District 4 average crash rate for an unsignalized intersection. However, this location experiences congested conditions, particularly during the evening peak period, as the main Vinal Square intersection traffic queues back up into the Route 3A/Middlesex Street intersection. This results in delays for turning vehicles on Middlesex Street. Improvements made at the main Vinal Square intersection would benefit operations at this location. Recommendations specific to this location include the following:

- Improve pavement markings at the crosswalk on Middlesex Street.
- Left turning vehicles from Princeton Street often cross over the left turn lane for Middlesex Street. The addition of pavement markings delineating the path for turning vehicles would help mitigate this situation.

Route 3A at Route 40/Wotton Street/Adams Street

The crash rate for this intersection is low when compared to MassDOT District 4 averages. However, the intersection is congested, with low levels of service for the Route 40 movement during each peak period, and unacceptable delays for southbound Route 3A movements during the evening peak period. Analysis has shown that operating conditions at this location could be improved by adding a right-turn lane on the Groton Road approach. This would require the elimination of three (3) on-street parking spaces. With this improvement the Groton Road movement will flow in conjunction with the Route 3A northbound left turn movement, allowing a reduction in the amount of green time needed for the Groton Road exclusive movements, which in turn reduces the delays for other movements. As shown in Table 14 on the following page, the implementation of this recommendation would improve the level of service for the overall intersection from LOS E to LOS C under existing conditions.

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Table 14: Intersection Capacity Analysis with an added right turn lane for Groton Road Eastbound

Approach Movement	AM Peak Hour		PM Peak Hour	
	LOS ¹	Delay (sec) ²	LOS ¹	Delay (sec) ²
Route 40 EB	C	25.5	D	39.0
Route 40 EB Right	D	43.1	D	44.3
Wotton St SB	D	41.9	D	42.9
Route 3A NB Left	C	22.6	B	19.7
Route 3A NB	B	13.8	B	12.8
Route 3A SB	D	38.7	C	27.0
Overall Intersection	C	31.9	C	24.3

¹ LOS = Level of Service

² Delay = control delay measured in seconds per vehicle

Other recommendations for this intersection include:

- Relocate the “Do Not Block Intersection” sign on northbound Route 3A to a location in advance of the intersection.
- Repair broken pedestrian signals at the intersection of Route 3A and Wotton Street and upgrade pedestrian crossing lenses to LED illumination.
- Repair missing back plate on Northbound Route 3A signal heads.
- Upgrade signal to include emergency vehicle signal pre-emption.

Route 40 at Dunstable Road

The intersection of Route 40 and Dunstable Road experiences a high crash rate when compared to MassDOT District 4 averages. The intersection is distinctly tied to the main Vinal Square intersection. Delays that occur at the main intersection cause queues on Groton Road, which in turn create queues on Dunstable Road. Recommendations for this intersection include:

- Add a stop line for Groton Road at Route 3A west of the Dunstable Road intersection, allowing traffic from Dunstable Road to turn left onto eastbound Groton Road at the intersection. Update signage and pavement markings at the new stop line.

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- Install a pedestrian crosswalk for those crossing Groton Road to access residences and businesses on Dunstable Road and in the Vinal Square neighborhood.

C. Bicycle and Pedestrian Accommodation Recommendations

There are a number of opportunities to improve bicycle and pedestrian accommodations throughout Vinal Square. There is sufficient right-of-way to install a bicycle lane within the Square. However, in order to obtain the right-of-way needed for a bike lane on each side of the roadway, it would be necessary to eliminate on-street parking on one side of the street. Given the comments that were received during the public input process for the Master Plan, it is likely that any proposal to remove on-street parking would not be well-received by the business community. Other bicycle and pedestrian accommodation recommendations for the area include the following:

- Repair and upgrade pedestrian signals at crosswalks;
- Install “Share the Road” signs and include “sharrow” pavement markings along the travel lanes;
- Install additional bike racks at the MacKay Library, Varney Playground, Southwell Park, Ayotte Field, the municipal parking lot and on the North Common;
- Make improvements to existing sidewalks to bring them up to ADA standards;
- Install sidewalks from Wellman Avenue to Vinal Square to connect the sidewalk network;
- Install sidewalks on residential streets to link the neighborhood to the Vinal Square business area;
- Establish a town “Complete Streets” policy to provide accommodations for all roadway users on future roadway reconstruction projects, where possible and practical;
- Enforce the sidewalk snow removal bylaw;
- Install signage on Adams Street designating the road as a bike route between Varney Playground, residential areas, and the Vinal Square businesses;
- Install share the road markings and signage on Groton Road;
- Consider installing a bike lane on Middlesex Street leading into Vinal Square from the east. Close to the Square, a share the road designation may be required, assuming that the Town wishes to retain on-street parking
- Pavement markings on Tyngsborough Road could be altered to allow for two 11-foot travel lanes and a 4-foot bike lane on each side. In the Square, narrowing the travel lanes to 12 feet would provide the necessary width to include a bike lane.
- Consider installing a bicycle lane on Princeton Street south of Middlesex Street, where there is available roadway width. In the Square itself, share the road markings would likely be a more reasonable option due to the presence of on-street parking and turning lanes.
- Establish a streetscape program that includes street trees, street furniture, and pedestrian scale lighting; and

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- Include Vinal Square as part of the future town-wide Bicycle and Pedestrian Plan.

D. Parking

As discussed earlier, there does not appear to be a need for additional parking in Vinal Square. Observations made during site visits found that parking was always available. Parking occupancy averaged 50% over the course of the day, with occupancy levels reaching 70% during evening peak traffic hours. It was noted that there are significant commercial vacancies within the Square. Should additional businesses reoccupy these spaces or if the proposed commuter rail station becomes a reality, there could be a significant increase in the demand for parking. The Town of Chelmsford should closely monitor business development in Vinal Square, and, depending on future development activity, there may be a need to re-evaluate parking demand and utilization.

E. Commuter Rail Station Traffic Impacts

As discussed in Section III of this report, the additional 1,000 vehicles per day accessing the proposed commuter rail station by 2025 would be distributed between Wotton Street and the proposed new access road located north of Vinal Square on Route 3A. In general, the roadway network can handle the added traffic volume, but during the peak periods delays would increase throughout the study area. During the existing P.M. peak hour, the Wotton Street approach to Vinal Square operates at LOS E. Given that 90% of traffic at the new station is vehicle-related, it is estimated that 100 additional vehicles would be added in the peak fifteen-minute period occurring within the afternoon peak hour. This would degrade the level of service for the Wotton Street approach from LOS E to LOS F and require mitigation.

Should the traffic improvements previously outlined for the Groton Road intersection be implemented, the traffic impacts of the station would be less significant than under current conditions. Adding a right-turn lane on the Groton Road approach would reduce the amount of green time needed for the Groton Road exclusive movements, which in turn would reduce the delays for other movements. As shown in Table 15 on the following page, with these improvements in place and assuming that the commuter rail station is constructed off Wotton Street, by 2025 the main Vinal Square intersection will function at LOS E in the A.M. peak hour and LOS D in the P.M. peak hour. Without these improvements, the intersection would function at LOS F in both the morning and evening peak periods under these conditions, as shown in Table 11 on page 38.

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Table 15: Intersection Capacity Analysis with added right turn lane for Groton Road eastbound, 2025 Conditions

Approach Movement	AM Peak Hour		PM Peak Hour	
	LOS ¹	Delay (sec) ²	LOS ¹	Delay (sec) ²
Route 40 EB	D	47.6	D	40.4
Route 40 EB Right	D	52.3	D	38.7
Wotton St SB	D	53.4	D	52.3
Route 3A NB Left	C	26.0	D	52.4
Route 3A NB	B	11.7	B	18.7
Route 3A SB	F	159.1	D	54.0
Overall Intersection	E	77.4	D	39.3

¹ LOS = Level of Service

² Delay = control delay measured in seconds per vehicle