

Exit 36 Study Area

Existing and Future Conditions



August 2014



A joint project of the Nashua Regional Planning Commission and the
Northern Middlesex Council of Governments



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I. Executive Summary

As a vibrant commercial and residential district bustling with shoppers, office workers and residents, the Exit 36 area of South Nashua, New Hampshire and Tyngsborough, Massachusetts represents one of New England's most dynamic mixed-use corridors. Located approximately four miles from Downtown Nashua and ten miles from Downtown Lowell, the Exit 36 study area is located off U.S. Route 3 and strategically situated between two regionally significant urban areas.

While the corridor has enjoyed significant development and economic success, it has incurred significant challenges in the form of peak hour and seasonal traffic congestion along Daniel Webster Highway, Middlesex Road and Spit Brook Road.

The Exit 36 interchange lies just south of the New Hampshire border in Tyngsborough Massachusetts. The ramp system terminates/originates at the signalized intersection with Middlesex Road and the Pheasant Lane Mall. The current configuration of the interchange provides for all movements except for southbound Route 3 traffic.

The Exit 36 Southbound Planning Study provides an analysis and summary of the potential benefits to regional traffic and economic development that would be realized by constructing a Route 3 southbound off ramp at Exit 36. This study was funded by the Federal Highway Administration through the Transportation System and Community Preservation (TCSP) Grant Program.

The Exit 36S off ramp significantly improves operating conditions along the major roads in the study area, by relieving traffic congestion and delay, reducing greenhouse gas emissions, improving travel times, and decreasing lost productivity. The project enhances the effectiveness of public transportation and supports future passenger rail service. The southbound ramp and related improvements will provide more efficient access to services, area business establishments, and local and regional job centers. The proposed improvements will also generate opportunities for sustainable growth and serve as a catalyst for future economic development and community investment. The bi-state aspect of the project provides exceptional opportunities for innovative financing, interstate cooperation and coordination, and public/private partnerships.

The Exit 36 Southbound study presents several desired outcomes that address livability and integrate transportation, community and system preservation plans and practices, including the following:



A. IMPROVE THE OPERATION OF THE MAJOR ROADS IN THE VICINITY OF THE PROPOSED EXIT 36 SOUTHBOUND RAMP

Reduced Congestion

The construction of the southbound off ramp at Exit 36 will result in a substantial reduction in traffic volume on Spit Brook Road east of the F.E. Everett Turnpike and Daniel Webster Highway, by providing an efficient and direct alternative for travelers seeking to access the Pheasant Lane Mall and other retail and commercial land uses along southern D. W. Highway and the northern reaches of Middlesex Road. The 24- hour traffic volumes are forecast to decrease by an average of 9 percent on Spit Brook Road east of the F.E. Everett Turnpike, and by an average of 20 percent on D.W. Highway south of Spit Brook Road.

Reduced Intersection Delay

The retail nature of development in the study area results in heavy traffic on Saturdays and during the holiday season. With Exit 36 Southbound in place, eastbound travelers on Spit Brook Road and Daniel Webster Highway will spend less time idling at traffic lights. At Danforth Road, for example, Saturday peak hour southbound volume will drop from 1,490 vehicles to 698 vehicles with Exit 36S in operation. In addition, the southbound delay per vehicle improves from 221 seconds to 48 seconds. Operations for southbound traffic flow at Danforth Road improve from Level of Service F to Level of Service D.

B. ADDRESS ALL MODES OF TRANSPORTATION

Opportunity to Improve Transit

The construction of Exit 36S will provide transit service with direct access to commercial and residential destinations in the study area. Reduced congestion along Spit Brook Road and Daniel Webster Highway will improve the efficiency of existing service and potentially allow for increased service frequency.

Exit 36S facilitates possible expansion of transit service in the study area, including:

- Connections between Nashua Transit System and the Lowell Regional Transit Authority (LRTA)
- Express service directly linking the Merrimack Outlets, Exit 8 Park and Ride lot and Pheasant Lane Mall
- Implementation of the proposed Daniel Webster Highway Circulator Service, linking many retail destinations in the study area



Opportunity for Passenger Rail

Exit 36S will influence the location of passenger rail facilities in south Nashua, should service be implemented. The Capitol Corridor Study is evaluating two potential south Nashua rail station locations: the former Hampshire Chemical site off Spit Brook Road and the Pheasant Lane Mall at the Massachusetts border.

The effectiveness of a passenger rail and intermodal facility near the Pheasant Lane Mall largely depends upon the development and construction of an Exit 36 southbound off ramp. A new Exit 36S off ramp will provide direct access for passenger rail users and allow for quick and efficient bus service connections from the Nashua Transit System.

A station located at the Dow Chemical site would benefit by reduced congestion levels on Spit Brook Road. This site is also in close proximity to a concentration of multifamily residential developments, increasing the likelihood of individuals accessing the proposed station by a non-motorized means of transportation.

It is recommended that both Nashua and Tyngsborough consider zoning changes in this area to support Transit Oriented development and accommodate the possibility of passenger rail returning to the region.

Bike and Pedestrian Improvements

The Nashua portion of the study area accommodates more than 5,900 residents in approximately one square mile. Most live within walking or biking distance of retail and commercial amenities, and a potential passenger rail station. Current conditions along the Daniel Webster Highway and Spit Brook Road do not encourage the use of non-motorized, active transportation.

The Exit 36S project offers multiple opportunities to reimagine the Daniel Webster Highway and Spit Brook Road Corridors as pedestrian friendly boulevards. The reduced traffic volumes along these major corridors are the starting points for a revitalized active transportation strategy. Opportunities include:

- Reconstructing substandard sidewalk infrastructure to improve overall accessibility and meet ADA standards.
- Develop public-private agreements to implement pedestrian and bicycle connections between existing developments.
- Improve existing pedestrian crossings and consider grade separated pedestrian overpasses to improve safety and minimize impact on traffic flow.
- Investigate opportunities to provide bicycle access from the north and south via on road and off road infrastructure.



C. IMPROVE ACCESSIBILITY TO LOCAL AND REGIONAL JOB CENTERS

Access to Jobs

The Exit 36S off ramp provides direct access to major regional employers located along the southern Daniel Webster Highway in Nashua and northern Middlesex Road in Tyngsborough. More than 22 percent of all jobs in Nashua are located within the one square mile that makes up the study area in South Nashua. The Exit 36S off ramp will enhance access to these jobs through reduced congestion and a direct link to the DW Highway and Middlesex Road Corridor. Reduced congestion on Spit Brook Road improves access to Gateway Hills/ Nashua Technology Park which is anticipated to employ more than 1,900 workers when fully built out. It also improves access to the Dow Chemical site which is a 40-acre parcel with the potential to provide additional retail and commercial jobs.

D. GENERATE OPPORTUNITIES FOR SUSTAINABLE GROWTH AND ECONOMIC DEVELOPMENT

Land Use Opportunities

In Nashua, Exit 36S preserves capacity on the existing road network. This, combined with sustainable redevelopment practices, will ensure that the area remains an economic driver well into the future. The project supports the Gateway Hills Development and enhances the opportunity for development at the former Dow Chemical site. Reduced congestion along Daniel Webster Highway will support low vacancy rates and attract redevelopment opportunities.

As previously mentioned, the study area in Nashua is already home to nearly 5,900 residents, with the possibility of an additional 800 residents in the Gateway Hills Development. The concentration of residential development in close proximity to retail and commercial amenities provides the opportunity to provide a livable, walkable suburban environment that supports the local economy. Reduced traffic volumes, potential transit enhancements, and active transportation amenities made possible by Exit 36S will promote sustainable growth and encourage economic development.

In Tyngsborough, Middlesex Road from the Town Center north to the New Hampshire state line is viewed by the Town as a future commercial corridor, with a special focus on restaurant development. Exit 36S plays a critical role in realizing this vision. In addition, the construction of sewer infrastructure would be advantageous in terms of attracting this type of “Restaurant Row” style development.



E. INITIATE NEW OPPORTUNITIES FOR INNOVATIVE FINANCING AND PUBLIC/PRIVATE PARTNERSHIPS

Funding Sources

From a transportation perspective, the Exit 36S project is unique as the majority of the construction falls in Massachusetts while the majority of the traffic benefit is realized in New Hampshire. A project of this scope and nature will likely require federal funding. With limited transportation funds available in both states, innovative financing opportunities need to be explored to support federal investment in the project. In addition to state and local funding, opportunities need to be explored to involve private sector investment. Developments along Middlesex Road could support a portion of the match for the project.

In New Hampshire, concepts such as Tax Increment Finance districts could be considered to help raise revenue for local match. In Tyngsborough, concepts such as a Business Improvement District may be more appropriate approach to generate matching funds. To the extent the Exit 36S project is connected to future passenger rail service, private investors interested in Transit Oriented Development opportunities could make contributions to support the project which directly benefits their development.

F. DEMONSTRATE REDUCTION IN TRAFFIC CONGESTION AND GREENHOUSE GAS EMISSIONS ASSOCIATED WITH THE TRANSPORTATION SECTOR.

Travel Time

On an average day, it is estimated that vehicle trips from the north passing through the intersection of the Exit 36 ramps at the southern Pheasant Lane mall entrance will save up to 7 minutes in travel time. Using a conservative estimate of one passenger per vehicle, an annual cost savings of \$2 Million dollars per year will be realized by eliminating lost productivity.

Fuel Usage

Comparing current travel time from Exit 1 to the intersection of the Exit 36 ramps at the southern Pheasant Lane mall entrance with the travel time estimate under the Build Scenario shows a typical time savings of approximately 7 minute per vehicle. Based on travel time, average speed, fuel economy data, and an estimated fuel cost of \$3.75 gallon, the construction of Exit 36S could save as much as \$333,000 per year.



Reduction in Greenhouse Gas Emissions

The fuel savings realized by developing Exit 36S contributes to a reduction on Carbon Dioxide (CO₂) emissions. CO₂ is a greenhouse gas and widely accepted as a contributor to climate change. With Exit 36S constructed conservative estimates place fuel savings in the range of 89,000 gallons per year, with a corresponding reduction in CO₂ emissions of 1.8 Million pounds per year.

Cost Estimate

A planning level project cost estimate was developed for a loop ramp concept on the west side of U.S. Route 3 Southbound with bridges crossing over the highway ending in an at grade intersection at Middlesex Road. A simple breakdown of the cost estimate is shown below in Table ##.

Exit 36S Off Ramp Planning Level Estimate	
Project Component	Cost
Roadway Construction	\$ 10,104,563.00
Bridge Construction	\$ 2,340,000.00
Preliminary Engineering and Permitting	\$ 2,055,000.00
Construction Engineering	\$ 1,244,456.00
Total	\$ 15,744,019.00
Rounded Estimate (2014 dollars)	\$ 16,000,000.00
Inflated Estimate (2020 dollars)	\$ 19,850,000.00

The cost estimate is shown in 2014 dollars and does not include the cost to acquire the necessary Right of Way to construct the project. Assuming construction begins in 2020 and using a 4% inflation factor as recommended by the FHWA, the cost of the project is expected to be approximately \$20M.

Recommendation and Implementation Strategy

It is recommended that Massachusetts and New Hampshire officials continue to collaborate and advance the project by building political and community support, and pursuing multiple funding options for environmental permitting, right of way acquisition, engineering, design and construction.

This study documents benefits to both Tyngsborough and Nashua. The proposed ramp will result in significant improvements to traffic operating conditions in Nashua and will support existing businesses as well as important statewide initiatives, such as passenger rail. In Tyngsborough, improved accessibility will result in greatly enhanced economic development opportunities along Middlesex Road.

The footprint of a future Exit 36S off ramp will lay almost exclusively in Massachusetts. With the



significant benefits the project brings to New Hampshire it is important for leadership in both states work cooperatively to advance the project. A project of this magnitude will require multiple funding sources. The following steps will need to be taken to advance the project:

- Local and regional leaders must cooperatively seek support of State Executive Branch and present the benefits of the project.
- Begin early coordination with Massachusetts Department of Environmental Protection and the Massachusetts Natural Heritage Program
- State and local officials will need to work jointly with the Federal delegation from both States to identify funding sources to support the Environmental Permitting, Engineering, Design, Right of Way, and Construction costs. Sources may include:
 - Federal Highway Administration (STP, CMAQ, Interstate Maintenance, National Highway, Bridge funding)
 - TIGER grant funding
 - Federal Transit Administration
 - EDA Public Works funding
 - State and Local Matching funds
 - Private developer contributions
 - Determine the relationship between Exit 36S and Passenger Rail
 - Consider establishing TIF or BID districts to support local match for both projects.
 - Transit Oriented Development – Massachusetts Funding sources
- Add the project to the Northern Middlesex Council of Governments and Nashua Regional Planning Commission Transportation Improvement Program
- Initiate the Environmental permitting process, Engineering, Design and Right of Way Acquisition.
 - Cost of Environmental and Engineering study estimated to be \$2.1 M
 - Duration of permitting and Design is estimated to be 2 - 3 years
- Construct the Exit 36S off ramp
 - Preliminary cost estimate \$16M in 2014 dollars
 - Construction duration approximately 2 years



II. Existing Conditions



Thriving with shoppers, office workers and residents, the Exit 36 area of South Nashua, New Hampshire and Tyngsborough, Massachusetts represents one of New England's most dynamic mixed-use corridors. Located approximately four miles from Downtown Nashua and 10 miles from Downtown Lowell, the Exit 36 study area is strategically situated between two regionally significant urban areas.

An economic driver for the region, more than 22 percent of all jobs in Nashua are located within the one square mile that makes up the study area in South Nashua.¹ Driven by the success of the Pheasant Lane Mall, retail uses have proliferated along the Daniel Webster Highway and Spit Brook Road corridors, while major regional employers, including many technology-based companies, retain a significant presence in the area. A substantial number of residential uses, largely made up of compact multi-family structures, also occupy large swaths of the study area.

While the corridor has enjoyed significant development and economic success, it has incurred some challenges as well. Traffic congestion along Daniel Webster Highway, Middlesex Road and Spit Brook Road presents a significant and chronic regional concern. Though the area includes a diverse mix of land uses, the automobile-dominant nature of the area's transportation infrastructure and development design profile make walking or cycling trips in the area unpleasant and challenging. Finally, there are many opportunities to improve public transit coverage and service connections between the regionally significant cities of Lowell and Nashua.

The planning of a southbound exit ramp from U.S. Route 3/F. E. Everett Turnpike at Exit 36 presents an important opportunity to evaluate existing conditions relating to zoning and land uses, traffic conditions, pedestrian and bicycle infrastructure, and transit access and availability in the study area.

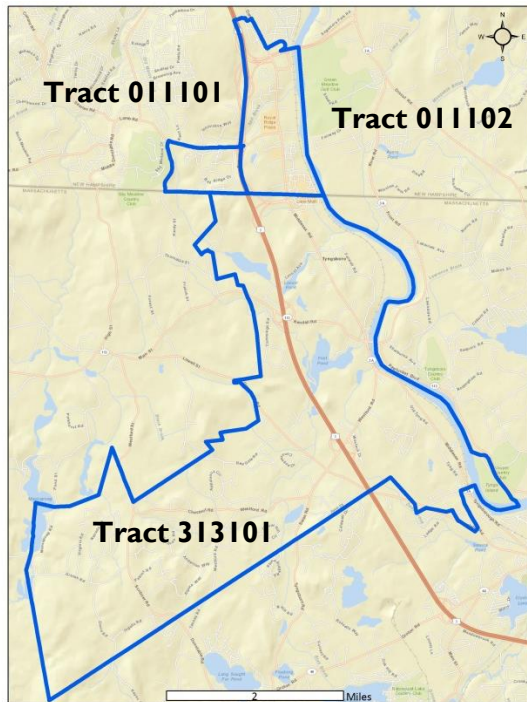
¹ U.S. Census Bureau. 2013. OnTheMap Application. Longitudinal-Employer Household Dynamics Program. <http://onthemap.ces.census.gov/>, all primary jobs for the year 2011.



A. DEMOGRAPHIC PROFILE

A review of Census records indicates that South Nashua and Western Tyngsborough, while geographically close, boast very divergent demographic profiles. South Nashua residents are younger, more racially diverse, and much more likely to live in a rental unit and multi-family housing. Western Tyngsborough residents are more affluent, more likely to have children, and much more likely to live in a single-family house. The two areas do share several similarities, including low poverty rates, and very

MAP 2.1: STUDY AREA CENSUS TRACTS



well educated populations. While South Nashua residents are much more likely than their peers in Tyngsborough to utilize alternative travel modes for commuting trips, more than 82 percent travel alone by car. Census tracts 011101 and 011102, which include all of the study area in Nashua as well as land between Spit Brook Road and the Sagamore Bridge, were used to measure conditions in South Nashua. Census tract 313101, which includes all of Western Tyngsborough, was used to measure conditions in the study area of Tyngsborough.

South Nashua

South Nashua boasts a larger share of young adults in the 25-34 demographic than any other census tract in New Hampshire, save for an area of Downtown Portsmouth. Approximately 27 percent of residents in South Nashua fall within this age demographic. Additionally, the area's median age of 33.2 is well below medians for the city as a whole (39.5) and the state (41.1). It is likely that the area's close proximity to the F.E. Everett Turnpike/Route 3, convenient access to employment centers along the Route 128 corridor of Massachusetts, and the high number of major employers in the South Nashua area itself contribute to make South Nashua attractive for young adults. Moreover, the compact nature of housing stock in the area - Census records indicate that more than 70 percent of housing units are renter-occupied and that approximately 90 percent are located within structures containing 5 or more residential units – helps the area remain accessible to young adults. Fewer than 3 percent of housing units in South Nashua are single-family homes.

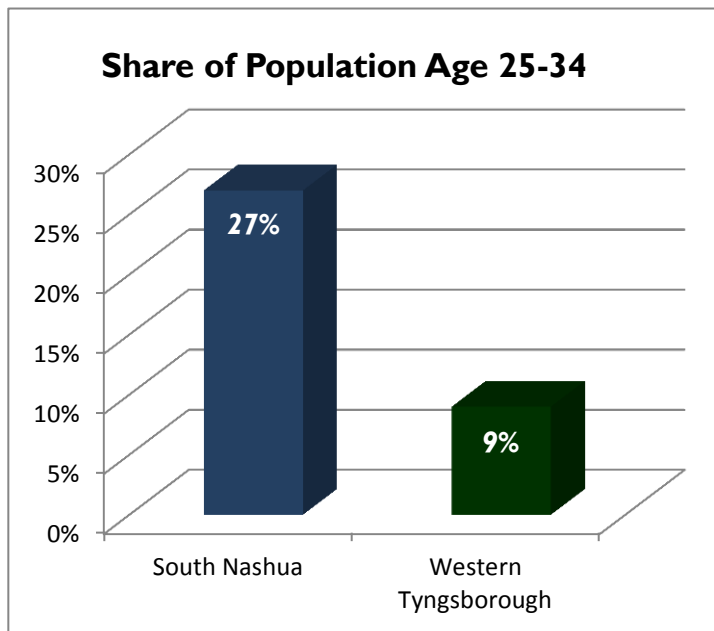


A Census analysis also indicates that South Nashua is significantly more densely populated and its residents more racially diverse, and more likely to have advanced degrees, than their counterparts across the state. According to the 2010 Census, 6,497 residents live within a land area of only 1.1 square miles in South Nashua.

Census records indicate that the median household income in the area is \$52,668, which is well below the state median of \$63,277. However, with fewer than two people per household, the average household size is below the state average of 2.5 people per household. Additionally, the poverty rate is 5 percent, which is below the New Hampshire rate of 7.8 percent.

An analysis of commuting patterns from the 2006-2010 American Community Survey indicate that residents are slightly more likely to utilize alternative travel modes, while approximately 81.9% commute alone by car. Nearly 55 percent of households have only one vehicle, and 5.2 percent have no vehicle at all. The average commuting trip time of 24.6 minutes is nearly identical to the state average.

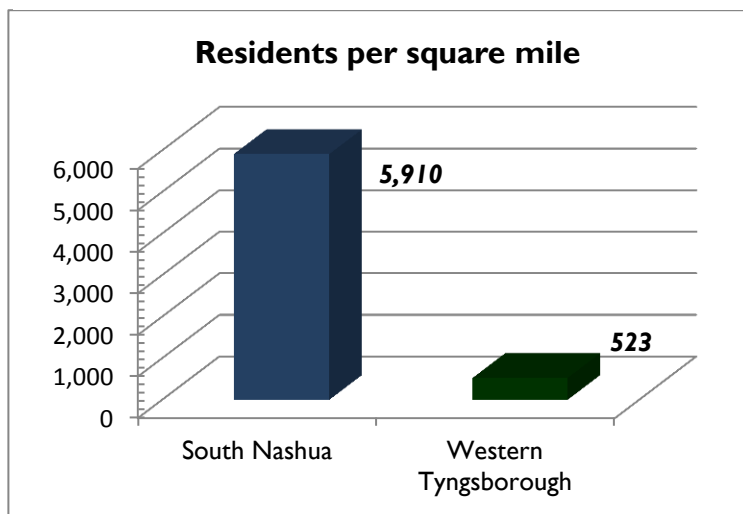
TABLE 2.1: SHARE OF POPULATION AGE 25-34



Western Tyngsborough

A Census analysis of western Tyngsborough reveals an older, more affluent, and more racially homogeneous population. The median age is 40.1 and only 8.7 percent of the population are members of the age 25-34 demographic. The average household size is 2.85, likely indicating more families with children than in the Nashua census tracts. Only 8.7 percent of residents fall within the age 25-34

TABLE 2.2: RESIDENTS PER SQUARE MILE



demographic. Single-family homes make up more than 80 percent of the housing supply and only 11.5 percent of units are occupied by renters.

Tyngsborough is significantly less densely developed than South Nashua. The 5,488 residents of Western Tyngsborough are spread across an area of approximately 10.5 square miles. In South Nashua, 6,497 residents live within a land area of only 1.1 square miles. This indicates a much less intense development of the land in Tyngsborough.

The median household income, at \$106,111, is more than double the median for the Nashua census tracts and significantly higher than the Massachusetts median of \$64,509. Just 1.2 percent of residents in Western Tyngsborough fall below the poverty line, a rate well below the statewide poverty rate of 10.6 percent. Residents are much less likely to utilize alternative travel modes for commuting trips than their Massachusetts counterparts. More than 92 percent of residents commute alone to work, compared to 72.6 percent statewide, and more than 82 percent of households have two or more vehicles. The average commute time of 30.6 minutes is approximately five minutes longer than for those in the Nashua census tracts.



B. ZONING

Both the City of Nashua and the Town of Tyngsborough employ zoning regulations on land surrounding the proposed Exit 36 South project. There are nine zoning districts across the study area accommodating a significant range of land uses. See Map 2.2 for zoning district boundaries.

Nashua

All development on the New Hampshire side of the study area falls under five zoning district designations implemented by the City of Nashua: Urban Residence; Park Industrial; General Industrial; Highway Business and General Business. The following descriptions are taken from the City of Nashua Land Use Code.

Urban Residence: The urban residence designation is utilized in well-established areas of the city, particularly for areas surrounding the urban core. The district permits all residential types by right, provided dimensional requirements are met. Some limited commercial uses are allowed in the Urban Residence district, particularly if such uses are located in the same structure as the residential uses, either by right, conditional or accessory use or special exception. Approximately 28 percent of land in the study area is zoned as Urban Residential.

Highway Business: The Highway Business designation is used for commercial areas located adjacent to major arterials. Approximately 11 percent of land in the study area is zoned as Highway Business.

General Business: The General Business designation is similar to the Highway Business District in purpose and function but requires a smaller minimum lot size. Areas with this designation tend to be developed as shopping centers with large parking areas rather than 'strip' commercial development. Approximately 22 percent of land in the study area is zoned as General Business, in areas located along the Spit Brook Road and Daniel Webster Highway corridors.

Park Industrial: The Park Industrial designation is utilized for light industry and industrial parks. The districts typically abut highway interchanges and residential areas. Approximately 35 percent of land in the study area is zoned as Park Industrial, centralized in the areas surrounding the Nashua Technology Park and the BAE Systems facility.



General Industrial: The General Industrial designation is more conducive to heavy industry uses. Such areas are generally found in older areas of the city or adjacent to the Merrimack and Nashua Rivers. Approximately 4 percent of land in the study area is zoned as General Industrial, all of which is located at the eastern end of Spit Brook Road.

Current land uses are largely consistent with the zoning designations in the study area, with a few minor exceptions. Three lots on the south side of Spit Brook Road are currently occupied by commercial uses, though the area is zoned as Urban Residential. Additionally, the area surrounding Tara Boulevard is occupied by commercial uses though the area is zoned as Park Industrial.

The City of Nashua has also implemented a Transit-Oriented Overlay District, which the city would consider applying to portions of the study area should commuter rail service be extended to the area. The overlay district requires higher residential densities and more pedestrian-oriented building and site designs than is required under the city's traditional zoning districts.

Tyngsborough

Tyngsborough demarcates four zoning districts within the study area: Residential I Low Density (R-1); Business 2 Office/Professional (B-2); Business 3 General Shopping (B-3); and Industrial I Light (I-1). The B-3 zone occupies both sides of Middlesex Road from the N.H. border to Bryant Lane (several parcels along Middlesex Road are split-zoned and include B-3 zoning as well as either I-1 or R-1). Along the N.H. border, the B-3 zone extends from Route 3 to the Merrimack River. Much of the area between Middlesex Road and Route 3 is zoned I-1, while the area to the west of Route 3 is primarily zoned R-1 (the one exception is an area zoned I-1 surrounding Business Park Drive). Much of the area east of Middlesex Road and primarily south of its intersection with Locust Avenue is also zoned R-1. Tyngsborough Center, in the southeastern portion of the study area, is zoned B-2. See Map 2.2 for exact zoning boundaries.

Residential I Low Density: Uses in the Residential I District are limited to single-family residential dwellings as well as municipal structures, cemeteries, recreational areas and agriculture. Structures in this zone are subject to a minimum lot area requirement of 65,000 square feet or 1.14 acres, frontage of at least 200 feet and must be no taller than 2.5 stories. The town's Open Space residential regulations allow for smaller lots provided that land is set aside for open space.



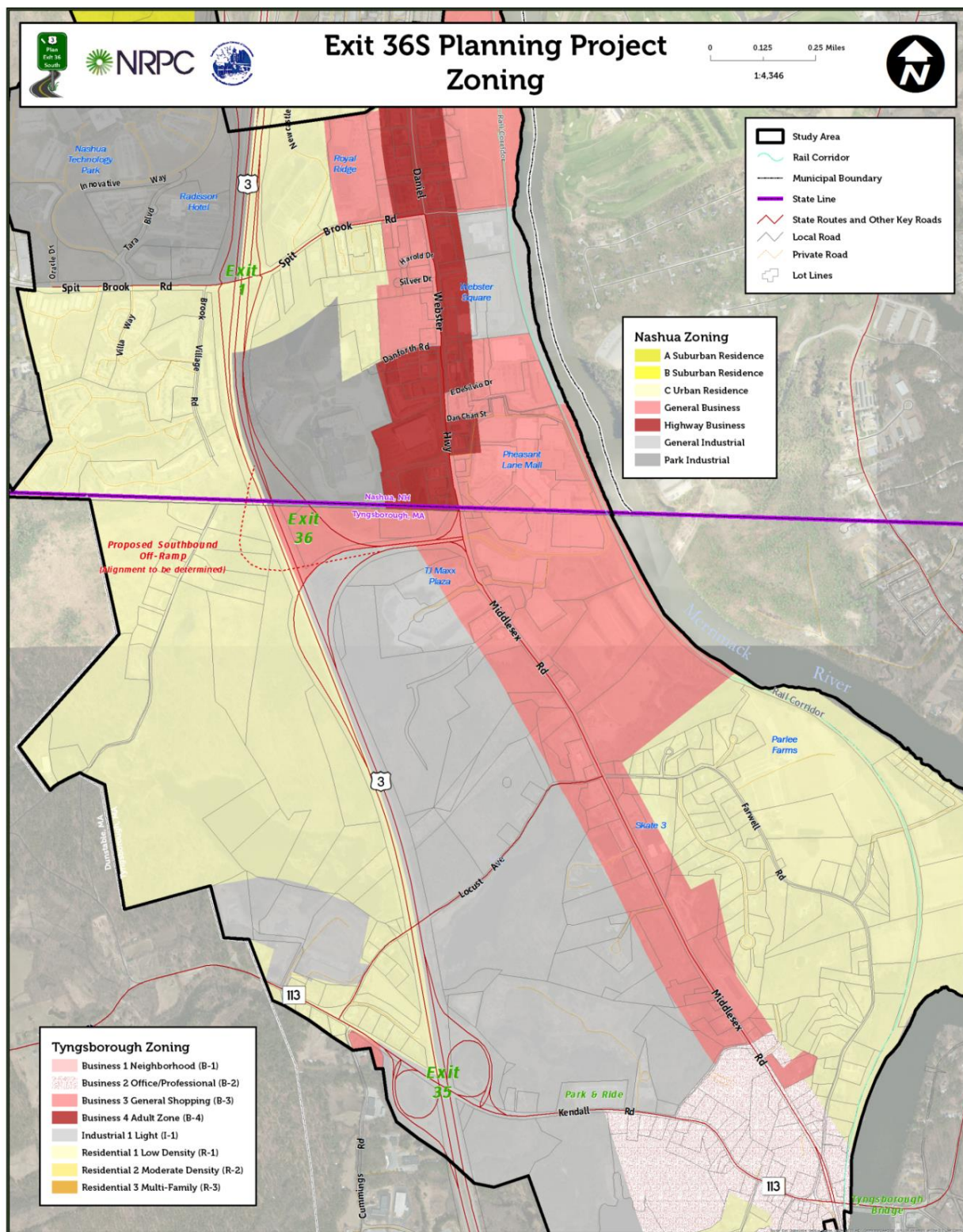
Business 2 Office/Professional: Uses in the Business 2 District are limited to small retail stores and some commercial uses like studios, veterinarian clinics or funeral homes, as well as agriculture, religious facilities and municipal facilities. Many uses, like small professional structures, not fast-food restaurants, pubs or lounges and daycare facilities, are allowed with a special permit. Residential and industrial uses are not permitted.

Business 3 General Shopping: A significant range of commercial and professional uses are permitted in the Business 3 General Shopping District. A small number of commercial uses, including gas stations motor vehicle repair and sales shops, lounges and pubs, and amusement facilities, are allowed only with a special permit. Residential and most industrial uses are not permitted.

Industrial I Light: Uses in the Industrial I District are limited to light industrial uses, including manufacturing facilities. Residential uses and most commercial uses are prohibited. Most heavy industrial uses, including junkyards and major distribution centers, are also prohibited.



MAP 2.2: STUDY AREA ZONING DISTRICTS



Existing Conditions



C. UTILITIES

While major commercial and residential corridors in South Nashua are served by sewer, much of the study area in Tyngsborough is not. Tyngsborough officials have long recognized the town's lack of sewer access, particularly on Middlesex Road near the New Hampshire border, as a continued barrier to economic growth.

Currently a small number of Tyngsborough businesses, located on the east side of Middlesex Road and situated very close to the Nashua border are connected to the Nashua Sewer System via an extension from the Pheasant Lane Mall. The mall has its own pump station and these businesses are located on the periphery of the mall's southern parking lot, which is also located in Tyngsborough.

Several businesses on the west side of Middlesex Road approached the City of Nashua in 2013 regarding the possibility of connecting in to the city's sewer system. To do so, they would need to provide design documents and estimated flow to the city. A pump station would also need to be constructed on the west side of Daniel Webster Highway to connect in with the City of Nashua sewer system. The applicant(s) would need to pay for these improvements.

Tyngsborough receives water service from a number of sources including from Pennichuck Water Works in Nashua, the Tyngsborough Water District, the Dracut Water Supply District, and the North Chelmsford Water District. Within the study area, there is a gap in water service in the vicinity of Bryant Road.

The area just south of the Pheasant Lane Mall in Tyngsborough has been proposed as one possible location for a multi-modal transit station, should commuter rail service be extended to the area. The NH Department of Transportation has contracted with URS Corporation to conduct an alternatives analysis of potential rail and transit investments in New Hampshire, including possible station locations. Though currently not serviced by sewer, the location's close proximity to the Pheasant Lane Mall would likely make a sewer extension feasible with some investment.

Moving forward, the City of Nashua plans to develop a capacity analysis for future sewer needs, which may include researching possible linkages with Tyngsborough. Nashua officials have articulated a willingness to work with Tyngsborough officials to address sewer needs. The Town of Hudson, NH, located across the Merrimack River from the study area, may also be a potential partner with which to address sewer needs.



D. LAND USES

Development in the study area is largely concentrated in Nashua, itself remarkably mixed-use in nature with few vacant parcels remaining. Development opportunities are prevalent in Tyngsborough, where a large number of vacant parcels remain. However, the community is somewhat handicapped in attracting commercial development as retail activity tends to concentrate in New Hampshire, because of the state's lack of a state sales tax on retail purchases. Tyngsborough has largely focused most of its economic development efforts in attracting industrial and restaurant uses, capitalizing on the lower meals tax rates in Massachusetts than New Hampshire. Several restaurants have already congregated in northern Tyngsborough near the Nashua border.

Nashua Land Use Profile

The New Hampshire section of the planning study area includes a fairly dense conglomeration of commercial, industrial and residential uses. The area west of the F. E. Everett Turnpike and south of Spit Brook Road is almost entirely residential in nature, consisting of several large multi-unit developments. Just north of this area (west of U.S. Route 3 and north of Spit Brook Road), commercial and industrial uses are most prevalent. Many of the area's large employers, a number of high technology firms among them, are located in this area principally within the Nashua Technology Park.

There are approximately 798 acres in the Nashua portion of the study area. Of that land area, 258.9 acres, or 32.5 percent of the study area accommodates industrial uses. Commercial uses make up 249.5 acres, or 31.3 percent of the study area. Residential uses cover 195.2 acres, or 24.5 percent of the study area. Approximately 60.5 acres, or 7.6 percent of the study area, is vacant while 33.8 acres or 4.2 percent of the area is utilized by right of ways.

TABLE 2.3: EXISTING LAND USES, NASHUA

Land Use	Acres	Share of Study Area
Industrial	258.9	32.5%
Commercial	249.5	31.3%
Residential	195.1	24.5%
Vacant	60.5	7.6%
Right of Way	33.8	4.2%

The area to the east of the F.E. Everett Turnpike is heavily developed and includes a significant mix of commercial, residential and industrial uses. Retail uses are most conspicuous, as shopping centers maintain an almost continuous presence directly on the main corridors of Spit Brook Road and Daniel



Webster Highway. Chief among those is the Pheasant Lane Mall, a 1 million square-foot indoor shopping center, located a very short distance from the Tyngsborough, Massachusetts border (the mall's southern parking lot is located in Tyngsborough itself).

Development along Daniel Webster Highway intensified after the construction of the mall, which opened in 1986. New Hampshire's lack of a state sales tax helped the shopping center prove a powerful draw for out-of-state residents and the mall proved financially successful. The nearby major shopping centers of Webster Square and Willow Springs Plaza opened in 1990 and 1991 respectively, cementing the area's status as a major retail destination. Today, retailers maintain an uninterrupted presence on Daniel Webster Highway from the Massachusetts border well beyond its intersection with Spit Brook Road. Additionally, there is a significant residential presence located just west of the roadway, centered on minor cul-de-sacs like Danforth and Silver Drives. Spit Brook Road also accommodates several residential uses, including the large Royal Crest Estates development on the north side of the roadway. All residential uses east of the F.E. Everett Turnpike are housed in multi-unit structures.

The Nashua Technology Park dominates the northwestern quadrant of the study area. The park features a number of industrial and office buildings, as well as a major hotel, situated in a park-like industrial environment. The park serves as a major employment center for both the city and the surrounding region.

Most development along the major arterials in the study area feature significant setbacks with large surface parking lots. This development profile helps contribute to the automobile-dominant nature of the study area. However, some exceptions do exist. A furniture store at the corner of Spit Brook Road and Daniel Webster is situated closer to the roadway with comfortable pedestrian amenities and no parking in the setback. The Royal Ridge Shopping Center also features a separate pedestrian right of way offering direct access to the structure.

The study team consulted with City of Nashua planning staff as to the status of city design codes in the study area. The city does not currently have any guidelines or regulations regarding building design or parking placement specific to South Nashua. However, other districts of the city, including Downtown Nashua, do have design guidelines in place. Additionally, sidewalks are mandated in front of developments in areas where no sidewalks exist. Sidewalks are typically straight rather than curvilinear in design because they are less expensive to install and maintain and take up less room on site. Nashua officials have indicated a willingness to work with applicants to improve site design and pedestrian circulation in South Nashua.

The city indicated that if rail service is extended to the study area, design standards would likely be



instituted in the area and pedestrian circulation would become a significant priority. According to Census records, 6,497 residents live in a 1.1 square mile area making up the study area in South Nashua.

Tyngsborough Land Use Profile

Tyngsborough's portion of the study area is much less heavily developed than the Nashua portion. Many areas, particularly Locust Avenue and Farwell Road, retain a rural and agricultural character. Many vacant commercial and industrial parcels remain undeveloped along Middlesex Road. The T.J. Maxx Shopping Center and several restaurants are situated along the New Hampshire border near Exit 36 and some commercial uses line Middlesex Road to the south, but much of the area remains undeveloped. Uses to the east of Middlesex Road are agricultural or low density residential.

The Tyngsborough portion of the study area consists of 1428.07 acres. Residential uses occupy the largest portion at 538.61 acres or 37.7% of the total, followed by commercial at 254.22 acres or 17.8% of the total. The smallest portion is occupied by multiple-uses at 78.59 acres or 5.5% of the total, followed by commercial at 81.7 acres or 5.7%. Table 2.4 below breaks down existing land uses by acreage.

TABLE 2.4: EXISTING LAND USES, TYNGSBOROUGH

Land Use	Acres	Share of Study Area
Industrial	252.2	17.7%
Commercial	254.2	17.8%
Residential	538.6	37.7%
Agricultural	81.7	5.7%
Exempt	222.7	15.6%
Multiple-Use	78.6	5.5%

Tyngsborough Town Center, located around the intersection of Route 113 and Middlesex Road and bounded to the north by Bryants Lane, retains a traditional New England village atmosphere with several homes, churches and municipal facilities clustered in the area. However, the area is not a major commercial center. Historically, Tyngsborough boasted a thriving and mixed-use town center. The first Tyngsborough Bridge, constructed in 1874, provided a critical link between the flourishing industrial cities of Lowell and Nashua. Industry, residences and several commercial stores clustered around the town green, located just west of the bridge crossing. Over time, several of the town center's structures were demolished when Middlesex Road and Route 3A were widened in the mid-nineteenth century to facilitate increased automobile traffic.

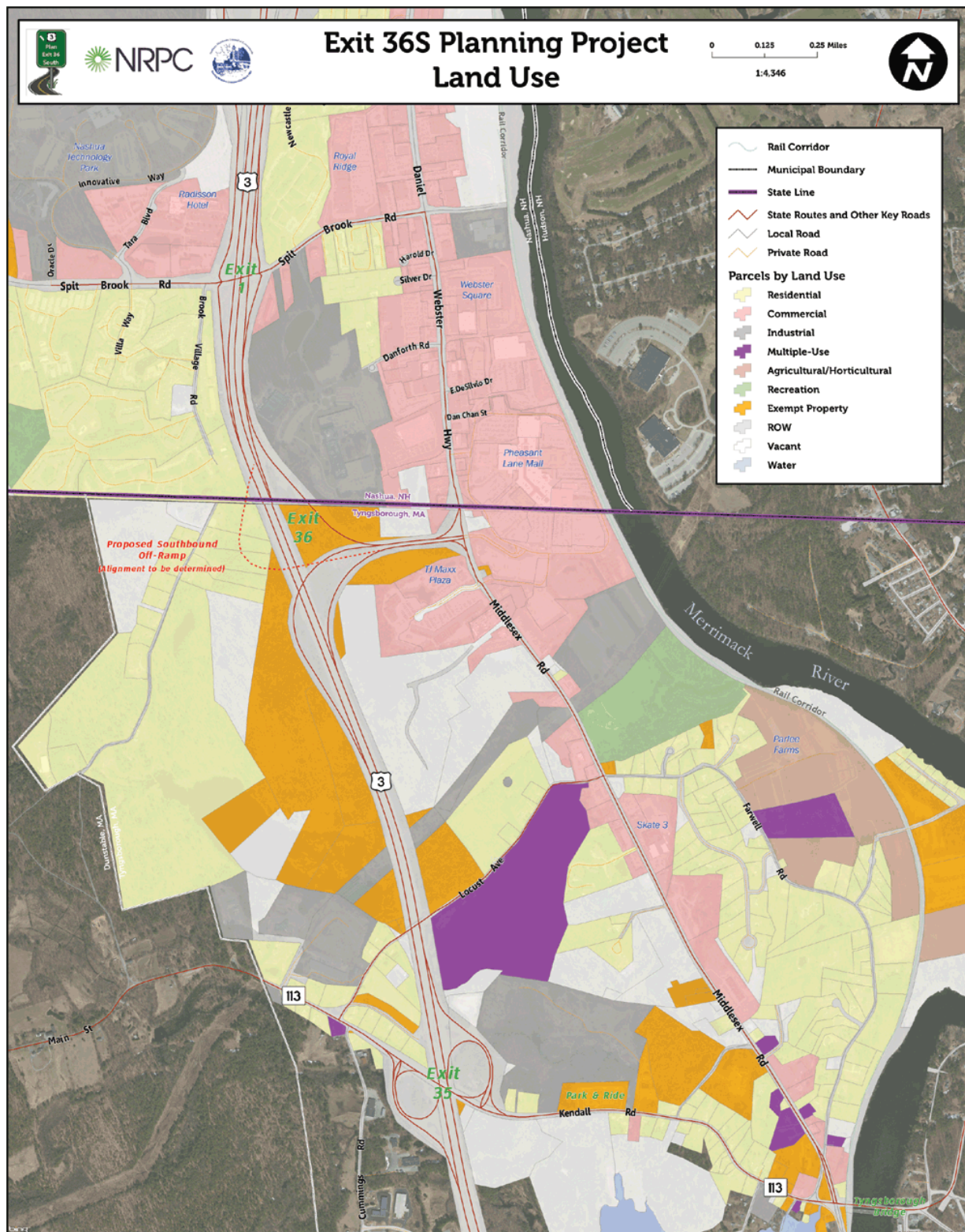


Tyngsborough town officials have indicated that they would like to restore the town center to a more active and dynamic village district. The Tyngsborough Master Plan (2006) and the Tyngsborough Town Center Plan (2008) identify enhancing the town center as a major community goal. The plan calls for a 'multi-nodal' approach to redevelopment in the town center with minimal new development or commercial activity on Kendall Road/Route 3A where historic buildings are concentrated. The plan promotes the construction of an additional bridge crossing approximately 800 feet south of the Tyngsborough Bridge and the addition of pedestrian-scaled mixed-use development along Pawtucket Boulevard. While an additional bridge crossing remains a significant town priority, it should be noted that such a project is unlikely to occur in the short term, as no funds have yet been identified allocated to design or construct a new crossing.

Several restaurants have opened in Tyngsborough along Middlesex Road just south of the Pheasant Lane Mall, including an Olive Garden, Smokey Bones and Bahama Breeze. Tyngsborough officials have indicated a desire to market the area north of Bryants Lane as a 'Restaurant Row' and attract new eateries to the area. This effort will be evaluated in the Future Conditions chapter of the Exit 36 report.



MAP 2.3: LAND USES IN STUDY AREA



Existing Conditions



E. TRAFFIC CONDITIONS

Introduction

The Nashua Regional Planning Commission and Northern Middlesex Council of Governments conducted a comprehensive traffic study of the existing road network near the border between Nashua, New Hampshire and Tyngsborough, Massachusetts to understand the impacts of a potential southbound off-ramp at Exit 36 on U.S. Route 3/F.E. Everett Turnpike. This included corridor and intersection analyses of all the major roadways in the study area including U.S. Route 3/F.E. Everett Turnpike, Daniel Webster Highway, Spit Brook Road, Middlesex Road, and Kendall Road/Route 113.

This chapter includes a description of the Level of Service analysis employed to measure traffic operating conditions in the study area, followed by a description of each corridor, traffic volume and turning movement counts and levels of service at key corridor intersections and analysis.

Traffic operations within the Exit 36 Southbound Ramp Study area are assessed from the study of key intersections, both signalized and stop controlled, along Middlesex Road/Daniel Webster Highway, Spit Brook Road, and Route 113. 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. For purposes of this analysis, the computer software Synchro 7.0 was used to perform the LOS analysis. This software was used for both signalized and stop controlled intersections and is consistent with procedures outlined in the Highway Capacity Manual.

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.

Levels of Service

As described in the 2000 Highway Capacity Manual, Level of Service (LOS) criteria for automobile-modes are based on performance measures that are field measured and perceived by travelers. LOS can be characterized for the entire intersection, each intersection approach, and each lane group. Control delay is used to characterize LOS for an entire intersection or an approach. Control delay and volume to capacity ratio are used to characterize LOS for a lane group. Delay quantifies the increase in travel



time due to traffic signal control. It is also a surrogate measure of driver discomfort and fuel consumption. It is important to note that while C and D level LOS ratings might not be ideal, they are considered acceptable in urban environments. Only E and F ratings indicate considerable delay.

Signalized Intersections

Level of service at a signalized intersection is evaluated based on control delay per vehicle (in seconds per vehicle). Control delay includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. The average control delay per vehicle is determined for each lane group of an approach and for the intersection as a whole. Table 2.5 provides the relationship between control delay and LOS as presented in the *2000 Highway Capacity Manual (HCM 2000)*.

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

**Highway Capacity Manual*; Transportation Research Board; Washington DC; 2000; p 16-2.

Two Way Stop Controlled 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 from a stop. The LOS criteria are presented in the *2000 HCM* and are provided in Table 2.6.



TABLE 2.6: LEVEL OF SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS*

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

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

F. U.S. ROUTE 3/ F.E. EVERETT TURNPIKE

U.S. Route 3/F.E. Everett Turnpike is a north-south limited access highway that provides access to regional centers in both Massachusetts and New Hampshire. Beginning in Burlington, Massachusetts, the limited access portion of Route 3 crosses both Tyngsborough (Exits 35 and 36) and Nashua (Exit 1) in the study area. After crossing into Nashua, US Route 3 is referred to as the F.E. Everett Turnpike. The highway links the Interstate 95/Route 128 corridor of Massachusetts, a major employment center, with communities of Northern Massachusetts and Southern New Hampshire including Nashua, Manchester, and Concord, the three largest cities and the three largest employment centers, in the state.

Route 3, classified as a principal arterial, is median-divided with 3 travel-lanes in each direction through the study area. There are three key interchanges within the study area, Exits 35 and 36 in Tyngsborough and Exit 1 in Nashua. These interchanges are discussed in detail in Appendix 3.

Traffic Volume Counts

Twenty-four-hour traffic volume counts were conducted during Fall 2012 along the mainline and at each exit ramp of Route 3/F.E. Everett Turnpike. Table 2.7 summarizes the data collected.



TABLE 2.7: U.S. ROUTE 3/F.E. EVERETT TURNPIKE TRAFFIC VOLUME COUNTS

Location	Community	2012 Average Daily Traffic
Route 3 at Massachusetts/New Hampshire SL	Tyngsborough	80,721
FEE Turnpike Exit 1 SB Off Ramp	Nashua	12,900
FEE Turnpike Exit 1 SB On Ramp	Nashua	6,130
FEE Turnpike Exit 1 NB Off Ramp	Nashua	7,600
FEE Turnpike Exit 1 NB On Ramp	Nashua	11,100
Route 3 Exit 36 NB Off Ramp	Tyngsborough	7,500
Route 3 Exit 36 NB On Ramp	Tyngsborough	5,900
Route 3 Exit 36 SB On Ramp	Tyngsborough	7,000
Route 3 Exit 35 NB Off Ramp	Tyngsborough	12,100
Route 3 Exit 35 NB On Ramp	Tyngsborough	12,200
Route 3 Exit 35 SB Off Ramp	Tyngsborough	4,600
Route 3 Exit 35 SB On Ramp	Tyngsborough	4,000

Traffic Volume Analysis

Exit 35

Traffic Counts indicate heaviest demand on both the northbound on and off ramp, which are more than double the counts for southbound traffic. This can partly be accounted for due to the exit's close proximity to Exit 34 approximately 1.25 miles to the south. Population centers in Tyngsborough are located approximately equidistant to the two exits so it is likely that southbound traffic diverts to Exit 34 further to the south, while northbound traffic is more likely to utilize Exit 35. The relatively high northbound off-ramp count is likely related to commuters as Tyngsborough is a largely residential area and residents are more likely to commute to points south.

Exit 36

Traffic counts are relatively consistent for all Exit 36 traffic. Counts are slightly higher for northbound on-ramp and southbound off-ramp traffic. This is likely due to the heavy retail presence in the Exit 36 area and the exit's location in the approximate area of the Massachusetts and New Hampshire border. New Hampshire's lack of a state sales tax attracts a steady influx of shoppers from Massachusetts, and South Nashua's location so close to the state border makes it particularly attractive for such shoppers.



Exit 1

Traffic counts indicate heaviest demand for both the southbound off ramp and the northbound on ramp at Exit 1. Commuting data from the U.S. Census American Community Survey 5-year estimates indicate that most commuters to the study area live in New Hampshire and thus are likely to access the area from the north. These commuters access the area via the southbound off ramp and return via the northbound on ramp at Exit 1, accounting for the increased demand on those segments. Additionally, since there is currently no Exit 36 access for southbound traffic on Route 3/F.E. Everett Turnpike, most New Hampshire-based traffic utilizes Exit 1 to access the Exit 36 retail area.



U.S. Route 3 looking north toward Exit 36 in Tyngsborough. (Credit: NRPC)



U.S. Route 3/ F.E. Everett Turnpike Interchange Levels of Service

As shown in Table 2.8, a Level of Service analysis was undertaken for each ramp intersection in the study area based on turning movement counts collected during peak periods.

TABLE 2.8: U.S. ROUTE 3/ F.E. EVERETT TURNPIKE INTERCHANGE LEVELS OF SERVICE

Morning/ Mid-Day Peak

Location	Peak Time	Intersection Delay seconds/vehicle	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) SB Ramps	7-9 a.m.	3.3	0.3	A
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) NB Ramps	7-9 a.m.	25	0.39	C
Middlesex Rd at Exit 36 Ramps	11 a.m.-1 p.m.	28.4	1.27	C
Spit Brook Rd at Rte 3 (Exit 1) SB Ramps	12-2 p.m.	22.3	0.71	C
Spit Brook Rd at Rte 3 (Exit 1) NB Ramps	12-2 p.m.	17.6	0.76	B

Evening Peak

Location	Peak Time	Intersection Delay seconds/vehicle	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) SB Ramps	4-6 p.m.	8.2	0.57	A
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) NB Ramps	4-6 p.m.	38.4	0.57	D
Middlesex Rd at Exit 36 Ramps	4-6 p.m.	23.9	0.99	C
Spit Brook Rd at Rte 3 (Exit 1) SB Ramps	4-6 p.m.	31.4	0.84	C
Spit Brook Rd at Rte 3 (Exit 1) NB Ramps	4-6 p.m.	50	0.97	D

Saturday Peak

Location	Peak Time	Intersection Delay seconds/vehicle	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) SB Ramps	1-3 p.m.	7.5	0.53	A
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) NB Ramps	1-3 p.m.	19.2	0.19	C
Middlesex Rd at Exit 36 Ramps	1-3 p.m.	102.3	2.12	F
Spit Brook Rd at Rte 3 (Exit 1) SB Ramps	1-3 p.m.	28.7	0.85	C
Spit Brook Rd at Rte 3 (Exit 1) NB Ramps	1-3 p.m.	51.3	1.19	D



U.S. Route 3/F.E. Everett Turnpike Level of Service Analysis

Exit 35

Across the study area, intersection delays were most limited at the intersection of Kendall Road and the Exit 35 southbound ramps, which operated at LOS A for all peak periods. Intersection delay at the ramps did not exceed 9 seconds during any of the peak periods. Left-turning traffic at the northbound ramps experiences longer delays at the non-signalized intersection. During the morning and Saturday peaks, levels of service are rated at C and intersection delays range from between 19 and 25 seconds. The ramps are most burdened during the evening peak, when they rate at D and intersection delays average 38 seconds.

Exit 36

During the morning and evening peaks, intersection delays at the Exit 36 ramps and Middlesex Road, located just yards from the New Hampshire border in Tyngsborough, ranged from between 24 and 28 seconds and rated as C. However, during the Saturday peak, intersection delays averaged 102 seconds. The intersection operated at LOS F during this period. The extremely large retail presence in the Exit 36 area accounts for the Saturday delays, as retail traffic is strongest during those periods.

Exit 1

During all peak periods, the intersection of Spit Brook Road and the southbound Exit 1 ramps operated at LOS C. Intersection delays ranged from 22 seconds during the morning peak to 31 seconds during the evening peak. The intersection of Spit Brook Road and the northbound ramps performed best during the morning peak when intersection delay averaged 18 seconds and operated at LOS B. Congestion at the intersection was heavier during the evening and Saturday peak periods, when intersection delays averaged between 50 and 51 seconds, and operated at LOS D. The longer intersection delays during the evening and Saturday peaks are somewhat attributable to the heavy retail presence along the Daniel Webster Highway corridor. All southbound traffic departing the highway to access the retail area must cross through the Spit Brook Road and Exit 1 northbound ramps intersection. The evening and Saturday peaks incurred the longest delays likely in part because retail demand is stronger during those periods.



G. SPIT BROOK ROAD

Spit Brook Road is an east-west roadway that provides a connection between the F.E. Everett Turnpike (Exit 1) and the Daniel Webster Highway, a major regional commercial center. It also connects the heavily residential southwest area of Nashua with Boston and Manchester (via the F.E. Everett Turnpike) and retail and employment along Daniel Webster Highway.

Designated as a Class V (local road) under the NH State Highway Classification System, Spit Brook Road is median-divided with generally two travel-lanes in each direction. There are left and right-hand turn pockets throughout the corridor with the number and length varying by intersection. There are nine intersections along the corridor, eight of which are signalized. For a complete description of each intersection, see Appendix 3.

Traffic Volume Counts

Twenty-four-hour traffic volume counts were conducted during Fall 2012 along Spit Brook Road. Table 2.9 summarizes the data collected.

TABLE 2.9: SPIT BROOK ROAD TRAFFIC VOLUME COUNTS

Location	Community	2012 Adjusted Traffic Volume
Spit Brook Road east of Hampton Drive	Nashua	19,200
Spit Brook Road east of Everett Turnpike	Nashua	24,300
Spit Brook Road west of Everett Turnpike	Nashua	28,300
Spit Brook Road west of Brook Village Road	Nashua	22,400
Spit Brook Road west of Tara Blvd.	Nashua	16,400
Tara Blvd. north of Spit Brook Road	Nashua	7,200

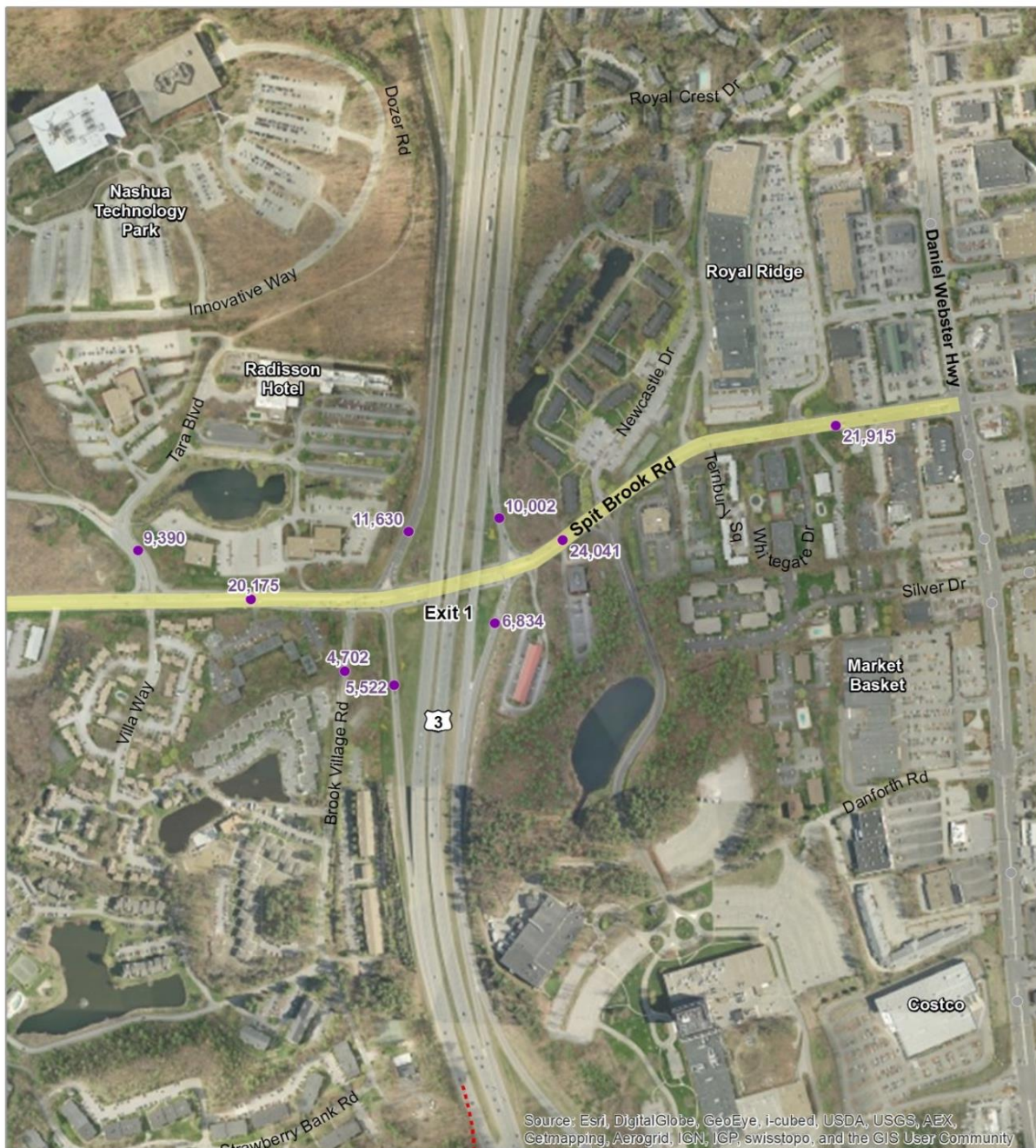
Traffic Volume Analysis

Traffic counts indicate that Spit Brook Road is most travelled in the vicinity of the F.E. Everett Turnpike. Traffic counts drop significantly west of Tara Boulevard as the area becomes largely residential in nature. Traffic counts also drop to the east of Exit 1, though by a much smaller margin as one approaches the Daniel Webster Highway commercial corridor.



MAP 2.4: SPIT BROOK ROAD TRAFFIC COLLECTION SITES

Traffic Collection Sites - Spit Brook Road Corridor



- Average Weekday Volume*
- Other Traffic Count Location
- Exit 36 South Proposed Ramp
- State Line

*Unadjusted average weekday volumes. Data from NRPC, NMCOG, and NHDOT.

Sources:
 NMCOG/NRPC (Sept-Oct 2012 traffic study); NRPC;
 MassDOT/NMCOG (2009 roads); UNH GRANIT
 (New Hampshire roads)

Data provided on this map is not sufficient for either
 boundary determination or regulatory interpretation.

Produced by NMCOG 12/16/2013

0 500 Feet

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 Lowell, Massachusetts 01852-2686
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NRPC



Spit Brook Road Intersections Levels of Service

As shown in Table 2.10, a Level of Service analysis was undertaken for each Spit Brook Road intersection based on turning movement counts collected during peak periods. No analysis was conducted for Tara Boulevard and Oracle Drive because the intersections generate very limited traffic on Saturdays.

TABLE 2.10: SPIT BROOK ROAD INTERSECTIONS LEVELS OF SERVICE

Morning/ Mid-Day Peak

Location	Peak Time	Intersection Delay <i>seconds/vehicle</i>	V/C Ratio	LOS
Spit Brook Road at Oracle Drive	7-9 a.m.	2.6	0.55	A
Spit Brook Road at Tara Boulevard	7-9 a.m.	35.1	1.56	D
Spit Brook Road at Newcastle Drive	11 a.m.-1 p.m.	19	0.61	B
Spit Brook Road at Royal Ridge Drive	11 a.m.-1 p.m.	24.8	0.88	C
Spit Brook Road at Daniel Webster Highway	11 a.m.-1 p.m.	34.9	0.98	C

Evening Peak

Location	Peak Time	Intersection Delay <i>seconds/vehicle</i>	V/C Ratio	LOS
Spit Brook Road at Oracle Drive	4-6 p.m.	9.1	0.64	A
Spit Brook Road at Tara Boulevard	4-6 p.m.	138.5	1.33	F
Spit Brook Road at Newcastle Drive	4-6 p.m.	33.9	0.78	C
Spit Brook Road at Royal Ridge Drive	4-6 p.m.	19.3	0.75	B
Spit Brook Road at Daniel Webster Highway	4-6 p.m.	26	0.72	C

Saturday Peak

Location	Peak Time	Intersection Delay <i>seconds/vehicle</i>	V/C Ratio	LOS
Spit Brook Road at Newcastle Drive	1-3 p.m.	33.1	1.03	C
Spit Brook Road at Royal Ridge Drive	1-3 p.m.	28.7	0.78	C
Spit Brook Road at Daniel Webster Highway	1-3 p.m.	47.2	0.93	D



Spit Brook Road Level of Service Analysis

During the morning and evening peaks, intersection delays were most severe at the Spit Brook Road and Tara Boulevard intersection, which operated at a level of service F. Tara Boulevard serves as the access road for both the Nashua Office Park and the Nashua Technology Park, both of which are major employment centers in the city. The average intersection delay of 139 seconds at the intersection during the evening peak was the longest delay measured at any intersection in the study area. Traffic volumes also exceeded capacity at the intersection during both peak periods.

During the weekday peak periods, no other intersection operated lower than a C on Spit Brook Road. Average intersection delays were under 30 seconds for most of the remaining intersections, with two exceptions. Spit Brook Road at Daniel Webster Highway incurred an average 34.9 second intersection delay during the morning peak while motorists at the intersection with Newcastle Drive encountered an average 33.9 second delay. Both intersections rated at a level of service C during those periods.

During the Saturday peak, Spit Brook Road at both Newcastle Drive and Royal Ridge Drive rated a level of service C and average intersection delays were 33.1 seconds and 28.9 seconds respectively. Additionally, traffic volumes at Newcastle Drive exceeded capacity. Spit Brook Road at Daniel Webster Highway incurred the most congestion during Saturday peaks at where average intersection delay was 47.2 seconds. The intersection rated a level of service D.

H. DANIEL WEBSTER HIGHWAY

Daniel Webster Highway is a major north-south arterial roadway situated between the F. E. Everett Turnpike (to the west) and the Merrimack River (to the east). It is a major transportation corridor, providing access to the turnpike and to NH Route 3A (via the Sagamore Bridge). The route also serves as a significant regional retail and commercial corridor and is extensively developed.

Designated as a Class IV (urban compact) roadway under the State Highway Classification System, Daniel Webster Highway is median-divided with two to three travel lanes in each direction. There are left and right-hand turn pockets throughout the corridor with the number and length varying by intersection. For a complete description of each intersection see Appendix 3.

Traffic Volume Counts

Twenty-four hour traffic volume counts were conducted during Fall 2012 along Daniel Webster Highway. Saturday counts were also collected for most major intersections along the corridor. Table 2.11 summarizes the data collected.



TABLE 2.11: DANIEL WEBSTER HIGHWAY TRAFFIC VOLUME COUNTS

Location	Community	2012 Adjusted Traffic Volumes	Saturday Volumes
Daniel Webster Highway at MA/NH Stateline	-	17,956	
Daniel Webster Highway at Dan Chan Street	Nashua	21,600	16,140
Daniel Webster Highway south of Danforth Drive	Nashua	23,200	33,600
Daniel Webster Highway south of Silver Drive	Nashua	25,900	35,200
Daniel Webster Highway north of Silver Drive	Nashua	28,100	38,800
Daniel Webster Highway south of Spit Brook Dr.	Nashua	31,000	40,300
Daniel Webster Highway north of Spit Brook Dr.	Nashua	21,600	25,900
Danforth Drive east of Daniel Webster Highway	Nashua	3,300	5,050
Dan Chan Street east of Daniel Webster Highway	Nashua	11,000	16,150
Webster Sq. driveway east of Daniel Webster Hwy.	Nashua	7050	9,700

Traffic Volume Analysis

Traffic counts indicate that for all segments of Daniel Webster Highway, Saturday volumes are higher than weekday volumes, with the exception of the segment at Dan Chan Street. This is likely due to the very strong retail presence along Daniel Webster Highway – the corridor is densely lined with a number of shopping centers, including the Pheasant Lane Mall. Both weekday and Saturday volumes are highest just south of Spit Brook Road. This is due to the fact that Exit 1 traffic accesses Daniel Webster Highway via Spit Brook Road. Most of that traffic is directed south as destinations to the north are better access by exiting at Exit 2 off of the turnpike. Traffic volumes slowly but steadily decrease as one travels further south on Daniel Webster Highway, likely due to motorists concluding trips at the residential and commercial destinations that line the corridor. With Saturday traffic volumes approaching 40,000 cars per day, the Daniel Webster Highway is the most heavily traveled surface corridor in the study area.



MAP 2.5: DANIEL WEBSTER HIGHWAY TRAFFIC COLLECTION SITES

Traffic Collection Sites - Daniel Webster Highway Corridor



Sources: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, JGP, swisstopo, and the GIS User Community

- Average Weekday Volume*
 - Other Traffic Count Location
 - Exit 36 South Proposed Ramp
 - State Line
- *Unadjusted average weekday volumes. Data from NRPC, NMCOG, and NHDOT.

Sources:
 NMCOG/NRPC (Sept-Oct 2012 traffic study); NRPC;
 MassDOT/NMCOG (2009 roads); UNH GRANIT
 (New Hampshire roads)

Data provided on this map is not sufficient for either boundary determination or regulatory interpretation.

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Daniel Webster Highway Intersections Levels of Service

As shown in Table 2.12, a Level of Service analysis was undertaken for each Daniel Webster Highway intersection based on turning movement counts collected during peak periods.

TABLE 2.12: DANIEL WEBSTER HIGHWAY LEVELS OF SERVICE



Mid-Day Peak

Location	Peak Time	Intersection Delay <i>seconds/vehicle</i>	V/C Ratio	LOS
Daniel Webster Highway at Silver Drive	11 a.m.-1 p.m.	25.5	0.83	C
Daniel Webster Highway at Danforth Rd	11 a.m.-1 p.m.	53.7	0.98	D
Daniel Webster Highway at Dan Chan Rd	11 a.m.-1 p.m.	22.7	0.77	C
Daniel Webster Highway at Pheasant Ln	11 a.m.-1 p.m.	34.7	1.15	C



Evening Peak

Location	Peak Time	Intersection Delay <i>seconds/vehicle</i>	V/C Ratio	LOS
Daniel Webster Highway at Silver Drive	4-6 p.m.	23.9	0.79	C
Daniel Webster Highway at Danforth Rd	4-6 p.m.	56	1.07	E
Daniel Webster Highway at Dan Chan Rd	4-6 p.m.	26.9	0.79	C
Daniel Webster Highway at Pheasant Ln	4-6 p.m.	20.4	0.77	C



Saturday Peak

Location	Peak Time	Intersection Delay <i>seconds/vehicle</i>	V/C Ratio	LOS
Daniel Webster Highway at Silver Drive	1-3 p.m.	45.7	0.99	D
Daniel Webster Highway at Danforth Rd	1-3 p.m.	153.3	1.38	F
Daniel Webster Highway at Dan Chan Rd	2-4 p.m.	33.8	0.83	C
Daniel Webster Highway at Pheasant Ln	1-3 p.m.	61.3	2.57	E



Daniel Webster Highway Level of Service Analysis

As with other corridors in the New Hampshire part of the study area, intersection delays are most pronounced during the Saturday peaks, due to the heavy retail traffic during those periods. Daniel Webster Highway at both Danforth Road and Pheasant Lane (providing access to the mall as well as a Costco Store) both operate below acceptable levels of service during the Saturday peak, operating at a LOS of F and E respectively. Average intersection delays at Danforth are longest at 153 seconds. Additionally, during the evening peak, the Danforth Road intersection experiences delays of approximately 56 seconds and operates at a LOS E.

I. MIDDLESEX ROAD

Middlesex Road is a major north-south arterial roadway situated between Route 3 (to the west) and the Merrimack River (to the east). The transportation corridor provides access from Tyngsborough Town Center to Northern Tyngsborough and Southern Nashua. The route serves as a retail and commercial corridor with several businesses lining the roadway, though not nearly at the density level at which they are found in South Nashua.

Middlesex Road is classified as an urban minor arterial running from the Tyngsborough Bridge (Route 113) north to the New Hampshire State Line. North of the Route 113 intersection, the Middlesex Road cross section includes two 12-14 ft travel lanes with 4-9 shoulders until just south of the Farwell Road/Locust Road intersection, where the road expands back to four lanes to the TJ Maxx Plaza intersection. Shoulders in the four lane section average 1 ft in width. At this intersection, the northbound side expands to three lanes with exclusive left turn lanes evident at the exit 36 Ramps to Route 3. There are four intersections located along the corridor, which are discussed in detail in Appendix 3.



MAP 2.6: MIDDLESEX ROAD TRAFFIC COLLECTION SITES

Traffic Collection Sites - Middlesex Corridor



- Average Weekday Volume*
- Other Traffic Count Location
- Exit 36 South Proposed Ramp
- State Line

*Unadjusted average weekday volumes. Data from NRPC, NMCOG, and NHDOT.

Sources:
 NMCOG/NRPC (Sept-Oct 2012 traffic study); NRPC;
 MassDOT/NMCOG (2009 roads); UNH GRANIT
 (New Hampshire roads); MassGIS/DigitalGlobe 2011
 (imagery)

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Middlesex Road Corridor Traffic Volume

Twenty-four hour volume counts were conducted during Fall 2012 at four locations along Middlesex Road. The locations of the counts are included in Table 2.13.

TABLE 2.13: MIDDLESEX ROAD TRAFFIC VOLUME COUNTS

Location	Community	2012 Adjusted Traffic Volume	Saturday Volumes
Middlesex Road South of Bryant Lane	Tyngsborough	12,050	16,300
Middlesex Road north of Locust Avenue	Tyngsborough	13,300	19,300
Middlesex Road South of Route 3 Exit 36 Ramps	Tyngsborough	14,400	18,900
Daniel Webster Hwy at MA/NH State Line	Nashua	18,000	

Middlesex Road Corridor Traffic Volume Analysis

Like many of the New Hampshire corridors, traffic volumes along Middlesex Road were higher on Saturdays than during weekdays, owing to the heavy retail presence in the area. Traffic counts are highest in the vicinity of the New Hampshire border but incrementally drop as one travels south approaching Tyngsborough Town Center. Traffic counts drop significantly from the Daniel Webster Highway corridor indicating many motorists exit the roadway as they reach commercial and residential destinations or to access U.S. Route 3/ F.E. Everett Turnpike via Exit 36.

Middlesex Road Intersections Levels of Service

As shown in Table 2.14, a Level of Service analysis was undertaken for each Middlesex Road intersection based on turning movement counts collected during peak periods. Because of the retail nature of the area in northern Tyngsborough, higher traffic volumes were noted during the mid-day rather than the early morning hours, as well as during the evening and Saturday peaks.



TABLE 2.14: MIDDLESEX ROAD INTERSECTIONS LEVELS OF SERVICE**Mid-Day Peak**

Location	Peak Time	Intersection Delay <i>seconds/vehicle</i>	V/C Ratio	LOS
Middlesex Rd at TJ Maxx Plaza Entrance	11 a.m.-1 p.m.	13.2	0.58	B
Middlesex Rd at Locust Ave	11 a.m.-1 p.m.	10.8	0.68	B

**Evening Peak**

Location	Peak Time	Intersection Delay <i>seconds/vehicle</i>	V/C Ratio	LOS
Middlesex Rd at TJ Maxx Plaza Entrance	4-6 p.m.	11.4	0.5	B
Middlesex Rd at Locust Ave	4-6 p.m.	8	0.56	A

**Saturday Peak**

Location	Peak Time	Intersection Delay <i>seconds/vehicle</i>	V/C Ratio	LOS
Middlesex Rd at TJ Maxx Plaza Entrance	1-3 p.m.	32.7	1.17	C
Middlesex Rd at Locust Ave	1-3 p.m.	17.7	0.98	B

Middlesex Road Level of Service Analysis

Neither Middlesex Road intersection operates below acceptable levels of service during any of the peak periods. During the weekday peaks the intersections function with very little measurable delay at all. However during the Saturday peak, traffic volumes exceed capacity at the TJ Maxx Plaza entrance and nearly exceed capacity at Locust Avenue.

J. KENDALL ROAD / ROUTE 113

Route 113 is classified as an urban minor arterial between the Tyngsborough Bridge and the Route 3 Exit 35 Northbound interchange ramps. West of the northbound ramps at Exit 35, the roadway becomes a principal arterial to the western edge of the study area. Kendall Road runs in a general east-



west direction from the Tyngsborough Bridge, through Tyngsborough Center, passing the MassDOT Park and Ride Lot and connecting to Route 3 at Exit 35.

Four key intersections located along the corridor are discussed in detail in Appendix 3.

Traffic Volume Counts

Twenty-four hour traffic volume counts were conducted during Fall 2012 along Kendall Road/Route 113. Saturday counts were also collected for major intersections along the corridor. Table 2.15 summarizes the data collected.

TABLE 2.15: KENDALL ROAD/ROUTE 113 TRAFFIC VOLUME COUNTS

Location	Community	2012 Adjusted Traffic Volume	Saturday Volumes
Route 113 East of Locust Avenue	Tyngsborough	12,700	10,400
Cummings Road South of Route 113	Tyngsborough	2,480	1,330
Locust Avenue North of Route 113	Tyngsborough	2,720	3,620
Route 113 East of Route 3 Exit 35 NB Ramps	Tyngsborough	7,750	10,440

Kendall Road/Route 113 Traffic Volume Analysis

Kendall Road/Route 113 is not a major commercial corridor so traffic counts are highest during the weekday peaks. The counts indicate that Kendall Road experiences more traffic west of the Exit 35 interchange, heading toward the direction of Dunstable, Mass., than it does to the east headed toward Tyngsborough Town Center. Minor roads located off Route 113, including Cummings Road and Locust Avenue, experience relatively low traffic volumes.

Kendall Road/Route 113 Turning Movement Counts

Turning movement counts were conducted at four different locations along the Route 113 corridor. Because this roadway is more commuter oriented rather than retail focused, the AM peak was counted (rather than the mid-day peak), in addition to the evening and Saturday peaks.

Kendall Road/Route 113 Intersections Levels of Service

As shown in Table 2.16, a Level of Service analysis was undertaken for each Kendall Road/Route 113 intersection based on turning movement counts collected during peak periods.



TABLE 2.16: KENDALL ROAD/ROUTE 113 LEVELS OF SERVICE

 **Morning Peak, 7-9 a.m.**

Location	Peak Time	Intersection Delay seconds/vehicle	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Locust Ave*	7-9 a.m.	27.2	0.28	D
Rte 113 (Kendall Rd) at Cummings St*	7-9 a.m.	26.3	0.35	D
Rte 113 (Kendall Rd) at Middlesex Rd	7-9 a.m.	48.7	1.11	D

 **Evening Peak**

Location	Peak Time	Intersection Delay seconds/vehicle	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Locust Ave	4-6 p.m.	27.9	0.49	D
Rte 113 (Kendall Rd) at Cummings St	4-6 p.m.	23	0.47	C
Rte 113 (Kendall Rd) at Middlesex Rd	4-6 p.m.	48.3	1	D

 **Saturday Peak**

Location	Peak Time	Intersection Delay seconds/vehicle	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Locust Ave	1-3 p.m.	23.1	0.48	C
Rte 113 (Kendall Rd) at Cummings St	1-3 p.m.	14.1	.10	B
Rte 113 (Kendall Rd) at Middlesex Rd	1-3 p.m.	93.1	2.36	F

Kendall Road Level of Service Analysis

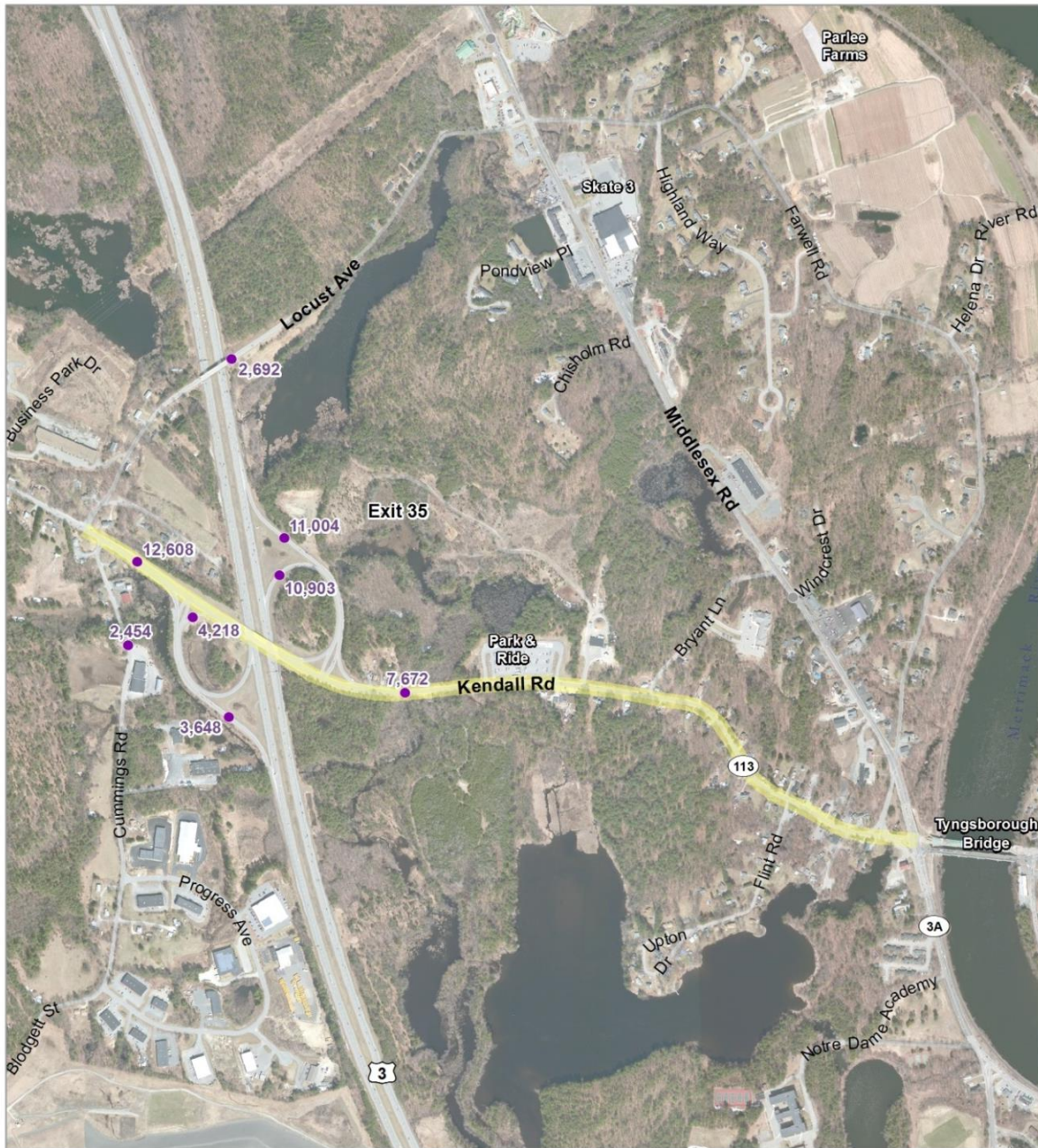
Intersection delays are most acute at the Kendall Road and Middlesex Road intersection during the Saturday peak, when average delays top 93 seconds and traffic volumes exceed intersection capacity. The intersection operates at a LOS of F for that period. This intersection is located directly in front of the Tyngsborough Bridge, which provides access to population centers to the east including eastern Tyngsborough, Dracut, Lowell, and Hudson, NH. As the only Merrimack River crossing in Tyngsborough, and the only one in the study area, the Tyngsborough Bridge serves as a critical link in the region's transportation network and handles significant traffic. Many Massachusetts motorists utilize the bridge for shopping trips to the Exit 36 area, accounting, in part, for the Saturday delays.

No other intersections along Kendall Road incur significant delays during the peak periods.



MAP 2.7: KENDALL ROAD/ROUTE 113 TRAFFIC COLLECTION SITES

Traffic Collection Sites - Route 113 Corridor



- Average Weekday Volume*
 - Other Traffic Count Location
 - Exit 36 South Proposed Ramp
 - State Line
- *Unadjusted average weekday volumes. Data from NRPC, NMCOG, and NHDOT.

Sources:
 NMCOG/NRPC (Sept-Oct 2012 traffic study); NRPC;
 MassDOT/NMCOG (2009 roads); UNH GRANIT
 (New Hampshire roads); MassGIS/DigitalGlobe 2011
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K. TRAFFIC SAFETY

A traffic safety analysis was conducted for major corridors in the study area, including Daniel Webster Highway, Spit Brook Road, Kendall Road (Route 113), and Middlesex Road. The summary data is included below.

Crash Summary for Daniel Webster Highway Key Intersections

Table 2.17 summarizes the findings of crash data analysis at key intersections along Daniel Webster Highway. The crash data, collected from NH DOT, includes the three latest years available, 2009-2011. The NH DOT does not use a standard crash rate like MassDOT. The table below includes the MassDOT District 4 Crash Rate for comparison purposes with intersections in Massachusetts which are analyzed in this plan. Some of the observations from the crash data analysis are discussed below.

- The intersection with Spit Brook Road experienced 70 crashes over 3 years, with a calculated crash rate of 1.69, much higher than the MassDOT standard rate of .77. Angled crashes, due to turning vehicles improperly yielding to oncoming traffic, comprised 38% of incidents, while 40% were rear-endings. Most crashes (80%) reported property damage only, and only 20% had injuries.
- The Dan Chan Street intersection had 63 accidents, with a calculated crash rate of 2.08%, the highest crash rate along Daniel Webster Highway. Rear endings comprised the highest number of accidents at 48% with 23% in angled crashes. Again, most crashes (90%) involved property damage only and 10% had injuries.
- All other intersection were at or below the MassDOT standard crash rate.



TABLE 2.17: DANIEL WEBSTER HIGHWAY KEY INTERSECTION CRASH DATA SUMMARY

Major Street	Daniel Webster Highway						
Minor Street	Spit Brook Road	Harold Drive	Silver Drive	Danforth Road	East Desilvio Dr	Dan Chan St	Pheasant Lane/Costco
Total Crashes 2009-11	70	8	18	25	5	63	15
MassDOT District 4 Crash Rate	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Calculated Crash Rate	1.69	0.24	0.52	0.77	0.20	2.08	0.61
Higher than expected?	Yes	No	No	Equal	No	Yes	No
Type							
Angle	27	0	9	6	2	16	0
Rear-End	28	7	6	9	3	30	6
Run off Rd	0	0	0	0	0	0	0
Other	15	1	3	10	0	17	9
Severity							
Property Damage Only	56	7	15	21	2	56	14
Personal Injury	14	1	3	4	3 (1 bike)	7	1
Fatal	0	0	0	0	0	0	0

Spit Brook Road Key Intersection Safety

Table 2.18 summarizes the findings of crash data analysis at key intersections along Spit Brook Road. The crash data, collected from NH DOT, includes the three latest years available, 2009-2011. The NH DOT does not use a standard crash rate like MassDOT. The table below includes the MassDOT District 4 Crash Rate for comparison purposes with intersections in Massachusetts which are analyzed in this plan. Some of the observations from the crash data analysis are discussed below.

- The following intersections had over 10 crashes in the 3 year period: Royal Ridge (13); F.E. Everett Turnpike SB (17); and Tara Boulevard (16). All of the intersections had calculated crash rates below the MassDOT crash rate, with Tara Blvd being just under.
- At Tara Boulevard 11 out of 16 crashed were rear endings (69%). This was a much higher rate of rear-end collisions than at any other intersection along Spit Brook Road.
- The vast majority of crashes occurred outside of the AM, PM and Mid-Day Peak (64%), except for the F.E. Everett Turnpike SB where just under half of all crashes occurred in the PM and Mid-Day Peak.
- Pavement conditions were generally dry and most crashes had property damage only (81%), with some personal injury (19%) and no fatalities



TABLE 2.18: SPIT BROOK ROAD: KEY INTERSECTION CRASH DATA SUMMARY

Major Street	Spit Brook Road							
Minor Street	Royal Ridge Dr	BAE/ Newcastle	FEE Tpke NB	FEE Tpke SB	Brook Village Rd	Tara Blvd	Sapling Cr	Oracle Dr
Total Crashes 2009-11	13	10	5	17	7	16	1	6
MassDOT District 4 Crash Rate	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Calculated Crash Rate	0.49	0.38	0.14	0.5	0.21	0.68	no data	0.39
Higher than expected?	No	No	No	No	No	No		No
Type								
Angle	6	5	0	7	1	3	1	2
Rear-End	6	3	2	5	5	11	0	4
Run off Rd	0	0	0	0	0	0	0	0
Other	1	2	3	5	1	2	0	0
Severity								
Property Damage Only	9	8	4	16	7	13	0	4
Personal Injury	4	2	1	1	0	3 (1 ped)	1	2
Fatal	0	0	0	0	0	0	0	0

Middlesex Road Key Intersection Safety

Table 2.19 summarizes the findings of crash data analysis at key intersections along Middlesex Road. The crash data, collected from the MassDOT crash database, includes the three latest years available, 2008-2010. Some of the observations from the crash data analysis:

- Middlesex Road at Locust Avenue/Farwell Road experienced 23 crashes over three years. The calculated crash rate of 1.64 crashes per million entering vehicles is higher than MassDOT District 4's published average crash rate for a signalized intersection. The majority of the crashes were angle type incidents (47%) due to turning vehicles improperly yielding to oncoming traffic. Most were property damage only crashes (91%) with only 2 crashes reported to involve injuries.
- Middlesex Road at the TJ Maxx Plaza experienced 5 crashes over the three year study period. The calculated crash rate of 0.27 crashes per million entering vehicles is much lower than MassDOT District 4's published average crash rate for a signalized intersection. Two crashes were angle type incidents and no crashes reported resulted in injuries.
- Middlesex Road at the Exit 36 Ramps reported 14 crashes between 2008 and 2010. The calculated crash rate of 0.64 crashes per million entering vehicles is lower than MassDOT



District 4's published average crash rate for a signalized intersection. The crashes were pretty evenly divided between angle and rear end type incidents. Only 3 of the 14 crashes resulted in injuries.

TABLE 2.19: MIDDLESEX ROAD KEY INTERSECTION CRASH DATA SUMMARY

Major Street	Middlesex Rd at		
Minor Street	Locust Ave/ Farwell Rd	TJ Maxx Plaza/ Pheasant Lane Mall Entrance	Route 3 Exit 36 Ramps/ Pheasant Lane Mall Entrance
Total Crashes 2008-10	23	5	14
MassDOT District 4 Crash Rate	0.77	0.77	0.77
Calculated Crash Rate	1.64	0.27	0.64
Higher than expected?	Yes	No	No
Type			
Angle	11	2	6
Rear-End	4	1	5
Run off Rd	0	0	0
Other	8	2	3
Severity			
Property Damage Only	21	5	11
Personal Injury	2	0	3
Fatal	0	0	0

Route 113 Key Intersection Safety

Table 2.20 summarizes the findings of crash data analysis at key intersections along Route 113. The crash data, collected from the MassDOT crash database, includes the three latest year's available, 2008-2010. Some of the observations from the crash data analysis are summarized below:

- Route 113 at Locust Avenue/Cummings Road experienced 6 crashes over three years. The calculated crash rate of 0.40 crashes per million entering vehicles is lower than MassDOT District 4's published average crash rate for a stop controlled intersection. Two of the six crashes involved injuries.
- Route 113 at Route 3 Exit 35 Southbound ramps experienced 2 crashes over the three year study period. The calculated crash rate of 0.14 crashes per million entering vehicles is much lower than MassDOT District 4's published average crash rate for a signalized intersection. The two crashes were angle type incidents with no injuries.



- Route 113 at Route 3 Exit 35 Northbound ramp experienced one angle crash at a non-peak hour under dry conditions involving one injury. The calculated crash rate of 0.07 crashes per million entering vehicles is much lower than the MassDOT District 4 published average crash rate for a stop controlled intersection.
- The intersection of Route 113 and Middlesex Road/Route 3A had a significant number of crashes totaling 31 over three years. This intersection is listed in the NMCOG Top 100 high Crash Intersection Report for 2008-2010, thus is deemed a high crash location. The majority of the crashes were rear end type incidents (68%). Most were property damage only (84%) crashes occurring on dry pavement conditions (81%). The calculated crash rate of 1.09 crashes per million entering vehicles is higher than MassDOT District 4's rate of 0.77 for signalized intersections.

TABLE 2.20: ROUTE 113/KENDALL ROAD KEY INTERSECTION CRASH DATA SUMMARY

Major Street	Route 113 at			
Minor Street	Locust Ave/ Cummings Rd	Route 3 Exit 35 SB Ramps	Route 3 Exit 35 NB Ramps	Route 3A/ Middlesex Rd
Total Crashes 2008-10	6	2	1	31
MassDOT District 4 Crash Rate	0.58	0.77	0.58	0.77
Calculated Crash Rate	0.40	0.14	0.07	1.09
Higher than expected?	No	No	No	Yes
Type				
Angle	1	2	1	4
Rear-End	1	0	0	21
Run off Rd	0	0	0	0
Other	4	0	0	6
Severity				
Property Damage Only	4	2	0	26
Personal Injury	2	0	1	5
Fatal	0	0	0	0



L. ACCESS MANAGEMENT

Access management is a set of techniques utilized to control access to highways, major arterials, and other roadways. In some areas of the Exit 36 study area, traffic flow as well as pedestrian and traffic safety is hampered by poor access management to surrounding development. Namely, access points to developments are spaced too close together in some areas and some access points are not clearly delineated. Additionally, while a network of cross-connections between developments is well developed, there are significant missing linkages.

Access Points

The placement of access points within very close proximity to each other along a corridor creates the potential for more conflicts between vehicles, pedestrians and bicycles and can trigger and aggravate congestion levels. Parts of Spit Brook Road are illustrative. On that corridor, the driveways for the office development of Executive Tower and the multi-family residential developments of Village Green, Ternbury Square, Whitegate, and Hampshire Heights are all located within a 350 foot segment on the same side of the roadway. Each individual development includes its own driveway on to the corridor and there are no cross-connections between the developments. The driveways between Executive Tower and Village Green are located only 8 feet apart, while the access points for Whitegate and Hampshire Heights are only 15 feet apart. In these areas, opportunities for single shared driveways will be investigated in the Future Conditions chapter of the Exit 36 South report.

There are several other areas of the study area where driveways are spaced very close to one and other and the potential for shared driveways appears feasible, including retail developments along Daniel Webster Highway in Nashua and Middlesex Road in Tyngsborough. Additionally, there is the opportunity to consolidate access points within individual developments.

Some areas of the study area can serve as models for their utilization of access management strategies. In the T.J. Maxx Plaza in Tyngsborough, a single access driveway from Middlesex Road serves a very large shopping center (consisting of three different structures) as well as a 12-screen movie theater. Additionally, the Nashua Technology Park, Radisson Hotel, and a large part of the Nashua Office Park is served by a single access point on to Spit Brook Road via Tara Boulevard.



Cross-Connections

Cross-connections between commercial and residential sites provide motorists and pedestrians with the ability to travel between developments without needing to access and place additional traffic burdens on the main corridors in the study area. Existing cross connections are relatively well developed along Daniel Webster Highway in the study area, where development is most densely clustered.

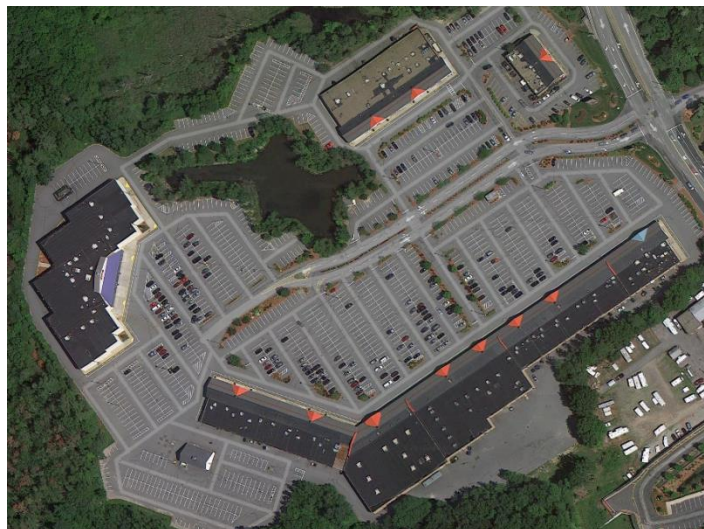
The most connections are located on the east side of Daniel Webster Highway, while more limited options are available on the west side of the corridor. A series of access roads link the Pheasant Lane Mall as far north as Webster Square. Notably however, there is no cross-connection linking Webster Square to Spit Brook Road, which many motorists utilize to access the F. E. Everett Turnpike. To the north, cross connections and a series of inter-connecting driveways provide the opportunity to travel from Spit Brook Road north past Harold Drive and Silver Drive to access Poisson Avenue.

Cross connections are more limited on the west side of Daniel Webster Highway.

North of Spit Brook Road a number of internal connections are available between Barnes and Noble, numerous plazas and the Royal Ridge Mall. However, south of Spit Brook Road the connections are disjointed with the most significant gaps noted between Lui-Lui Restaurant and the Market Basket Shopping Center as well as between Sun Plaza and Costco.



These two driveways on Spit Brook Road are situated close together, increasing conflict points between vehicles as well as vehicles and pedestrians.



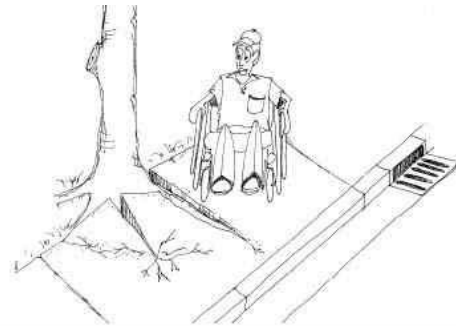
T.J. Maxx Plaza in Tyngsborough includes just a single access point from Middlesex Road.



Because of the density of development on Daniel Webster Highway and heavy traffic demand on the corridor, cross-connections take particular importance there, and there is not a significant network of connections in other parts of the study area. The potential for additional cross-connections will be evaluated in the Future Conditions chapter of the Exit 36 report.

M. BICYCLE AND PEDESTRIAN FACILITIES

Pedestrian facilities are available along the major corridors in the study area, however they are quite limited in both dimension and scope. Bicycle facilities are even more limited in the study area. There are no designated on-road bicycle lanes or multi-use paths. A few sporadic stretches of roadway include shoulders large enough to accommodate bicyclists, but such areas are very limited. Very few pedestrian facilities in the study area meet requirements associated with the Americans with Disabilities Act (ADA), passed by Congress in 1991. In addition to those requirements, the Federal Highway Administration offers a set of guidelines for sidewalk placement and construction.



While cracked, uneven sidewalks might be a nuisance for many pedestrians, they can be especially perilous for wheelchair users. (Illustration provided by FHWA)

Nashua

Sidewalks are present on both sides of the Daniel Webster Highway through the study area, save for the area between Pheasant Lane and the Tyngsborough border (a stretch of approximately 400 feet). Along most of Daniel Webster Highway, sidewalks are placed directly adjacent to travel lanes. While the sidewalk surface appeared in fair condition along this corridor, the sidewalks were only 40 inches across in many places, well short of the 60 inches necessary to meet ADA compliance.

As one nears the Massachusetts border on Daniel Webster Highway, sidewalks are present in very limited areas, for example in front of the Jordan's Furniture store on the west side of the roadway (this is one of the few stretches that does meet ADA requirements), but entirely absent in other areas. A small stretch of sidewalk in front of the Pheasant Lane Mall is almost entirely overgrown by shrubbery, making it virtually impassible.



Along Spit Brook Road, sidewalks are present only on the south side of the roadway, save for a short stretch on the north side from Daniel Webster Highway to the Royal Ridge Shopping Center where sidewalks are present. For the most part, sidewalks are not present on most minor streets within the study area, but there are some significant exceptions. Sidewalks are present along E. Desilvio Drive, and along limited stretches of Pheasant Lane, Danforth Road, Newcastle Drive and Villa Way. Notably, there are no clear pedestrian routes from the major arterials into either the Pheasant Lane Mall or the Nashua Technology Park, two major traffic generators in the study area.

It is clear that most existing sidewalk facilities fail to meet ADA standards. In many areas, obstructions like utility poles and signage impede pedestrian access because they are located directly within the sidewalk right-of-way, with no extra space provided to negotiate around them. This lack of space poses the most pressing challenges for those in wheelchairs and those pushing baby strollers, but it also limits virtually all pedestrian traffic that is not traveling in single file. These barriers are most prevalent along the Spit Brook Road corridor, particularly in the area immediately across from the Royal Crest apartment complex and the Royal Ridge Shopping Center.

In all areas, sidewalks are situated adjacent to travel lanes, with very little space separating pedestrians from vehicles. For the major arterials in the study area, Daniel Webster Highway and Spit Brook Road, this can pose significant challenges because the roadways are between 4 to 7 lanes across, and with posted speed limits of 35-40 miles per hour, traffic volumes and speeds can discourage pedestrian travel.

LACK OF CONNECTIVITY



This sidewalk in front of a furniture store on Daniel Webster Highway terminates abruptly approximately 300 feet north of Exit 36.

OBSTRUCTIONS



The placement of the sign post, utility pole and utility box on the corner of Silver Drive and Daniel Webster Highway obstructs pedestrian flow on the sidewalk.



The placement of this utility pole on Spit Brook Road impedes pedestrian flow and a poorly sited storm drain causes water to accumulate in the pedestrian path.



Ideally, the sidewalk should be separated from travel lanes by a grassy strip, known as an esplanade, to improve pedestrian safety. Additionally, most development in the study area is situated away from the roadway, with large parking lots fronting the road. Taken together, the lack of buffer space separating traffic lanes and sidewalks, the speed of car traffic, and the lack of pedestrian-oriented development contributes to a sidewalk environment that can be perceived as unpleasant and unsafe.

Many signalized intersections lack basic pedestrian amenities like crosswalks and pedestrian hand signals and some sidewalks, as noted previously, are not consistently maintained. Of the many curb cuts in the area, many lack crosswalks and all lack ADA-compliant detectable warning mats for pedestrians.

Safety concerns are exacerbated by the high traffic volumes and the breadth of the roadway. Additionally, right-of-way limitations in Nashua appear to impair opportunities to significantly expand existing pedestrian facilities. Perhaps as a consequence of the environment, pedestrian traffic in the area appears limited despite the heavily developed mixed-use nature of the planning area.

Tyngsborough

Pedestrian and bicycle accommodations are significantly more limited in Tyngsborough. Very few parts of the study area include sidewalks, as they are limited to the Tyngsborough Town Center area and the Tyngsborough Bridge. This includes a short section of Kendall Road, Middlesex Road nearest the town center, and Winslow Road.

Conditions for bicyclists and pedestrians are most limited on Middlesex Road within about one mile of Exit 36 and the New Hampshire border. The roadway is four lanes in this area with no sidewalks and no shoulder space. The traffic signal at Exit 36 in Tyngsborough, and at the Middlesex Road and Farwell and Locust Roads intersection also includes no pedestrian signal or amenities.

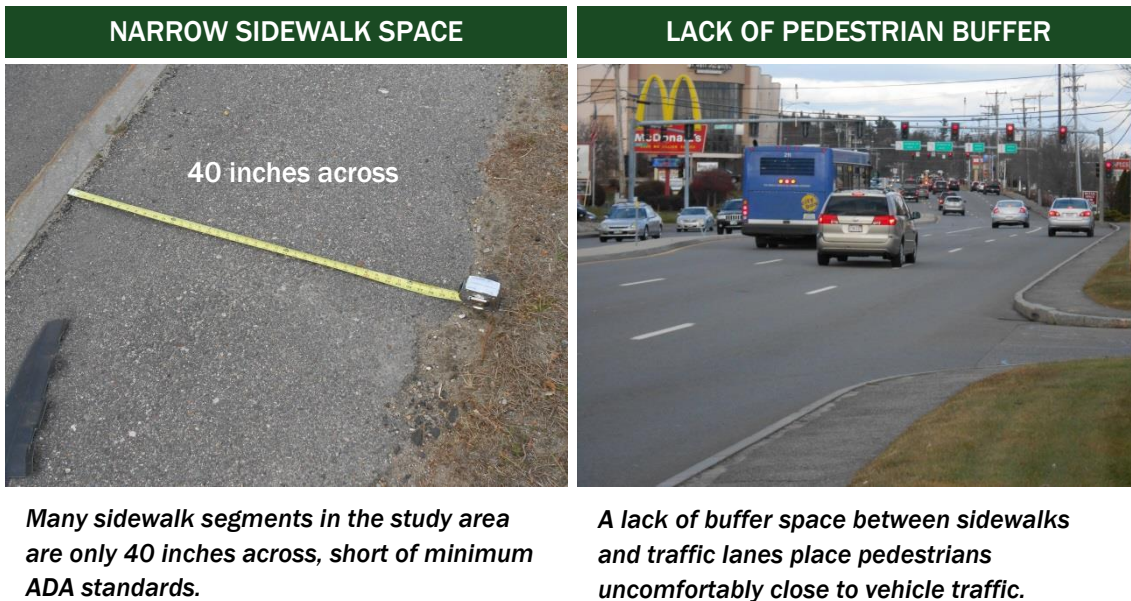
Conditions for pedestrians and bicyclists vastly improve after the intersection with Locust Road at which point the road narrows from four to two travel lanes and shoulders increase to 7-10 feet wide. Bicycles can take advantage of the wide shoulders in the segment to separate themselves from vehicles. The shoulders narrow again approaching the Route 113 intersection near Tyngsborough Town Center,



Most of Middlesex Road in the study area lacks sidewalks. There is very little shoulder space on the roadway north of Farwell Road.



forcing bicyclists to share the road in this area. Traffic signals in the Tyngsborough Town Center area do include signals and facilities for pedestrians and some segments include sidewalks. Additionally, the lower volume of traffic on this section of Middlesex Road makes pedestrian and bicycle more attractive and promotes a higher feeling of safety among such users.



Field analysis of the Exit 36 Study Area indicates that most signalized intersections lack at least some pedestrian amenities. Pedestrian infrastructure drops off almost entirely as one approaches Exit 36 from the north. There is no pedestrian infrastructure in Tyngsborough, save for the Tyngsborough Bridge, portions of Farwell Road, and roadway shoulders after Middlesex Road narrow to two lanes. The tables on the following page indicate the level of pedestrian amenities at each signalized intersection in the Nashua portion of the study area.



TABLE 2.21: DANIEL WEBSTER HIGHWAY PEDESTRIAN INFRASTRUCTURE

Pedestrian Infrastructure at Signalized Intersections						
Daniel Webster Highway, Exit 36 Study Area						
	at Spit Brook Road	at Silver Drive/Webster Sq. North	at Danforth Rd./Webster Sq. South	at Dan Chan St.	at Pheasant Ln./Costco Driveway	at Exit 36
Pedestrian hand signals/displays						
Crosswalks						
Sidewalk coverage						
Transit stop within 250 feet						

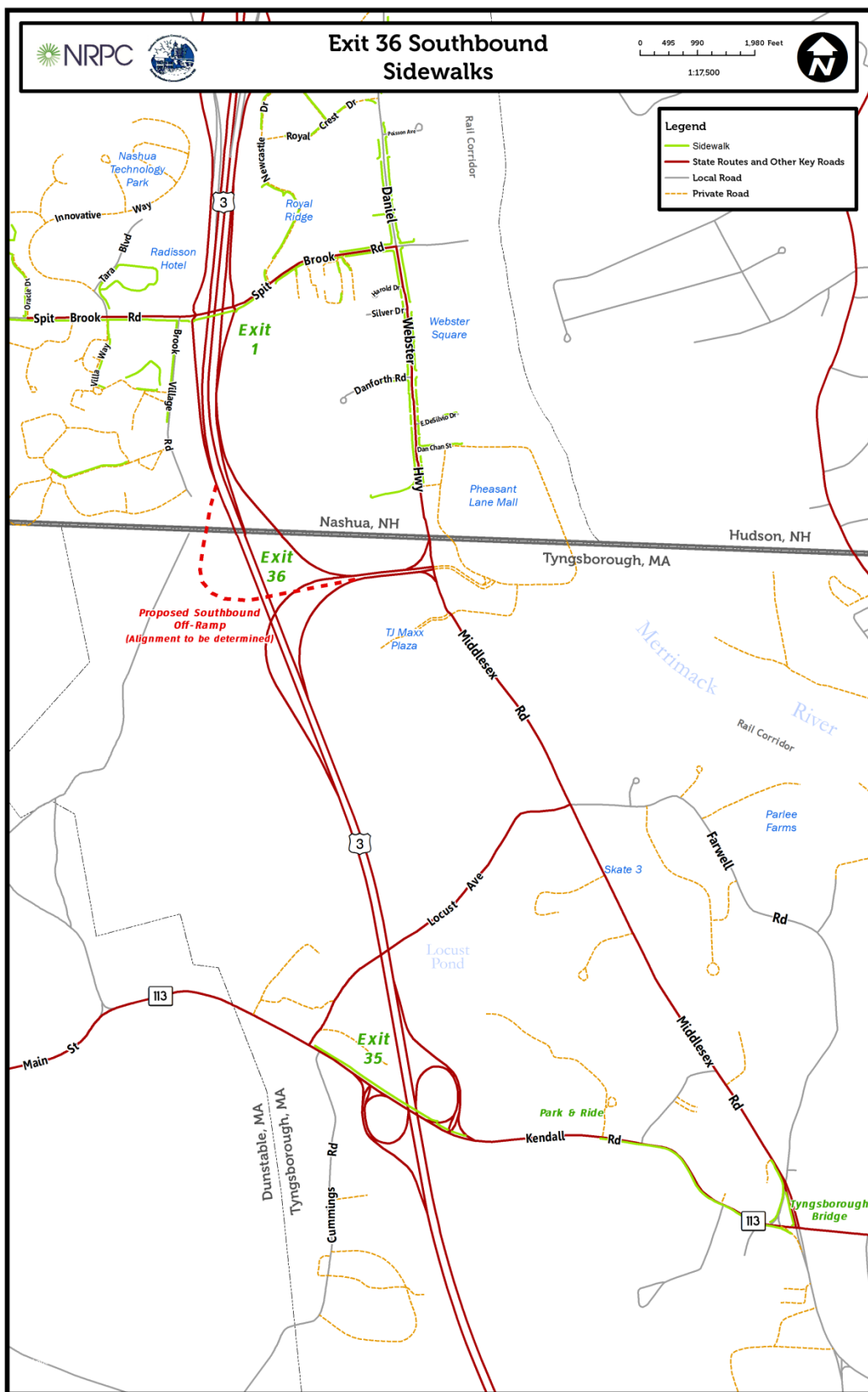
	Amenity available at one intersection crossing
	Amenity available at two intersection crossings
	Amenity available at three intersection crossings
	Amenity available at all crossings

TABLE 2.22: SPIT BROOK ROAD PEDESTRIAN INFRASTRUCTURE

Pedestrian Infrastructure at Signalized Intersections								
Spit Brook Road, Exit 36 Study Area								
	at Daniel Webster Highway	at Whitegate Dr. / Royal Ridge	at New Castle Dr. / BAE Systems	at Exit I North	at Exit I South	at Brook Village Rd.	at Tara Blvd.	at Oracle
Pedestrian hand signals/displays								
Crosswalks								
Sidewalk coverage								
Transit stop within 250 feet								



MAP 2.8: STUDY AREA SIDEWALKS



Existing Conditions



N. TRANSIT ACCESS

Public transit service is available within the study area in both Nashua and, to a limited degree, in Tyngsborough. Boston Express, a public/private bus service to South Station and Logan Airport in Boston, serves the Exit 35 Park and Ride facility in Tyngsborough. There is currently no regular transit service from Nashua to Tyngsborough or the more regionally significant city of Lowell, Massachusetts. The Lowell Regional Transit Authority does provide regular weekday and Saturday service to the west side of Tyngsborough (outside of the study area) via its Route 10 service.

Nashua

Nashua Transit System

The Nashua Transit System provides public bus service in the study area, linking destinations along the major arterials with Downtown Nashua. Routes 6 and 6A provide regular bus service to the project area via the Daniel Webster Highway and Spit Brook Road. Both routes travel the same designated route, but provide a greater frequency of service on weekdays with headways of one ½ hour. Route 6A runs every hour beginning at 6:15 am from the Nashua Transit Center, while Route 6 runs every hour beginning at 6:45 am. The route runs south on Main Street and East Dunstable Road before proceeding east on Spit Brook Avenue and then south on the Daniel Webster Highway to the Pheasant Lane Mall. On its return, the route travels north on Daniel Webster Highway before turning on to Main Street via Veterans Drive. Route 6A does not run on Saturdays and neither route runs on Sundays or later than 7 p.m. on weekdays.

In November 2003, the Nashua Transit System launched its ‘After 7’ service in response to ridership demand for expanded transit hours of operation later into the evening. The After 7 South End/Pheasant Lane route services the same area in the Exit 36 vicinity as Routes 6 and 6A, providing hourly transit service from 6:45 p.m. to approximately 10:45 p.m. every weekday.

NRPC Transit Plan for the Nashua Region

The most recent NRPC Transit Plan for the Nashua Region recommended expanding service frequency along the Route 6 corridor to ½ hour headways and expanding hours of operation to service the hours between 6:45 p.m. and 10:45 p.m.² Both recommendations have already been implemented.

Moving forward, the plan recommends one additional route, the Daniel Webster Highway Circulator, located directly in the project area. The proposed circulator would feature bus service along the Daniel Webster Highway from Poisson Avenue to the Pheasant Lane Mall. The route, focused to service the

² Nashua Regional Planning Commission. 2003. Transit Plan for the Nashua Region. Nashua, NH.



many retail outlets along the corridor, would be targeted to run on Saturdays and during other periods when retail traffic is high, particularly during the holiday shopping season. The significant conglomeration of retail activity in the area makes it attractive for retail trip chaining. And while the proposed route distance is only 1.2 miles, the severely automobile-oriented nature of both the roadway and its surrounding land uses combine to make pedestrian travel in the area difficult and unpleasant. Moreover, recurrent congestion along the Daniel Webster Highway discourages multiple automobile trips to different destinations, helping to potentially bolster demand for transit service.

Tyngsborough

Boston Express

The Boston Express bus service links park-and-ride facilities at Exit 8 off of the Frederick E. Everett Turnpike in Nashua and at Exit 35 of Route 3 in Tyngsborough to Boston's South Station and Logan International Airport. This service has been operating from Nashua since 2006 and from Tyngsborough since 2010. Small indoor bus terminals in both Nashua and Tyngsborough allow riders to purchase tickets and wait before boarding the bus.

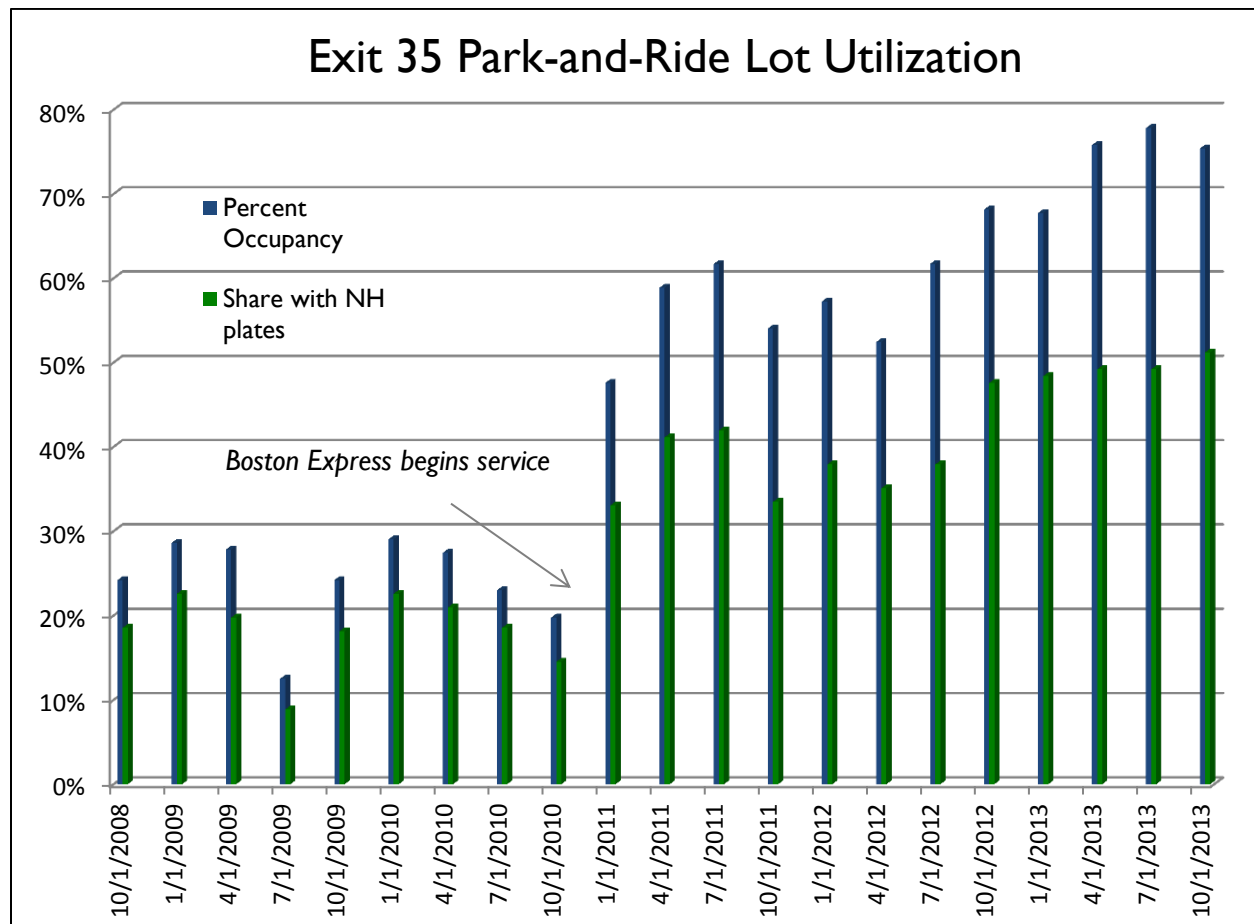
Boston Express allows residents and workers access to an extensive transit and transportation network -- South Station is the largest train station and intercity bus terminal in New England while Logan International Airport is the largest airport in New England. Both facilities are directly served by Boston's MBTA bus and heavy rail public transit service.

Boston Express is privately operated but receives subsidies from the State of New Hampshire to cover capital expenditures as well as the gap between fare revenue and operating costs. On weekdays, a total of 12 trips depart from Nashua and 11 trips from Tyngsborough between the hours of 6 a.m. and 7:30 p.m. Trips range from between 1 to 2 hours in length depending on the time of day, as well as the departure and arrival stations. The Nashua park-and-ride facility is maintained by the NH DOT and the Tyngsborough facility is maintained by MassDOT.

The Tyngsborough facility is extensively used by New Hampshire residents as it is less than two miles from the state border and is located a short distance from the Exit 35 interchange of Route 3. According to quarterly lot counts collected since October 2008, the lot utilization rate hovered between 11 and 29 percent between 2008 and late 2010. After Boston Express service was introduced in late 2010, the lot's utilization rate jumped to nearly 50 percent and has steadily increased since, peaking at a 78% utilization rate in July 2013. Vehicles with New Hampshire license plates have historically constituted a large majority of vehicles utilizing the lot. For example, in October 2013, the lot was 74% occupied, and New Hampshire-based vehicles occupied 50% of the lot, or approximately



67% of all parked vehicles. For a review of lot utilization rates since 2008, including the share of parked vehicles with New Hampshire license plates, see graph below.



Lowell Regional Transit Authority

The Lowell Regional Transit Authority (LRTA) offers limited transit service to the project area in Tyngsborough via its Route 19 service. The service is limited to the holiday shopping season (from late November through January), providing five round trips on Saturdays only. The route departs from Downtown Lowell and services both the TJ Maxx Plaza in Tyngsborough and the Pheasant Lane Mall in Nashua (the bus never crosses the state border into Nashua, because the mall's southerly parking lot is located in Tyngsborough) before returning to Lowell.

The LRTA also maintains the Gallagher Terminal Intermodal Station in Lowell, which provides passenger rail service from Lowell to Boston via the Massachusetts Bay Transportation Authority (MBTA). The station includes an attached parking garage consisting of 875 parking spaces. The station is located approximately 12 miles from the Exit 36 study area and is utilized by many New Hampshire residents to access locations in Boston and the surrounding areas. Weekday lot counts conducted by NMCOG since



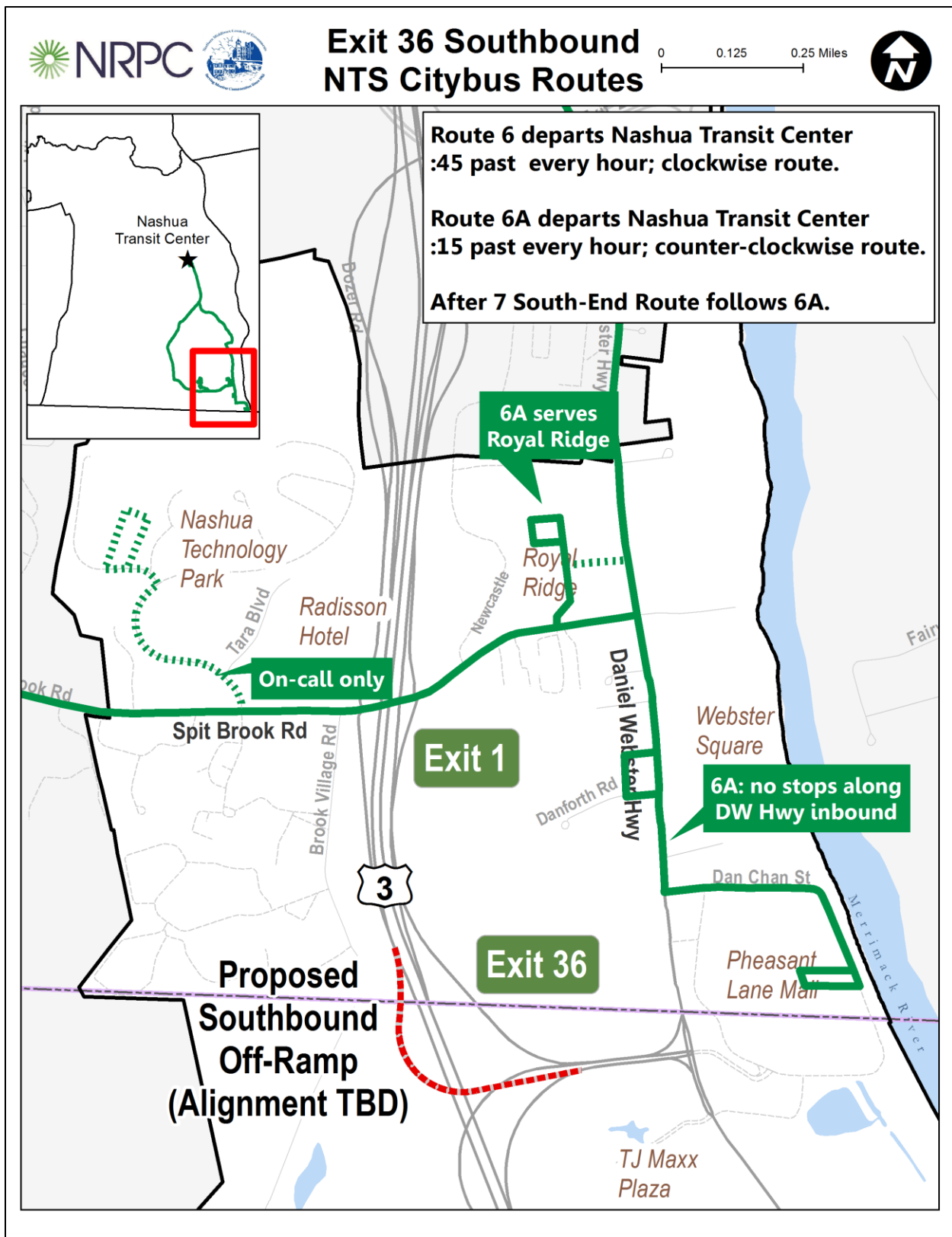
2008 indicate that the parking garage operates at between 66 to 83 percent capacity. The share of vehicles with New Hampshire license plates has fluctuated between 18 to 22 percent of all parked vehicles.

Nashua to Lowell Transit Service

No regular transit service currently operates between the cities of Nashua and Lowell, Massachusetts. Nashua and Lowell are regionally significant employment and population centers and are located only approximately 15 miles apart via Route 3/F. E. Everett Turnpike. Additionally, Lowell is home to an MBTA commuter rail station, the Charles A. Gallagher Transit Terminal, the northern terminus for the MBTA Lowell Line which provides service to and from Boston. Many New Hampshire residents travel to the station to access the MBTA commuter rail network. Approximately 1,400 passengers in total board a train at the facility every weekday. The station includes an attached parking garage consisting of 875 parking spaces. Weekday lot counts conducted by NMCOG since 2008 indicate that the parking garage operates at between 66 to 83 percent capacity. The share of vehicles with New Hampshire license plates has fluctuated between 18 to 22 percent of all parked vehicles, or approximately 135 vehicles on average.



MAP 2.9: PUBLIC TRANSIT SERVICE IN STUDY AREA



Existing Conditions



III. Future Traffic Conditions

A. INTRODUCTION

The effectiveness of the proposed Exit 36 Southbound off ramp was assessed for the assumed opening year of 2022 with a 20 year planning horizon of 2032.

This section evaluates a No Build Scenario. The No Build Scenario analyzes traffic volumes based upon growth trends for the area and assumes the development of projects currently under construction or programmed for construction. This section also discusses a Build Scenario in which traffic generated from the addition of the southbound off ramp on Route 3 at Exit 36 is added to the No Build projections. The evaluation of the built condition will help the communities of Nashua and Tyngsborough understand the traffic impacts associated with the proposed southbound off ramp.

The construction of an Exit 36 southbound off ramp will have clear and quantifiable impacts on future traffic conditions along the F.E. Everett Turnpike and at existing interchanges within the study area. Under the 2022 Build condition it is expected that the Exit 36 southbound off ramp will draw traffic away from Exit 1, Spit Brook Road and Daniel Webster Highway, and to a lesser extent, Exit 35 Southbound and Kendall Road in Tyngsborough. There will be a significant increase in traffic at the intersection of Middlesex Road, The Pheasant Lane Mall Driveway and the Exit 36 Ramps. This section will highlight and discuss the benefits and impacts of the construction of an Exit 36 southbound off ramp on several key intersections and corridor segments in the project area and will compare the 2022 Build vs 2022 No Build condition, and where warranted, comparisons will be made to the existing condition and the 2032 Build and No Build.

Developing forecasts of future conditions in the project area requires careful consideration of the existing conditions and trends, as well as research to estimate changes in future land use, demographics and employment. NRPC and NMCOG used a variety of tools to help identify opportunities for growth and redevelopment in the project area. Interviews were conducted with community development and planning staff from the City of Nashua and the Town of Tyngsborough to identify potential areas of development and redevelopment within the study area. Additional interviews and meetings were held to quantify the expected development in the Tara Heights development off of Spit Brook Road. The information collected from the meetings and interviews was used to inform the NRPC Regional Travel Demand Model and develop future growth projections. A description of the NRPC Travel Demand Model and the future assumptions utilized can be found on the following page.



NRPC Travel Demand Model – General Description

NRPC's Regional Travel Demand Forecasting Model uses a traditional 3-step modeling process: trip generation, trip distribution, and traffic assignment. A fourth step – mode choice – is not used by the NRPC model, as travel, other than by automobile represents an extremely small fraction of the total traffic on the road network.

NRPC maintains a regional model for the general purposes of transportation planning and air quality analysis. For the Exit 36 S Planning Project, a smaller model of just the study area and its immediate surroundings was developed to more accurately assess the impacts of future developments and changes to the road network.

The model uses household, business, and economic data to match up trip ends for each vehicle-trip in the area based on observed travel times. These data sets are organized geographically by traffic analysis zones (TAZs). Each zone contains the population and employment totals of the parcels inside it. Most of the socioeconomic data is derived from Census 2010 or related American Community Survey. Business data is derived from 2010 New Hampshire Department of Employment Security records. The Exit 36 S model has 97 TAZs, including external zones meant to represent other areas of the greater region that interact with South Nashua.

The road network has several attributes, including speed, capacity, presence of tolls, and direction of travel. A model of current conditions is calibrated to set a base year, off of which and future-year scenarios can be run and analyzed. The Exit 36 S model network includes 1,100 links, most of which are contained within the study area. In addition to roads, the model includes connector links which are used to load traffic onto the network from the known development in each TAZ. Traffic counts used to calibrate the model were conducted between 2005 and 2012 and represent a 24-hour weekday average. Map 3.1 provides a graphical representation of the travel demand model developed for the study area.



MAP 3.1: MODEL NETWORK DIAGRAM



NRPC Travel Demand Model – Future Assumptions

For future year scenario model runs, NRPC had to make several assumptions as to the land uses and road network. With few exceptions, the Nashua portion of the study area is built out, leaving redevelopment as the only possibility for changes in land use. Thus, population and employment for the general area were kept at current levels in the study area itself. For external zones, a general 1% annual population growth was assumed.

The only major land development planned for the study area is the Gateway Hills project proposed for a vacant parcel of over 200 acres situated off Tara Boulevard, immediately adjacent to the F.E. Everett Turnpike. Planners obtained information on the scale of the large mixed-use project from the developer John Flatley Company. The development is planned to include 584 new housing units with an average



household size of 1.5 persons per unit, 1.25 million square feet of research and development space, 250,000 square feet of general office space, a 100-room hotel, and approximately 15,000 square feet of retail space. Construction of some office and retail space, as well as multi-family residential units, is already well underway. Additional development of the project is expected to occur in phases over the next 17 years.

All of this development will be constructed surrounding existing uses in the Nashua Technology Park, already included in the base year model. Planners converted the planned size of the development into total employees and residents, using both input from the developer and industry standard averages. A portion of the technology park will be heavily shift-dependent, which is difficult for the NRPC traffic demand model to replicate. Thus, NRPC considers its analysis of the traffic generated during peak hours related to this development to be somewhat of a worst-case scenario.

All of the residential units, as well as half of the commercial development, was included in the initial analysis year of 2022. The remaining commercial data was then added into the 2032 model run.

There are several additional large vacant parcels within the study area however; no major development is slated for any of these sites. In Nashua, the former Dow Chemical site, a 70-acre parcel located at the eastern end of Spit Brook Road along the Merrimack River, has attracted unsuccessful development proposals in the past, however no development is slated for the site currently.

New Hampshire has long considered the possibility of extending passenger rail service from its current terminus in Downtown Lowell to Nashua, and potentially to cities to the north including Manchester and Concord. The rail right-of-way runs through the study area along a track that is adjacent to the Merrimack River. Two sites have been evaluated for potential stations, including land in Tyngsborough south of the Pheasant Lane Mall and the Dow Chemical site in Nashua. New Hampshire DOT is currently contracted with the URS Corporation to conduct a feasibility study regarding the extension of passenger rail service to New Hampshire, the results of which should be released in late 2014.

Absent data from that study, which will include an analysis of rail station locations, it would be premature to incorporate rail traffic into traffic demand models at this time. However, that data will be incorporated into the NRPC traffic demand model after the release of the URS Corp. study data. Additionally, it is likely that a majority of rail traffic will precede the morning peak by approximately 1-2 hours and succeed the evening peak by approximately the same margin in order for passengers to enjoy a full work-day and accounting for the travel times to and from work.



Finally, to add the new southbound ramp itself to the model network, NRPC assumed a very general location and layout, with a one-lane cross-section and 30-40 mph speeds. According to NRPC capacity tables, a one-lane ramp of this nature can carry roughly 25,000 vehicles per day under normal conditions.

In Massachusetts, growth was determined from a combination of the Wood Street/Rourke Bridge Study travel demand model, the NRPC travel demand model, and historical traffic growth in Tyngsborough. Since Tyngsborough has opportunities for new developments, traffic growth rates are higher than in Nashua. Historical traffic growth analysis resulted in a general annual traffic growth rate of 0.7-0.8% for Tyngsborough. The Wood Street/Rourke Bridge Feasibility Study travel demand model reaches the edge of this study area, including the intersection of Route 113 and Middlesex Road. This study utilized a background growth rate of 1.0%. Using these three techniques, the consensus of NRCOG and the Town of Tyngsborough was to use a general background growth rate of 1.0% per year, to be somewhat conservative in estimating traffic volume increases. Staff then interviewed Tyngsborough officials to discuss any relevant development projects within the study area. No specific projects were provided, so staff used the general background growth rate of 1.0% per year throughout.

Future Traffic Analysis

Traffic operations within the Exit 36 southbound study area are assessed from the analysis of forecasted 24 hour traffic volumes and the study of intersections; both signalized and stop controlled, along Middlesex Road/Daniel Webster Highway, Spit Brook Road, and Route 113. Level of Service (LOS), as defined within the Highway Capacity Manual, is used to measure traffic operating conditions along a traffic facility based on average delay at each of the intersections within the roadway network. For purposes of this analysis, the computer software Synchro 7.0 was used to perform the LOS analysis. This software was used for both signalized and stop controlled intersections and is consistent with procedures outlined in the Highway Capacity Manual.

Capacity analysis results in the assignment of levels of service to transportation facilities (intersections and roadways) under various traffic conditions. 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.



As described in the 2000 Highway Capacity Manual, Level of Service (LOS) criteria for automobile-modes are based on performance measures that are field measured and perceived by travelers. LOS can be characterized for the entire intersection, each intersection approach, and each lane group. This study reports the LOS for the entire intersection unless otherwise noted.

Control delay is used to characterize LOS for an entire intersection or an approach. Control delay and volume to capacity ratio are used to characterize LOS for a lane group. Delay quantifies the increase in travel time due to traffic signal control. It is also a surrogate measure of driver discomfort and fuel consumption. It is important to note that while C and D LOS ratings might not be ideal, they are considered acceptable in urban environments, while LOS E and F indicate delays and congestion that may warrant mitigation.

Signalized Intersections

LOS at a signalized intersection is evaluated based on control delay per vehicle (in seconds per vehicle). Control delay includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. The average control delay per vehicle is determined for each lane group of an approach and for the intersection as a whole. Table 3.1 provides the relationship between control delay and LOS as presented in the 2000 Highway Capacity Manual (HCM 2000).

**TABLE 3.1: SIGNALIZED INTERSECTION LEVEL OF SERVICE (LOS)
CRITERIA: AUTOMOBILE MODE**

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

*Highway Capacity Manual; Transportation Research Board; Washington DC; 2000; p 16-2.

Two Way Stop Controlled 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 LOS 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 from a stop. The LOS criteria are presented in the 2000 HCM and are provided in Table 3.2.

TABLE 3.2: 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 2000; Transportation Research Board; Washington DC; 2000; p 17-2.



IV. Existing Conditions vs. 2022 No Build

A. U.S. ROUTE 3/ F.E. EVERETT TURNPIKE

2022 Future Traffic Volume Analysis

As described in the Existing Conditions chapter, U.S. Route 3/F.E. Everett Turnpike is a north-south limited access highway that provides access to regional centers in both Massachusetts and New Hampshire.

Twenty-four-hour traffic volume counts were collected during fall 2012 along the mainline and at each exit ramp of Route 3/F.E. Everett Turnpike. Travel demand forecasts for 2022 No Build and Build Scenarios for the turnpike were made by applying output from the NRPC travel demand model and growth factors developed by NMCOG. Over the past decade traffic volumes in the study area have remained essentially flat, with only modest growth on the F.E. Everett Turnpike. The relatively low growth is in part due to the economic slowdown, and in part due to the fact that much of the study area is built out. The trend over the next ten years, through 2022, is expected to be similar. Table 4.1 shows a comparison of existing and projected traffic volumes on the F.E. Everett Turnpike and ramp systems in the study area.

TABLE 4.1: EXISTING VS. PROJECTED TRAFFIC VOLUMES

Location	2012 Adjusted Traffic Volume	2022 No Build Travel Demand Forecast*	% Change
Route 3 at Massachusetts/New Hampshire SL	80,721	82,731	2%
FEE Turnpike Exit I SB Off Ramp	12,900	13,743	6%
FEE Turnpike Exit I SB On Ramp	6,130	6,079	-1%
FEE Turnpike Exit I NB Off Ramp	7,600	7,513	-1%
FEE Turnpike Exit I NB On Ramp	11,100	12,441	12%
Route 3 Exit 36 NB Off Ramp	7,500	6,680	-11%
Route 3 Exit 36 NB On Ramp	5,900	5,781	-2%
Route 3 Exit 36 SB On Ramp	7,000	6,307	-10%
Route 3 Exit 35 NB Off Ramp	12,100	12,044	<1%
Route 3 Exit 35 NB On Ramp	12,200	12,155	<1%
Route 3 Exit 35 SB Off Ramp	4,600	4,659	<1%
Route 3 Exit 35 SB On Ramp	4,000	4,030	<1%



2022 No Build- 24 hour Traffic Volumes.

Limited availability of undeveloped land for new development may temper growth despite improving economic conditions. With this in mind, operations at the turnpike ramp intersections were analyzed for the 2022 No Build condition and compared to what is experienced today. Travel demand model projections were developed for a 2022 No Build Scenario, assuming the Exit 36 S ramp was not yet built. Under this 2022 No Build Scenario the travel demand model included all of the residential units and half of the commercial development at the Gateway Hills Development Project. A comparison of existing 24 hour traffic volumes to the projected 2022 No Build condition provides a forecasted snapshot of the future traffic conditions without the Exit 36 S off ramp.

Comparing the No Build Scenario to existing conditions, 24 hour traffic volumes along the F.E. Everett Turnpike main line are forecast to grow by approximately 2% or 2000 vehicles per day (vpd), over the ten-year forecast period. Similarly, the Exit I ramp system experiences increased volume in 2022. The Exit I Southbound off ramp and the northbound on ramp show the greatest increase at 6% and 12% respectively. Looking at the project area road network as a whole system, and comparing conditions to the No Build Scenario, an average change in 24-hour traffic volumes was produced for each major corridor in the study areas. Map 2.1, shown on page 22, provides a snapshot of the anticipated average changes in traffic volumes between 2013 and 2022 No Build conditions in the modeled portion of the study area.

The development at Gateway Hills influences 2022 traffic volumes on the Exit I ramp system under a No Build Scenario. The mixed use development features residential units geared towards young professionals working in high tech jobs. While the Gateway Hills development is designed to provide an opportunity to live and work in the same development, the location of the development is also attractive to professionals commuting to jobs in Greater Boston and Manchester. As such, forecasted increase in traffic volumes for the Exit I ramp system is supported. Little change is expected at the Exit 36 under the No Build Scenario, except for a slight increase in northbound on ramp volume likely influenced by development at Gateway Hills.

At Exit 35, the ramp growth is expected to be approximately <1% for both the northbound and southbound off and on ramps in the 2022 no build forecasted year. On the northbound side, traffic volumes are expected to remain at nearly 12,000 vehicles per day in each direction of the ramp interchange, while the southbound ramp will experience over 4,000 vehicles per day.



US Route 3/Turnpike Ramp Intersection Analyses

As shown below in Table 4.2, a Level of Service analysis was undertaken for each intersection at the ramp systems along the F.E. Everett Turnpike in the study area. The existing conditions were based on turning movement counts collected during peak periods. Travel demand model output and future growth factors were applied to the counts in order to estimate the 2022 No Build LOS forecasts.



TABLE 4.2: US ROUTE 3/TURNPIKE RAMP INTERSECTION ANALYSES

 Morning/ Mid-Day Peak

Location	Peak Time	Existing			2022 No Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Exit 35 SB Ramps at Route 113 (Kendall Rd)	7-9 a.m.	3	0.30	A	3	0.33	A	
Exit 35 NB Ramps at Route 113 (Kendall Rd)	7-9 a.m.	25	0.39	C	32	0.49	D	7
Exit 36 Ramps at Middlesex Rd	11 a.m.-1 p.m.	28	1.27	C	34	1.46	C	6
Exit 1 SB Ramps at Spit Brook Rd	12-2 p.m.	22	0.71	C	33	0.86	C	11
Exit 1 NB Ramps at Spit Brook Rd	12-2 p.m.	18	0.76	B	23	0.76	C	5

 Evening Peak

Location	Peak Time	Existing			2022 No Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Exit 35 SB Ramps at Route 113 (Kendall Rd)	4-6 p.m.	8	0.57	A	9	0.6	A	1
Exit 35 NB Ramps at Route 113 (Kendall Rd)	4-6 p.m.	38	0.57	D	119	0.98	F	81
Exit 36 Ramps at Middlesex Rd	4-6 p.m.	24	0.99	C	25	1.03	C	1
Exit 1 SB Ramps at Spit Brook Rd	4-6 p.m.	31	0.84	C	111	1.14	F	70
Exit 1 NB Ramps at Spit Brook Rd	4-6 p.m.	50	0.97	D	98	1.29	F	48

 Saturday Peak

Location	Peak Time	Existing			2022 No Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Exit 35 SB Ramps at Route 113 (Kendall Rd)	1-3 p.m.	8	0.53	A	8	0.59	A	0
Exit 35 NB Ramps at Route 113 (Kendall Rd)	1-3 p.m.	19	0.19	C	23	0.25	C	4
Exit 36 Ramps at Middlesex Rd	1-3 p.m.	102	2.12	F	114	2.24	F	12
Exit 1 SB Ramps at Spit Brook Rd	1-3 p.m.	29	0.85	C	28	0.85	C	-1
Exit 1 NB Ramps at Spit Brook Rd	1-3 p.m.	51	1.19	D	21	0.80	C	-30



Exit 35

Under existing conditions, intersection delays were most limited at the intersection of Kendall Road and the Exit 35 Southbound ramps, which operated at LOS A for all peak periods. These conditions remain true for the 2022 No Build condition.

At the northbound off ramp, the intersection is stop controlled and is subject to longer delays for left turning vehicles from the ramp to Route 113 eastbound in 2022. During the morning peak there are only minor increases in delay occur in 2022 and operations remain at acceptable levels. In the evening peak, the northbound off ramp experiences an additional 41 seconds of delay resulting in a LOS F for left turning vehicles during that time period. Saturday operations remain virtually unchanged through 2022.

Exit 36

During the 2022 No Build morning and evening peaks, intersection delays at the Exit 36 Ramps and Middlesex Road, ranged from between 25 and 34 seconds and operate near capacity with a LOS C. However, during the Saturday peak, intersection delays average 102 seconds under existing conditions and increase slightly to 112 seconds in the 2022 No Build Scenario. The intersection operates at LOS F during this period. The extremely large retail presence in the Exit 36 area accounts for the Saturday delays, as retail traffic is strongest during those periods. With the intersection operating near capacity only limited traffic growth is likely through 2022 during this time period.

Exit 1

During all peak periods under existing conditions, the intersection of Spit Brook Road and the Southbound Exit 1 ramps operated at LOS C. Intersection delays ranged from 22 seconds during the morning peak to 31 seconds during the evening peak. However, by 2022 the delay during the evening peak jumps to 111 seconds, resulting in a LOS F during that time period. This is in part, a result of additional volume generated by the development at Gateway Hills accessing the F.E. Everett Turnpike.

Similarly, the intersection of Spit Brook Road and the northbound ramps performed best during the morning peak in the 2022 No Build condition when the intersection delay increased by only 5 seconds and the intersection operated at LOS C. The evening peak saw the delay jump by more than 70 seconds per vehicle, resulting in a LOS F as the intersection began to exceed capacity. During the Saturday peak periods, traffic operations at the southbound ramps showed little change between existing conditions and the 2022 No Build condition.



B. SPIT BROOK ROAD

Future Traffic Volume Analysis

Spit Brook Road is an east-west roadway that provides a connection between the F.E. Everett Turnpike (Exit 1) and the Daniel Webster Highway, a major regional commercial center. It also connects the heavily residential southwest area of Nashua with Boston and Manchester (via the F.E. Everett Turnpike), and with retail and employment sites along Daniel Webster Highway.

Twenty-four-hour traffic volume counts were conducted during fall 2012 along Spit Brook Road. A travel demand forecast for the 2022 No Build Scenario for Spit Brook Road was made by applying output from the NRPC travel demand model. Table 4.3 compares the 24 hour traffic volume data collected and the forecast model output which estimates change in traffic on the identified segments of Spit Brook Road.

Over the past decade, a slow economy and stagnant population growth has resulted in traffic volumes remaining essentially flat in the study area, including most of Spit Brook Road. While this trend is expected to continue east of the turnpike with only a modest growth in traffic, a notable exception is the segment of Spit Brook Road west of the F.E. Everett Turnpike, where traffic volume will be influenced by the development at Gateway Hills. With these conditions in mind, traffic operations east and west of the F.E. Everett Turnpike and at key intersections along Spit Brook Road were analyzed for the 2022 No Build condition and compared to what is experienced today.

TABLE 4.3: SPIT BROOK ROAD TRAFFIC VOLUME COUNTS

Location	2012 Adjusted Traffic Volume	2022 No Build Travel Demand Forecast	Change
Spit Brook Road east of Hampton Drive	19,200	18,783	-1%
Spit Brook Road east of Everett Turnpike	24,300	24,150	-1%
Spit Brook Road west of Everett Turnpike	28,300	31,431	11%
Spit Brook Road west of Brook Village Road	22,400	26,300	17%
Spit Brook Road west of Tara Blvd.	16,400	16,600	1%
Tara Blvd. north of Spit Brook Road	7,200	15,200	112%

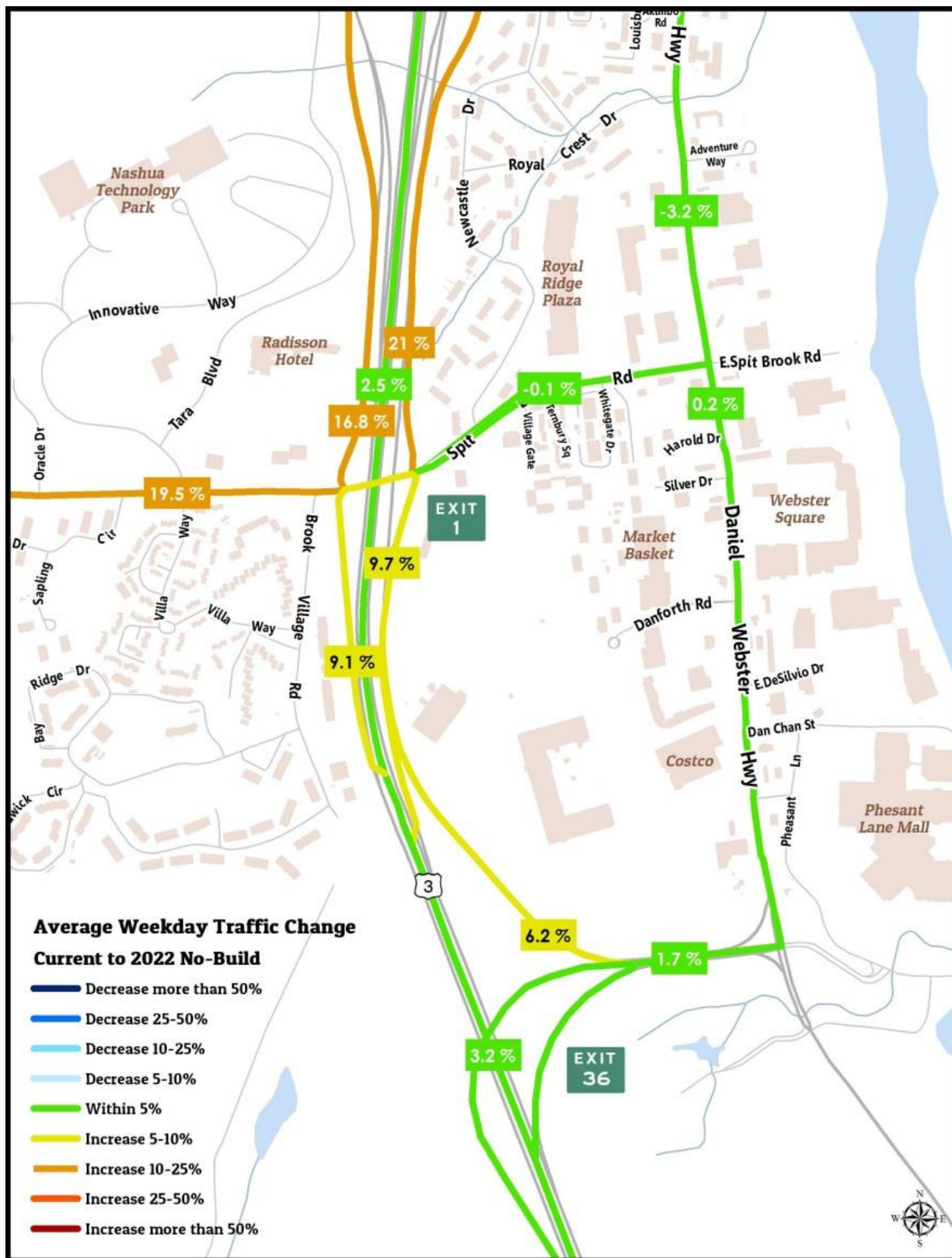


Existing traffic counts indicate that Spit Brook Road is most travelled in the vicinity of the F.E. Everett Turnpike. Traffic counts drop significantly west of Tara Boulevard as the area becomes largely residential in nature. Traffic counts also drop to the east of Exit 1, though by a much smaller margin, as one approaches the Daniel Webster Highway commercial corridor.

Modeled traffic, under a 2022 No Build Scenario, (along Spit Brook Road) shows an increase in 24 hour traffic volumes west of the F.E. Everett Turnpike associated with the Gateway Hills Development. Map 2.1 provides estimated average changes in 24-hour volumes along Spit Brook Road in 2022, compared to existing conditions. The projected 24-hour volume west of the Turnpike is estimated to approach 31,500 vehicles per day, representing an increase of 11% over existing conditions. This increase in traffic will result in additional congestion west of the F.E. Everett Turnpike and near the Exit 1 ramps. East of the F.E. Everett Turnpike, traffic volumes are expected to increase in a manner consistent with background growth.



MAP 4.1: EXISTING VS. 2022 NO BUILD TRAFFIC CHANGE



Existing Conditions vs. 2022 No Build



Spit Brook Road Intersections Levels of Service

As shown in Table 4.4, a LOS analysis was undertaken for each Spit Brook Road intersection comparing the existing conditions to the 2022 No Build Scenario. This analysis was based on turning movement counts collected during peak periods and travel demand model output. No Saturday analysis was conducted for Tara Boulevard and Oracle Drive because the adjacent land uses generate very limited traffic on weekends.



TABLE 4.4: SPIT BROOK ROAD INTERSECTIONS LEVELS OF SERVICE

 Morning Peak

Location	Peak Time	Existing			2022 No Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Spit Brook Road at Oracle Drive	7-9 a.m.	3	0.55	A	5	0.74	A	2
Spit Brook Road at Tara Boulevard	7-9 a.m.	35	1.56	D	216	3.57	F	181
Spit Brook Road at Newcastle Drive	11 a.m.-1 p.m.	19	0.61	B	24	0.62	C	5
Spit Brook Road at Royal Ridge Drive	11 a.m.-1 p.m.	25	0.88	C	18	0.73	B	-7
Spit Brook Road at Daniel Webster Highway	11 a.m.-1 p.m.	35	0.98	C	31	0.81	C	-4

 Evening Peak

Location	Peak Time	Existing			2022 No Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Spit Brook Road at Oracle Drive	4-6 p.m.	9	0.64	A	17	0.4	B	8
Spit Brook Road at Tara Boulevard	4-6 p.m.	139	1.33	F	330	2.51	F	191
Spit Brook Road at Newcastle Drive	4-6 p.m.	34	0.78	C	42	0.86	D	8
Spit Brook Road at Royal Ridge Drive	4-6 p.m.	19	0.75	B	18	0.75	B	-1
Spit Brook Road at Daniel Webster Highway	4-6 p.m.	26	0.72	C	27	0.77	C	1

 Saturday Peak

Location	Peak Time	Existing			2022 No Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Spit Brook Road at Newcastle Drive	1-3 p.m.	33	1.03	C	26	0.76	C	-7
Spit Brook Road at Royal Ridge Drive	1-3 p.m.	29	0.78	C	21	0.76	C	-8
Spit Brook Road at Daniel Webster Highway	1-3 p.m.	47	0.93	D	49	0.93	D	2



As noted previously, traffic growth over the past decade has been flat in the study area, including along most of Spit Brook Road. Forecast conditions for 2022 under a No Build Scenario suggest a continuation of slow growth in traffic volume in the study area. The built out nature of the Nashua portion of the study area, anticipated slow population growth and a recovering economy support this assumption. As such, 2022 No Build Scenario intersection operations along Spit Brook Road east of the F.E. Everett Turnpike are forecast to experience only minor changes in delay, and intersections are expected to operate in a similar manner to what is experienced in the existing 2013 condition.

West of the Turnpike, most notably at Tara Boulevard, intersection operations are projected to deteriorate under a 2022 No Build Scenario. Tara Boulevard serves as the access road for both the Nashua Office Park and the Gateway Hills Development Project, both of which are expected to be major employment centers in 2022 and beyond. The morning and evening peak hours are expected to operate at a LOS F without any mitigation to accommodate future development. During the 2022 No Build evening peak, volumes are approaching 2.5 times the capacity of the intersection, with vehicles projected to experience multi-minute delays unless significant modifications are made to the intersection.



C. DANIEL WEBSTER HIGHWAY

Traffic Volume Analysis

Twenty-four hour traffic volume counts were conducted during the fall of 2012 along Daniel Webster Highway. Saturday counts were also collected for most major intersections along the corridor. A travel demand forecast for the 2022 No Build Scenario for Daniel Webster Highway was made by applying output from the NRPC travel demand model. Table 4.5 summarizes the data collected and the model output which estimates changes in traffic on the identified segments of Daniel Webster Highway.

TABLE 4.5: DANIEL WEBSTER HIGHWAY TRAFFIC VOLUME COUNTS

Location	2012 Adjusted Traffic Volume	2022 No Build Forecast	% Change
Daniel Webster Highway at MA/NH Stateline	18,136	18,382	2%
Daniel Webster Highway at Dan Chan Street	21,600	N/A	N/A
Daniel Webster Highway south of Danforth Dr.	23,200	22,400	-4%
Daniel Webster Highway south of Silver Dr.	25,900	25,530	-2%
Daniel Webster Highway north of Silver Dr.	28,100	N/A	N/A
Daniel Webster Highway south of Spit Brook Dr.	31,000	30,500	-2%
Daniel Webster Highway north of Spit Brook Dr.	21,600	21,875	1%

Under existing conditions and the 2022 No Build Scenario, Saturday volumes are typically higher than weekday volumes. This is likely due to the very strong retail presence along Daniel Webster Highway. The corridor is densely lined with a number of shopping centers, including the Pheasant Lane Mall. Both weekday and Saturday volumes are highest just south of Spit Brook Road. This is due to the fact that Exit 1 traffic accesses Daniel Webster Highway via Spit Brook Road. Most of that traffic is directed south as destinations to the north are better accessed by exiting at Exit 2 from the F.E. Everett Turnpike. Traffic volumes slowly but steadily decrease as one travels further south on Daniel Webster Highway, likely due to motorists concluding trips at the residential and commercial destinations that line the corridor. With Saturday traffic volumes approaching 40,000 cars per day, the Daniel Webster Highway is the most heavily traveled surface corridor in the study area. Without an Exit 36 southbound off ramp, the 2022 traffic volumes along Daniel Webster Highway, south of Spit Brook Road are forecast to remain nearly flat with less than 1% growth on average. Background growth in this portion of the study area is constrained by the built out nature of the environment. Recent observations have shown little change in traffic over the last ten years and travel demand projections for 2022 support the continuation of this trend along the Daniel Webster Highway under a No Build Scenario.



Daniel Webster Highway Intersections Levels of Service

As shown in Table 4.6, a LOS analysis was undertaken for each Daniel Webster Highway intersection based on turning movement counts collected during peak periods. A comparison of existing conditions and the 2022 No Build Scenario is outlined in Table 2.6 and discussed in the subsequent narrative.



TABLE 4.6: DANIEL WEBSTER HIGHWAY LEVELS OF SERVICE

 Morning/ Mid-day

Location	Peak Time	Existing			2022 No Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Daniel Webster Highway at Silver Drive	11 a.m.-1 p.m.	26	0.83	C	24	.75	C	-2
Daniel Webster Highway at Danforth Rd	11 a.m.-1 p.m.	54	0.98	D	64	1.10	E	10
Daniel Webster Highway at Dan Chan Rd	11 a.m.-1 p.m.	23	0.77	C	28	0.79	C	5
Daniel Webster Highway at Pheasant Ln	11 a.m.-1 p.m.	35	1.15	C	33	1.24	C	-2

 Evening Peak

Location	Peak Time	Existing			2022 No Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Daniel Webster Highway at Silver Drive	4-6 p.m.	24	0.79	C	23	0.81	C	-1
Daniel Webster Highway at Danforth Rd	4-6 p.m.	56	1.07	E	55	1.04	D	1
Daniel Webster Highway at Dan Chan Rd	4-6 p.m.	27	0.79	C	26	0.75	C	-1
Daniel Webster Highway at Pheasant Ln	4-6 p.m.	20	0.77	C	21	0.76	C	1

 Saturday Peak

Location	Peak Time	Existing			2022 No Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Daniel Webster Highway at Silver Drive	1-3 p.m.	46	0.99	D	44	0.98	D	-2
Daniel Webster Highway at Danforth Rd	1-3 p.m.	153	1.38	F	161	1.41	F	8
Daniel Webster Highway at Dan Chan Rd	2-4 p.m.	34	0.83	C	33	0.81	C	-1
Daniel Webster Highway at Pheasant Ln	1-3 p.m.	61	2.57	E	64	2.54	E	3



Daniel Webster Highway Level of Service Analysis

As with other corridors in the New Hampshire portion of the study area, intersection delays along Daniel Webster Highway are most pronounced during the Saturday peaks, due to the heavy retail traffic. Daniel Webster Highway, at the intersections of Danforth Road and Pheasant Lane Mall (providing access to the mall as well as a Costco Store) operates below acceptable levels of service during the Saturday peak, at LOS of F and E respectively. The average intersection delays at Danforth Road is longest at 153 seconds. Additionally, during the evening peak, the Danforth Road intersection experiences delays of approximately 56 seconds and operates at an LOS E. Similar to other corridors in the study area, the traffic conditions under a 2022 No Build Scenario are not expected to be significantly different than under 2012/2013 conditions, with only minor increases in delay expected at most intersections. However, as noted above, several intersections are operating below acceptable LOS during the Saturday peak. Any additional traffic growth in the future is likely to exacerbate already difficult traffic operating conditions.

D. MIDDLESEX ROAD

Middlesex Road is a major north-south arterial roadway situated between Route 3 (to the west) and the Merrimack River (to the east). The transportation corridor provides access from Tyngsborough Town Center to northern Tyngsborough and southern Nashua. The route is a retail and commercial corridor with several businesses lining the roadway, though not nearly at the density level found in South Nashua.

Middlesex Road is classified as an urban minor arterial running from the Tyngsborough Bridge (Route 113) north to the New Hampshire State Line. North of the Route 113 intersection, the Middlesex Road cross section includes two 12-14 foot travel lanes with 4-9 foot shoulders until just south of the Farwell Road/Locust Avenue intersection. At this point, the road expands back to four lanes up to the TJ Maxx Plaza intersection. Shoulders within the four lane section average one foot in width. At this intersection, the northbound side expands to three lanes with exclusive left turn lanes at the Exit 36 Ramps to Route 3. There are four intersections located along the corridor, which are discussed in detail in Appendix 3.

Middlesex Road Corridor Traffic Volume

Twenty-four hour volume counts were conducted during the fall of 2012 at four locations along Middlesex Road. The 2022 No Build traffic volumes for Middlesex Road were developed by NMCOG using the latest available information on population and employment. Table 4.7 summarizes the data collected and the forecasted traffic volume estimates on Middlesex Road.



TABLE 4.7: MIDDLESEX ROAD TRAFFIC VOLUME COUNTS

Location	2012 Adjusted Traffic Volume	2022 Forecast Volumes	% Change
Middlesex Rd. South of Bryant Lane	12,050	13,180	9%
Middlesex Rd. north of Locust Avenue	13,300	14,860	11%
Middlesex Rd. South of Route 3 Exit 36 Ramps	14,400	14,478	1%

Under existing and 2022 No Build conditions, Saturday traffic volumes along Middlesex Road were higher than during weekdays, owing to the heavy retail presence in the area. Traffic counts are highest in the vicinity of the New Hampshire border but incrementally drop as one travels south toward Tyngsborough Town Center. Traffic counts drop significantly from the Daniel Webster Highway corridor, indicating many motorists exit the roadway as they reach commercial and residential destinations or to access U.S. Route 3/ F.E. Everett Turnpike via Exit 36.

Similar to Daniel Webster Highway, traffic volumes along Middlesex Road without Exit 36 are expected to experience limited growth without Exit 36 S in place. The Middlesex Road corridor has more opportunity for development than Nashua's portion of the study area, and as such will likely experience a slightly higher growth rate than other corridors within the study area. Background growth along the corridor is forecast by NMCOG to be 1.0% per year, resulting in approximately 200-1,600 vehicles per day in additional volume in a 2022 No Build Scenario.

Middlesex Road Intersections Levels of Service

As shown in Table 4.8, a LOS analysis was undertaken for each Middlesex Road intersection based on turning movement counts collected during peak periods. Because of the retail nature of the area in northern Tyngsborough, higher traffic volumes were noted during the mid-day at the intersections of Middlesex Road/TJ Maxx Plaza and Middlesex Road/Locust Avenue rather than during the early morning hours, or during the evening and Saturday peaks. The intersection with Kendall Road was studied at typical commuter peak hours, where traffic volumes were noted to be higher during the weekday as discussed in the Route 113 analysis.



TABLE 4.8: MIDDLESEX ROAD INTERSECTIONS LEVELS OF SERVICE

 **Morning Peak**

Location	Peak Time	Existing			2022 No Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Middlesex Rd at TJ Maxx Plaza Entrance	11 a.m.-1 p.m.	13	0.58	B	14	0.64	B	1
Middlesex Rd at Locust Ave	11 a.m.-1 p.m.	11	0.68	B	12	0.73	B	1

 **Evening Peak**

Location	Peak Time	Existing			2022 No Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Middlesex Rd at TJ Maxx Plaza Entrance	4-6 p.m.	11	0.5	B	12	0.53	B	1
Middlesex Rd at Locust Ave	4-6 p.m.	8	0.56	A	9	0.63	A	1

 **Saturday Peak**

Location	Peak Time	Existing			2022 No Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Middlesex Rd at TJ Maxx Plaza Entrance	1-3 p.m.	33	1.17	C	36	1.25	D	3
Middlesex Rd at Locust Ave	1-3 p.m.	18	0.98	B	33	1.27	C	15



Middlesex Road Level of Service Analysis

A comparison of the Existing Conditions to 2022 No Build Conditions shows that the Middlesex Road intersections operate at acceptable levels of service during the peak periods. Under both scenarios, the intersections function during the weekday peak with very little measurable delay. During the Saturday peak, traffic volumes begin to approach and exceed capacity at the TJ Maxx Plaza entrance. The eastbound approach to the intersection from the TJ Maxx Plaza to Middlesex Road experiences recurring congestion during the Saturday peak hour. The other three approaches to the intersection work adequately well so that additional time could be added to the TJ Maxx phase to improve the approach and the overall LOS of the intersection. At Locust Avenue, volumes exceed capacity on the Locust Avenue approach to Middlesex Road. By optimizing the traffic signal phasing to accommodate the increased volumes, the overall LOS could be improved.



E. KENDALL ROAD / ROUTE 113

Traffic Volume Counts

Saturday counts were also collected for major intersections along the Route 113 corridor. The 2022 No Build traffic volumes for Kendall Road were developed by NMCOG using the latest available information on population and employment. Table 4.9 summarizes the data collected and the forecasted traffic volumes on Kendall Road. Table 4.10 summarizes the results of the LOS analysis.

TABLE 4.9: KENDAL ROAD/ROUTE 113 EXISTING VS 2022 NO BUILD

Location	2012 Adjusted Traffic Volume	2022 Forecast	% Change
Route 113 East of Locust Avenue	12,700	13,535	6%
Cummings Road South of Route 113	2,480	2,710	9%
Locust Avenue North of Route 113	2,720	3,210	18%
Route 113 East of Route 3 Exit 35 NB Ramps	7,750	8,475	9%

Kendall Road/Route 113 Traffic Volume Analysis

Kendall Road/Route 113 is not a major regional commercial corridor but services commuting traffic, so traffic counts are highest during the weekday peaks. The traffic counts indicate that Kendall Road experiences more traffic west of the Exit 35 interchange, heading toward Dunstable, than it does to the east headed toward Tyngsborough Town Center. Minor roads located off Route 113, including Cummings Road and Locust Avenue, experience relatively low traffic volumes.

In 2022, Route 113 will carry over 13,500 vehicles per day east of Locust Avenue. While near the Route 3 ramps, volumes are lower at around 8,400 vehicles per day in the 2022 No Build Scenario. Locust Avenue processes more traffic during the Saturday peak (3,940 to 3,210), mainly from motorists coming from the west using the roadway to access Middlesex Road south of the mall area. Cummings Road, a local road with several businesses, continues to experience very low traffic volume on Saturday's in 2022 under the No Build Scenario.



Kendall Road/Route 113 Turning Movement Counts

Turning movement counts were conducted at four different locations along the Route 113 corridor. Because this roadway is more commuter oriented rather than retail focused, the AM peak was counted (rather than the mid-day peak), in addition to the evening and Saturday peaks.

Kendall Road/Route 113 Intersections Levels of Service

As shown in Table 4.10, a LOS analysis was undertaken for each Kendall Road/Route 113 intersection based on turning movement counts collected during peak periods.



TABLE 4.10: KENDAL ROAD/ROUTE 113 INTERSECTIONS LEVELS OF SERVICE
 **Morning Peak**

Location	Peak Time	Existing			2022 No Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Rte. 113 (Kendall Rd) at Locust Ave*	7-9 a.m.	27	0.28	D	35	0.36	D	8
Rte. 113 (Kendall Rd) at Cummings St*	7-9 a.m.	26	0.35	D	34	0.44	D	8
Rte. 113 (Kendall Rd) at Middlesex Rd	7-9 a.m.	49	1.11	D	72	1.28	E	23

 **Evening Peak**

Location	Peak Time	Existing			2022 No Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Rte. 113 (Kendall Rd) at Locust Ave	4-6 p.m.	28	0.49	D	54	1.72	F	26
Rte. 113 (Kendall Rd) at Cummings St	4-6 p.m.	23	0.47	C	35	0.60	D	12
Rte. 113 (Kendall Rd) at Middlesex Rd	4-6 p.m.	48	1	D	65	1.14	E	17

 **Saturday Peak**

Location	Peak Time	Existing			2022 No Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Rte. 113 (Kendall Rd) at Locust Ave	1-3 p.m.	23	0.48	C	34	0.62	D	11
Rte. 113 (Kendall Rd) at Cummings St	1-3 p.m.	14	.10	B	16	0.12	C	2
Rte. 113 (Kendall Rd) at Middlesex Rd	1-3 p.m.	93	2.36	F	112	2.65	F	19



Kendall Road Level of Service Analysis

A comparison of the existing conditions to the 2022 No Build Scenario shows that intersection delays are most acute at the Kendall Road and Middlesex Road intersection during the Saturday peak. In fact, project estimates of delay in 2022 without an Exit 36 S off ramp show delay increasing slightly at Kendall Road and Middlesex Road. This intersection has undergone improvements as part of the Tyngsborough Bridge rehabilitation project that was recently completed. High volumes of traffic are evident during each peak period as this is the only Merrimack River crossing in Tyngsborough. The bridge provides access to eastern parts of Tyngsborough, Hudson, NH, Dracut, and Lowell processing the large amounts of traffic.

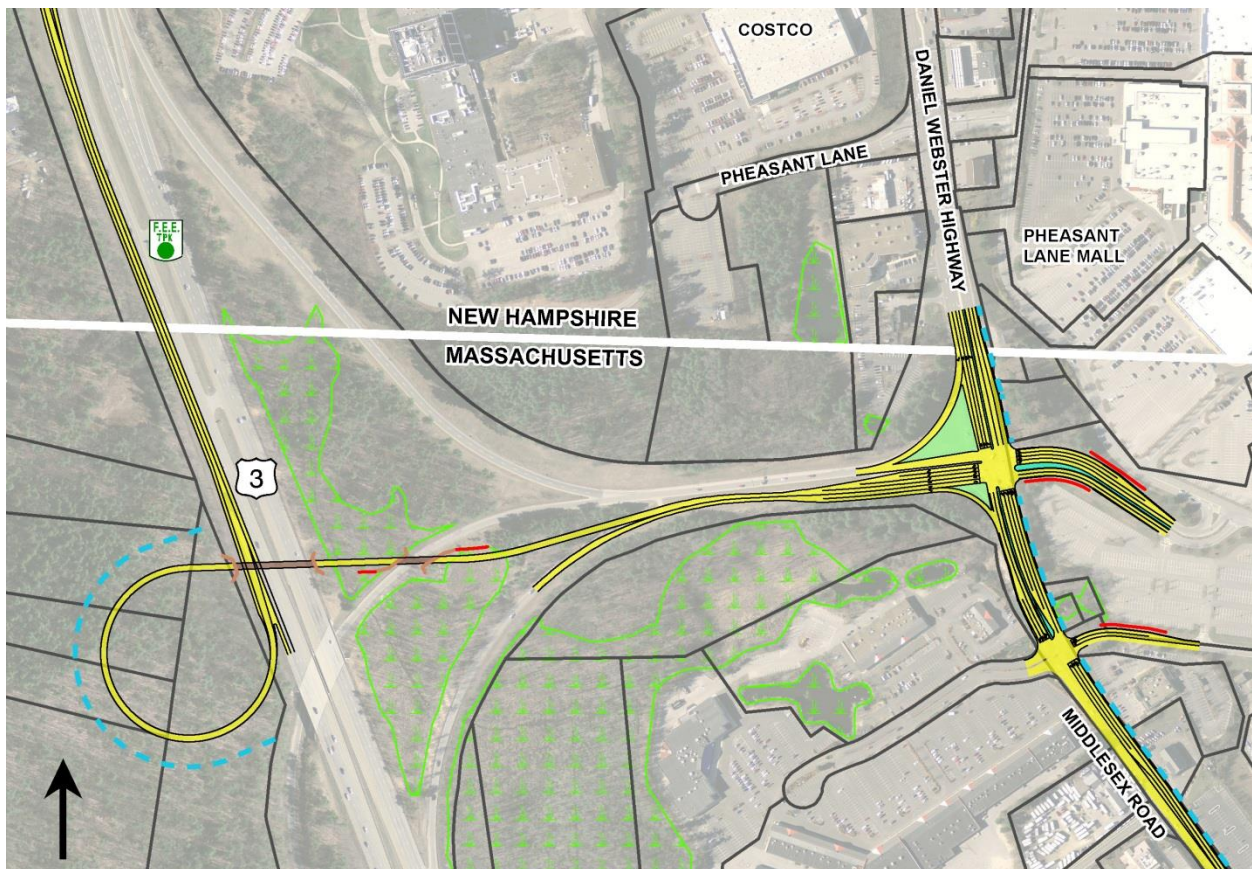
Operations at all intersections along Kendall Road deteriorate slightly in the 2022 No Build Scenario during the morning and evening peaks. The most notable change occurs at Kendall Road and Locust Ave in the evening, where delay nearly doubles with the future traffic volumes well in excess of capacity. Because this is an unsignalized intersection, the most delayed movement dictates how well the intersection operates. At this intersection, the left turning movement from Locust Avenue to Kendall Road operates at a LOS F during the evening peak. Signalization of this intersection would improve overall levels of service.



V. 2022 No Build Vs 2022 Build Future Traffic Volume Analysis

Travel demand forecasts for 2022 No Build and Build Scenarios for the turnpike were made by applying output from the NRPC travel demand model and growth factors developed by NMCOG. These forecasts provide a comparison of the conditions in 2022 without the Exit 36 southbound off ramp (the No Build Scenario), to the conditions in 2022 with the Exit 36 southbound off ramp in place (the Build Scenario). The comparison and analysis of traffic conditions under these two scenarios provides the best indication of the potential benefits of constructing the new Exit 36 southbound off ramp. This comparison analyzes changes in forecast 24-hour traffic volumes as well as the operations at critical intersections in the study area.

The Build Scenario assumes a loop ramp layout on the west side of US 3 in Tyngsborough, MA. The off ramp begins just north of the Massachusetts Border in Nashua NH, The ramp passes over the US 3 mainline and meets grade, merging with the existing Exit 36 northbound off ramp.



The ramp terminates at the intersection of Middlesex Road and the Pheasant Lane Mall Driveway.



A. F.E. EVERETT TURNPIKE AND RAMPS TRAFFIC VOLUME ANALYSIS:

Beginning with the F.E Everett Turnpike, travel demand model projections were developed for the 2022 No Build and Build Scenarios. Under both scenarios the travel demand model included all of the projected residential units and half of the anticipated future commercial development at Gateway Hills. A comparison of the No Build 24-hour traffic volumes to the projected 2022 Build Scenario provides a comparison of the forecasted impacts and benefits of constructing the Exit 36 southbound off ramp. Table 5.1 on the following page, shows projected traffic volumes on the F.E. Everett Turnpike and ramp systems in the study area under a Build and No Build Scenario.

With an Exit 36 southbound off ramp in place, traffic destined for the Daniel Webster Highway and Middlesex Road has direct access to the retail and commercial attractions along the corridor. In the 2022 Build Scenario, the proposed Exit 36 southbound off ramp is forecast to carry nearly 10,500 vehicles per day. The 24-hour forecasts for the F.E. Everett Turnpike show a reduction in traffic at the state line of 6%. A portion of this traffic will be using the new Exit 36 southbound off ramp while some traffic is using the Exit 1 southbound off ramp, as traffic redistributes on the road network throughout the study area. The remaining (existing) ramps on the Exit 36 ramp system show little change from the construction of the southbound off ramp. Volumes on the northbound on and off ramps change by less than 5%, while the southbound on ramp heading into Massachusetts shows no change in 24-hour volume.



TABLE 5.1: PROJECTED 2022 TRAFFIC VOLUMES ON THE F.E. EVERETT TURNPIKE

Location	2022 No Build Travel Demand Forecast	2022 Build Travel Demand Forecast*	Percent Change
Route 3 at Massachusetts/New Hampshire SL	82,731	77,730	-6%
FEE Turnpike Exit 1 SB Off Ramp	13,743	11,840	-14%
FEE Turnpike Exit 1 SB On Ramp	6,079	6,850	13%
FEE Turnpike Exit 1 NB Off Ramp	7,513	7,870	5%
FEE Turnpike Exit 1 NB On Ramp	12,441	11,990	-4%
Route 3 Exit 36 NB Off Ramp	6,680	6,350	-5%
Route 3 Exit 36 NB On Ramp	5,781	5,720	-1%
Route 3 Exit 36 Southbound On Ramp	6,307	6,290	0%
Exit 36 Southbound Off Ramp	N/A	10,500	N/A
Route 3 Exit 35 NB Off Ramp	12,044	12,240	2%
Route 3 Exit 35 NB On Ramp	12,155	12,397	2%
Route 3 Exit 35 SB Off Ramp	4,659	4,897	5%
Route 3 Exit 35 SB On Ramp	4,030	4,030	0%

The most immediate benefits are experienced at the Exit 1 southbound off ramp, where 24 hour volumes drop by 14% (1900 VPD). The reduction in traffic is tempered in part by the development at Gateway Hills, which will be attracting traffic to the Exit 1 ramp. The Exit 1 southbound on ramp experiences a slight increase in volume as local traffic from residential neighborhoods in Nashua use the ramp to access the new Exit 36 southbound off ramp and avoid delays along Spit Brook Road and Daniel Webster Highway. In addition, the development at Gateway Hills is also contributing to the increase in traffic on the Exit 1 southbound ramp as a percentage of the home work trips will originate in Massachusetts. The Exit 1 northbound on and off ramps show less change in volume, under the Build Scenario. The northbound off ramp shows a slight increase in volume likely due to the Gateway Hills development and local traffic completing the return trip from the southern portion of Daniel Webster Highway. The Exit 1 northbound on ramp will experience a decrease in traffic which is likely due to reduced volume on the Daniel Webster Highway north of Spit Brook Road. Map 5.2, shown on page 99 provides a graphic comparison of the average change in traffic volumes for the Build vs. No Build Scenarios.



The ramps at Exit 35 are outside the NRPC modeled area. Estimates to the benefits of the ramp were developed by NMCOG using the NRPC Model, historical growth rates in the area, the Rourke Bridge Feasibility Study travel demand model, and field observations. The reduction in traffic at the state line suggests that a portion of the traffic will use the new Exit 36 southbound off ramp as opposed to the Exit 35 ramp. This is supported by anecdotal evidence provided by input from local residents who use Exit 35 to reverse direction and access the existing Exit 36 northbound off ramp. Little change is expected at the remainder of the Exit 35 ramp system under the Build Scenario.

B. US 3/F.E. EVERETT TURNPIKE RAMP INTERSECTION LOS ANALYSES

As shown below in Table 5.2, a LOS analysis was undertaken for each intersection at the ramp systems along the F.E. Everett Turnpike in the study area. The existing condition turning movement counts were used in conjunction with output from the NRPC travel demand model and estimates from the NMCOG to forecast traffic operations at the ramp intersections for the 2022 Build and No Build Scenarios.



TABLE 5.2: US 3/F.E. EVERETT TURNPIKE RAMP 2022 NO BUILD VS. 2022 BUILD

**Morning/Mid-Day Peak**

Location	Peak Time	2022 No Build			2022 Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Exit 35 SB Ramps at Route 113 (Kendall Rd)	7-9 a.m.	3	0.33	A	3	0.33	A	0
Exit 35 NB Ramps Route 113 (Kendall Rd)	7-9 a.m.	32	0.49	D	32	0.49	E	0
Exit 36 Ramps at Middlesex Rd	11 a.m.-1 p.m.	34	1.46	C	54	1.53	D	20
Exit 1 SB Ramps at Spit Brook Rd	12-2 p.m.	33	0.86	C	28	0.91	C	-5
Exit 1 NB Ramps at Spit Brook Rd	12-2 p.m.	23	0.76	C	20	0.73	C	-3

**Evening Peak**

Location	Peak Time	2022 No Build			2022 Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Exit 35 SB Ramps at Route 113 (Kendall Rd)	4-6 p.m.	9	0.6	A	9	0.6	A	0
Exit 35 NB Ramps Route 113 (Kendall Rd)	4-6 p.m.	119	0.98	F	62	0.74	F	-57
Exit 36 Ramps at Middlesex Rd	4-6 p.m.	25	1.03	C	48	1.31	D	23
Exit 1 SB Ramps at Spit Brook Rd	4-6 p.m.	111	1.14	F	83	1.04	F	-28
Exit 1 NB Ramps at Spit Brook Rd	4-6 p.m.	98	1.29	F	103	1.27	F	5

**Saturday Peak**

Location	Peak Time	2022 No Build			2022 Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Exit 35 SB Ramps at Route 113 (Kendall Rd)	1-3 p.m.	8	0.59	A	8	0.57	A	0
Exit 35 NB Ramps Route 113 (Kendall Rd)	1-3 p.m.	23	0.25	C	22	0.24	C	-1
Exit 36 Ramps at Middlesex Rd	1-3 p.m.	114	2.24	F	40	0.92	D	-74
Exit 1 SB Ramps at Spit Brook Rd	1-3 p.m.	28	0.85	C	27	0.85	C	39
Exit 1 NB Ramps at Spit Brook Rd	1-3 p.m.	21	0.80	C	20	0.73	B	-1



Exit 35 Ramps

In the 2022 Build and No Build Scenarios, intersection delays were acceptable at the intersection of Kendall Road and the Exit 35 southbound ramps, which operated at LOS A for all peak periods.

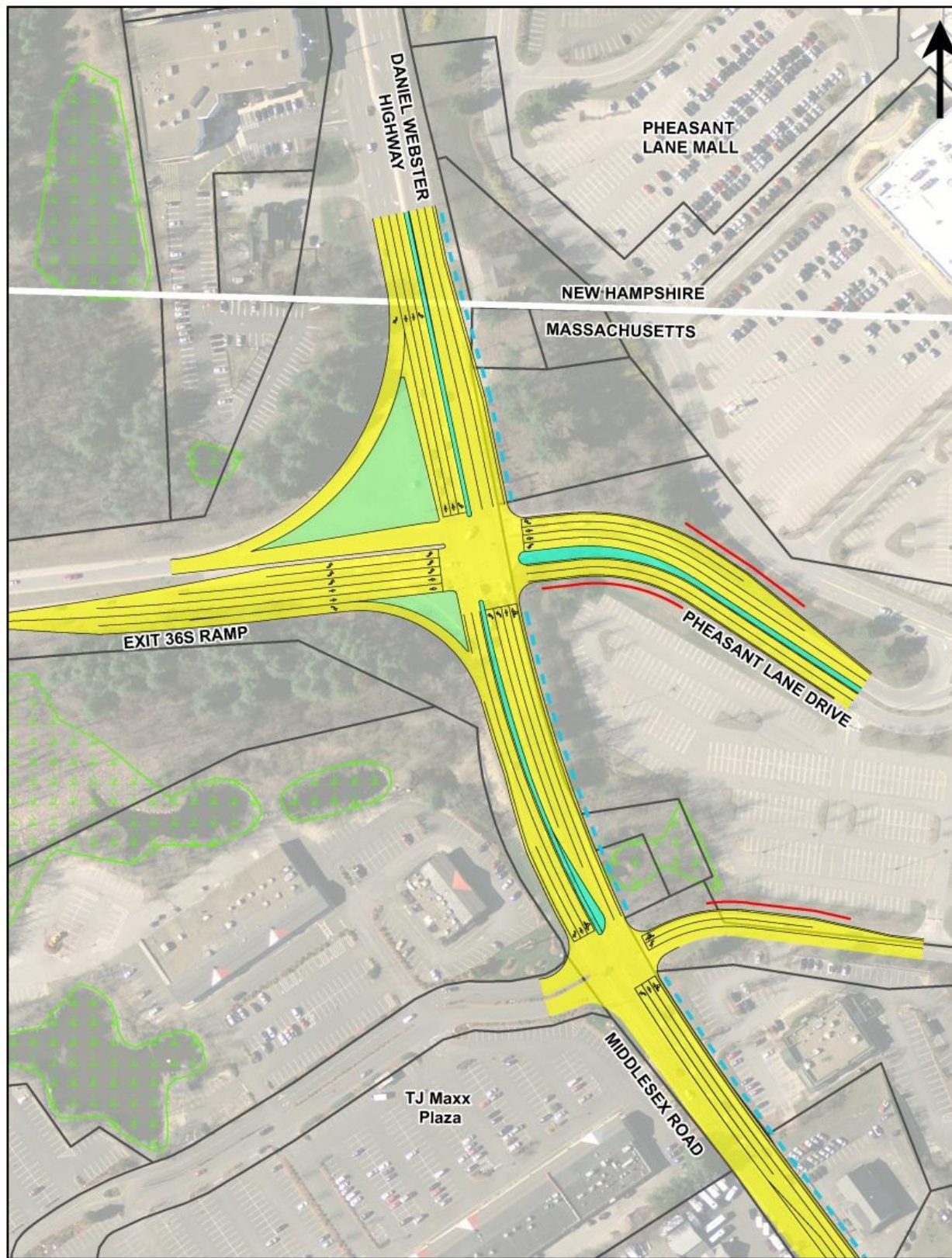
The Exit 35 northbound off ramp is subject to unacceptable delays for left turning vehicles in 2022. During the morning peak, the intersection operates at acceptable levels with virtually no difference between the Build and No Build Scenarios. In the evening peak under the No Build Scenario, the intersection is approaching capacity and average vehicle delay is almost two minutes. Under the Build Scenario, delay is almost cut in half as the intersection is expected to see less traffic volumes with Exit 36 southbound in place. The LOS remains at F as the left turns off of the ramp continue to show excessive delay. Saturday operations remain virtually unchanged in both scenarios through 2022.

Exit 36 Ramps

Comparing the intersection operations for the 2022 Build to 2022 No Build Scenarios at the Exit 36 Ramps and Middlesex Road, delay increases during the AM and PM peak periods in the Build Scenario as the new southbound off ramp adds additional traffic. Average delay per vehicle is expected to increase by about 20 seconds. The intersection is operating near or over capacity during the weekday AM and PM peak periods. During the Saturday peak, intersection delays average 114 seconds under the 2022 No Build Scenario and increase rather dramatically under the 2022 Build Scenario. In developing the conceptual layout and planning level cost estimate the Saturday peak hour was analyzed. The intersection at Middlesex Road, as currently configured, operates at LOS F in the Saturday peak for the 2022 Build Scenario. The extremely large retail presence in the Exit 36 area accounts for the Saturday delays, as retail traffic is strongest during those periods. The intersection of Middlesex Road and the Exit 36 ramps/Pheasant Lane Mall would require the construction of physical improvements to provide three left-turn lanes, two through lanes, and a right-turn lane from the off-ramps, as well as two through lanes, a left-turn lane and a right-turn lane from the Pheasant Lane Mall exit. The northbound approach of Middlesex Road from Massachusetts would require a redistribution of lanes, changing a through lane into a left turn lane; no changes are needed for the geometry of Middlesex Road southbound at this intersection. The intersection of Middlesex Road and TJ Maxx Plaza/Pheasant Lane Mall is expected to require several adjustments including constructing an additional lane on the Pheasant Lane Mall exit, repurposing of existing lanes for the TJ Maxx Plaza exit, and rephrasing of the traffic signal to attain LOS D operations.



MAP 5.1: EXIT 36S OFF RAMP AT MIDDLESEX ROAD



Future Traffic Conditions: 2022 No Build vs. 2022 Build



Additional information is available technical memo developed by Vanasse Hangen Brustlin, Inc. which is included in Appendix I. Minimal impact is anticipated from passenger rail should a station be located near the Pheasant Lane Mall, as the majority of the traffic accessing the rail station will occur outside of the forecast peak periods.

Exit I Ramps

Under the 2022 Build Scenario, the weekday peak periods at the intersection of Spit Brook Road and the Exit I ramps show an overall decrease in delay when compared to the No Build Scenario. During the evening peak period, delay will be reduced by about 30 seconds per vehicle at the intersection with Spit Brook Road. This is a direct result of the Exit 36 southbound ramp drawing traffic away from Spit Brook Road as vehicles use the proposed Exit 36 southbound off ramp. However, under both scenarios during the weekday evening peak, volume is still expected to exceed capacity and the intersection is expected to continue to operate at LOS F. Additionally, minimal impact is anticipated from passenger rail should a station be located off of Spit Brook Road, as the majority of the traffic accessing the rail station will occur outside of the forecast peak periods.

The Saturday peak hour left turns from southbound Exit I to Spit Brook Road will be reduced by 220 vehicles under the Build Scenario as traffic is diverted to the new Exit 36 S off ramp.

Additional mitigation to optimize intersection operations will be required at Exit I and Spit Brook Road to accommodate changes in the traffic pattern under the Build Scenario and with the future development at Gateway Hills.



C. SPIT BROOK ROAD:

Traffic Volume Analysis

Travel demand forecasts for the 2022 No Build and Build Scenarios for Spit Brook Road were developed by applying output from the NRPC travel demand model. Table 5.3 summarizes the data collected and the model output, which estimates change in traffic on the identified segments of Spit Brook Road.

Over the past decade, a slow economy and stagnant population growth has resulted in traffic volumes remaining essentially flat in the study area, including along most of Spit Brook Road. While this trend is expected to continue east of the turnpike, a notable exception is the segment of Spit Brook Road west of the turnpike where traffic volumes will be influenced by the development at Gateway Hills. With these conditions in mind, traffic operations east and west of the F.E. Everett Turnpike and at key intersections along Spit Brook Road were analyzed for the 2022 No Build Scenario and compared to the 2022 Build Scenario.

**TABLE 5.3: SPIT BROOK ROAD FORECAST 2022 TRAFFIC VOLUME COMPARISON
NO BUILD VS. BUILD**

Location	2022 No Build Travel Demand Forecast	2022 Build Travel Demand Forecast	Change
Spit Brook Road east of Hampton Drive	18,783	16,863	-10%
Spit Brook Road east of Everett Turnpike	24,150	22,400	-7%
Spit Brook Road west of Everett Turnpike	31,431	31,563	0%
Spit Brook Road west of Brook Village Road	26,300	26,400	0%
Spit Brook Road west of Tara Blvd.	16,600	16,666	0%
Tara Blvd. north of Spit Brook Road	15,200	14,100	-7%

Modeled traffic volumes for the 2022 Build and No Build Scenarios continue to show higher volumes east of Tara Boulevard. Points to the west of Tara Boulevard carry less volume as the area becomes largely residential. Forecasted traffic volumes also drop to the east of Exit 1, though by a much smaller margin, as one approaches the Daniel Webster Highway commercial corridor.

Modeled traffic, under the 2022 Build Scenario, along Spit Brook Road west of the F.E. Everett Turnpike and Tara Boulevard, suggest a minimal increase in 24 hour volumes. The increase of less than 1% is in part due to traffic being drawn toward the Exit 1 southbound on ramp as a means to access the new Exit 36 southbound off ramp.



Comparing the 2022 Build to No Build Scenarios, forecasted traffic volumes on Spit Brook Road east of the F.E. Everett Turnpike shows the benefit of the proposed Exit 36 southbound off ramp. Forecast volumes along Spit Brook Road are expected to decrease by about 9%, resulting in reduced congestion at intersections along the corridor. Map 5.2 (above) shows estimated changes in 24-hour volumes in 2022 compared to the No Build condition. Minimal impact is anticipated from passenger rail should a station be located off of Spit Brook Road, as the majority of the traffic accessing the rail station will occur outside of the forecast peak periods.

Spit Brook Road Intersections Level of Service Comparison

As shown in Table 5.4, a LOS analysis was undertaken for each Spit Brook Road intersection for the 2022 Build and No Build peak periods. No Saturday analysis was conducted for Tara Boulevard and Oracle Drive because the land uses generate very limited traffic on Saturdays.



TABLE 5.4: SPIT BROOK ROAD LEVEL OF SERVICE – 2022 NO BUILD VS. BUILD
 **Morning/Mid-day Peak**

Location	Peak Time	2022 No Build			2022 Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Spit Brook Road at Oracle Drive	7-9 a.m.	5	0.74	A	3	0.58	A	-2
Spit Brook Road at Tara Boulevard	7-9 a.m.	216	3.57	F	176	2.00	F	-40
Spit Brook Road at Newcastle Drive	11 a.m.-1 p.m.	24	0.62	C	20	0.57	B	-4
Spit Brook Road at Royal Ridge Drive	11 a.m.-1 p.m.	18	0.73	B	32	0.99	C	14
Spit Brook Road at Daniel Webster Highway	11 a.m.-1 p.m.	31	0.81	C	28	0.77	C	-3

 **Evening Peak**

Location	Peak Time	No build			2022 Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Spit Brook Road at Oracle Drive	4-6 p.m.	17	0.4	B	11	0.75	A	-6
Spit Brook Road at Tara Boulevard	4-6 p.m.	330	2.51	F	342	2.49	F	12
Spit Brook Road at Newcastle Drive	4-6 p.m.	42	0.86	D	38	0.84	D	-4
Spit Brook Road at Royal Ridge Drive	4-6 p.m.	18	0.75	B	19	0.76	B	1
Spit Brook Road at Daniel Webster Highway	4-6 p.m.	27	0.77	C	25	0.75	C	-2

 **Saturday Peak**

Location	Peak Time	No build			2022 Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Spit Brook Road at Newcastle Drive	1-3 p.m.	26	0.76	C	22	0.66	C	-4
Spit Brook Road at Royal Ridge Drive	1-3 p.m.	21	0.76	C	36	0.88	D	14
Spit Brook Road at Daniel Webster Highway	1-3 p.m.	49	0.93	D	42	0.95	D	-7



Traffic growth over the past decade has been flat in the study area, including along most of Spit Brook Road. Forecast conditions for 2022 under the Build and No Build Scenarios suggest a continuation of slow growth in traffic volumes throughout the study area. The built out nature of the study area, anticipated slow population growth and a recovering economy support this assumption. Under both scenarios the operations on the Spit Brook Road corridor east of the F.E. Everett turnpike will be good (overall LOS C or better). Comparing the 2022 No Build to the 2022 Build Scenario shows where improvements to intersection operations can be expected along the Spit Brook Road corridor. With an Exit 36 southbound off ramp in place, the volume and delay will be reduced along Spit Brook Road as traffic diverts to the new Exit 36 southbound off ramp. It is important to note that while the overall operations of the intersections along the corridor are good, there may be one or more intersection turning movements that will be operating at a poor LOS.

To provide an assessment of the potential benefits of the Exit 36 S Build Scenario, the **Saturday Peak Hour** was used to estimate the maximum improvement for the intersections along the Spit Brook Road Corridor east of the turnpike.

Spit Brook Road at Exit 1 Southbound Ramp

At the Exit 1 southbound off ramp intersection with Spit Brook Road, the greatest improvements in operation will be realized by the left turning movements onto Spit Brook Road eastbound. At this location, the peak hour volumes drop by 220 vehicles. Additional signal optimization will be required to reduce delay under the Build Scenario.

Spit Brook Road and New Castle Drive:

Under the Build Scenario, the eastbound traffic on Spit Brook Road, passing through the Newcastle Drive intersection is expected to be reduced by 180 vehicles during the Saturday peak hour. This will reduce the delay for eastbound traffic by approximately 5 seconds per vehicle.

Spit Brook Road and Royal Ridge Drive:

Similarly, the volume of eastbound traffic moving through the Royal Ridge Drive and Spit Brook Road intersection will decrease by approximately 170 vehicles. LOS for the eastbound movement will be rated as an A under the Build and No Build Scenarios.



Spit Brook Road and Daniel Webster Highway

That iconic piece of New England advertising that states “Left on Spit Brook right on Daniel Webster” could get a whole lot easier. The intersection of Spit Brook Road and Daniel Webster Highway will also experience the benefits of the Exit 36 S Build Scenario. It is estimated that as many as 300 fewer vehicles will be turning right from Spit Brook Road onto Daniel Webster Highway during the Saturday Peak hour. This will reduce the delay for right turning vehicles by 13 seconds and improve the LOS to a B.

West of the Turnpike, intersection operations show little change between the Build and No Build Scenarios. Delays remain significant at Spit Brook Road and Tara Boulevard. In all weekday peak periods, traffic volumes are forecast to be at least double the capacity of the intersection. Reduction in delay during the morning peak is forecast at Tara Boulevard in the Build Scenario. However, overall the intersection is expected to continue to operate at LOS F unless mitigating actions are taken.

D. DANIEL WEBSTER HIGHWAY

Traffic Volume Comparison

Travel demand forecasts for 2022 No Build and Build Scenarios for the Daniel Webster Highway were made by applying output from the NRPC travel demand model. Table 5.5 summarizes the data collected and the model output which estimates change in traffic on the identified segments of Daniel Webster Highway.

TABLE 5.5: DANIEL WEBSTER HIGHWAY 2022 TRAFFIC VOLUME COUNTS

Location	2022 No Build Forecast, Vehicles per	2022 Build Forecast, Vehicles per	Change
Daniel Webster Highway at MA/NH Stateline	18,382	19,800	8%
Daniel Webster Highway at Dan Chan Street	N/A	N/A	N/A
Daniel Webster Highway south of Danforth Drive	22,400	15,300	-32%
Daniel Webster Highway south of Silver Drive	25,530	19,700	-23%
Daniel Webster Highway north of Silver Drive	N/A	N/A	N/A
Daniel Webster Highway south of Spit Brook Dr.	30,500	25,106	-18%
Daniel Webster Highway north of Spit Brook Dr.	21,875	18,675	-15%

A comparison of the forecasted 24-hour traffic volumes for the 2022 No Build and Build Scenarios shows an **average 20%** reduction in 24-hour traffic volume between Spit Brook Road and the state line. This results in an overall improvement at all intersections along this portion of the corridor, with the greatest improvements in the northbound and southbound through movements.



Under the Build Scenario, the southern extent of Daniel Webster Highway, as it approaches the state line, is likely to see an increase in traffic because of the easy access from the Exit 36 southbound off ramp. Traffic entering and exiting the retail developments near the Pheasant Lane Mall will use Daniel Webster Highway to access Middlesex Road and the Exit 36 Ramp system.

North of Spit Brook Road, Daniel Webster Highway is also expected to see an estimated 15% reduction in traffic volume as the F.E. Everett Turnpike and additional capacity on Spit Brook Road draw traffic away from the northern segment of Daniel Webster Highway.

Saturday travelers will continue to experience higher traffic volumes than weekday travelers along most of Daniel Webster Highway. Saturday volumes will still approach 30,000 vehicles per day, while retail trips will continue to dominate in the study area.

Daniel Webster Highway Intersections Level of Service

As shown in Table 5.5, a LOS analysis was completed comparing the 2022 No Build to the 2022 Build intersection operations for each Daniel Webster Highway intersection during peak periods.



TABLE 5.6: DANIEL WEBSTER HIGHWAY 2022 PROJECTED LEVELS OF SERVICE

 Morning/Midday

Location	Peak Time	2022 No Build			2022 Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Daniel Webster Highway at Silver Drive	11 a.m.-1 p.m.	24	.75	C	25	.80	C	1
Daniel Webster Highway at Danforth Rd	11 a.m.-1 p.m.	64	1.10	E	54	1.08	D	-10
Daniel Webster Highway at Dan Chan Rd	11 a.m.-1 p.m.	28	0.79	C	20	0.53	C	-8
Daniel Webster Highway at Pheasant Ln	11 a.m.-1 p.m.	33	1.24	C	87	2.61	F	54

 Evening Peak

Location	Peak Time	No Build			2022 Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Daniel Webster Highway at Silver Drive	4-6 p.m.	23	0.81	C	26	0.82	C	3
Daniel Webster Highway at Danforth Rd	4-6 p.m.	55	1.04	D	47	0.98	D	-8
Daniel Webster Highway at Dan Chan Rd	4-6 p.m.	26	0.75	C	21	0.53	C	-5
Daniel Webster Highway at Pheasant Ln	4-6 p.m.	21	0.76	C	23	0.77	C	2

 Saturday Peak

Location	Peak Time	No Build			2022 Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Daniel Webster Highway at Silver Drive	1-3 p.m.	44	0.98	D	53	0.94	D	9
Daniel Webster Highway at Danforth Rd	1-3 p.m.	161	1.41	F	128	1.41	F	-33
Daniel Webster Highway at Dan Chan Rd	2-4 p.m.	33	0.81	C	31	0.88	C	-2
Daniel Webster Highway at Pheasant Ln	1-3 p.m.	64	2.54	E	81	2.55	F	17



Daniel Webster Highway Level of Service Analysis

With an Exit 36 southbound off ramp in place, traffic destined for retail and commercial locations at the southern end of the Daniel Webster Highway will be drawn to the new off ramp. As a result, the operations at many of the intersections along the Daniel Webster Highway north of Pheasant Lane will improve. Specifically, the intersection of Daniel Webster Highway and Danforth, as well as the intersection of Daniel Webster Highway at Dan Chan will experience the greatest reduction in delay. Overall operations will improve by up to 10 seconds per vehicle at these intersections. The southbound through movements will experience the greatest reduction in delay with wait times reduced by an average of 46 seconds per vehicle. The greatest reduction in delay for northbound traffic is expected at the intersection with Spit Brook Road, where time savings will approach 20 seconds per vehicle.

To provide an assessment of the potential benefits of the Exit 36 S 2022 Build Scenario, the **Saturday Peak Hour** was used to estimate the maximum improvement at the intersections along the Spit Brook Road Corridor east of the turnpike.

Sliver Drive and Daniel Webster Highway

The benefits of an Exit 36 S become clear as operations are analyzed at the intersections along Daniel Webster Highway. At the intersection of Silver Drive and Daniel Webster Highway, the Saturday Peak Hour southbound volume will be reduced from 1,496 vehicles under the No Build Scenario to 719 vehicles under the Build Scenario; a reduction of more than 50%. Southbound traffic turning left into the Webster Square retail development will realize a time savings of approximately 30 second per vehicle, as the left turn operation improves from a LOS F to a LOS E. Under the Build Scenario signal optimization will be necessary to maximize the benefits of the Exit 36 S ramp.

Danforth Road and Daniel Webster Highway

Similarly, at the intersection of Danforth Road and Daniel Webster Highway the Saturday Peak Hour southbound volume will drop from 1490 vehicles in the No Build Scenario to 698 in the Build Scenario. In addition the southbound delay per vehicle will improve from 221 seconds to 48 seconds. Operations for southbound traffic will improve from LOS F to LOS D. Left turning traffic from Daniel Webster Highway onto Danforth Road will be reduced by 80 vehicles in the Saturday Peak hour with each vehicles delay reduced by 14 seconds. Additional improvements under the Build Scenario could be realized through signal optimization for the Build Scenario and modifying the pedestrian phase of the signal.



Dan Chan Road and Daniel Webster Highway

The intersection of Dan Chan Road and Daniel Webster Highway, functions as a decision point in the 2022 travel demand model. Because the travel demand model uses an iterative shortest path algorithm, trips originating or destined for this location have the nearly same travel time to access Exit 36 or Exit 1. At this intersection the travel demand model begins to show a more even distribution as the model sends about half of the traffic towards the new Exit 36 Southbound and half towards Spit Brook and Exit 1. Despite the mid-model location, significant improvements in intersection operations are still evident under the Build Scenario as southbound through movements and left turns at Dan Chan Road improve dramatically. The No Build Scenario is forecast to have 1,887 southbound vehicles during the Saturday peak hour while the Build Scenario forecast is 1,104 for the same time period. Similar to intersections to the north additional cycle length optimization should be considered under the build scenario.

Pheasant Lane (Costco) and Daniel Webster Highway

The intersection of Daniel Webster and Pheasant Lane will be influenced by the construction of an Exit 36 Southbound off ramp. Under the Build Scenario the intersection of Daniel Webster Highway at Pheasant Lane will experience failing conditions during the Saturday peak hour as the proposed Exit 36 S off ramp provides quick and convenient access to the retail destinations in this area. Northbound traffic on Daniel Webster Highway at the Pheasant Lane (Costco) intersection increases with an additional 96 (224) left turning vehicles and 120 (1,168 total) vehicles continuing north through the intersection, contributing to the Saturday peak hour failing conditions. Mitigation will be needed at this intersection as delay in the morning peak is forecast to increase up to 54 seconds. Improvement options include simultaneous left turn phasing, coordination with the signals at Exit 36 in Massachusetts, and an additional left turn lane.

There is a reduction in southbound volume under the 2022 Build Scenario. As explained above, traffic is drawn to the retail destinations at the south end of Daniel Webster Highway and northern end of Middlesex Road because of the quick and convenient access provided by the proposed new ramp. Saturday peak hour southbound traffic passing through the intersection of Daniel Webster Highway at Pheasant Lane is reduced from 1,357 vehicles in the 2022 No Build Scenario to 1,100 vehicles in the Build Scenario. Similarly southbound traffic turning left is reduced by 50% from 219 vehicles to 101 vehicles.



E. COST OF CONGESTION

For many residents of New Hampshire the trip to retail destinations at the southern end of Daniel Webster Highway requires a left turn on Spit Brook Road and a right turn on D.W. Highway. This route was iconized in the 1980's when a prominent New England based furniture retailer advertised their Nashua location with the tag line "left on Spit Brook, right on Daniel Webster". This 1.2 mile journey remains the most direct route to the southern end of Daniel Webster Highway.

Travel time data collected in spring of 2014 indicates that the 1.2 mile trip from Exit 1 to the intersection of the Exit 36 ramps at the southern Pheasant Lane Mall entrance takes between 9 and 12 minutes during a typical Saturday peak period. Weekday peak periods are slightly better with travel times ranging between 7 and 9 minutes. It is widely accepted that peak periods during the holiday season result in additional delay along this corridor given its retail nature.

Value of fuel

The travel demand model estimates that approximately 3,500 vehicles destined for the intersection of the Exit 36 ramps at the southern Pheasant Lane Mall entrance use the Spit Brook Road to Daniel Webster Highway travel pattern. Similarly, under the Build Scenario it is estimated that approximately 3,700 vehicles will use the new Exit 36 Southbound off ramp to access Pheasant Lane Mall. Table 5.7 below highlights the estimated savings in fuel usage if Exit 36 Southbound is constructed.

TABLE 5.7: FUEL USAGE COMPARISON

	Trip Length (Miles)	Travel Time (Min)	Avg Speed (MPH)	Fuel Economy (MPG) ³	Fuel Used Gallons/Trip	Cost/day/Trip	Cost/Day	Annual Cost
Spit Brook/DW	1.3	10	8	12	0.11	\$ 0.41	\$ 1,218.75	\$ 444,843.75
Exit 36 S	1.2	3	24	31	0.04	\$ 0.15	\$ 508.06	\$ 185,443.55
Savings		7			0.07	\$ 0.26	\$ 913.81	\$ 333,540.83

Comparing current travel time from Exit 1 to the intersection of the Exit 36 ramps at the southern Pheasant Lane Mall entrance with the travel time estimate under a Build Scenario shows a typical time savings of approximately 7 minutes per vehicle. Based on travel time, average speed fuel economy data, and an estimated fuel cost of \$3.75 gallon the construction of Exit 36 Southbound could save as much as

³ Source: B.H. West, R.N. McGill, J.W. Hodgson, S.S. Sluder, D.E. Smith, *Development and Verification of Light-Duty Modal Emissions and Fuel Consumption Values for Traffic Models*, Washington, DC, April 1997, and additional project data, April 1998. (Additional resources: www.fhwa-tsis.com)



\$333,000 per year in fuel costs.

CO₂ Emissions

The fuel savings realized by developing Exit 36 also contributes to a reduction on Carbon Dioxide (CO₂) emissions. CO₂ is a greenhouse gas and widely accepted as a contributor to climate change. With Exit 36 Southbound constructed, conservative estimates place fuel savings in the range of 89,000 gallons per year with a corresponding reduction in CO₂ emissions of 1.8 million pounds per year.

Lost Productivity

Time spent in congestion bears costs related to lost productivity. To quantify lost productivity, national values calculated by the Texas Transportation Institute were applied to the congestion observed in the New Hampshire portion of the study area. Under this analysis, the average value of time is assumed to be \$16.30 per hour and an annual estimate is calculated by multiplying that figure by the average number of hours travelers spend idling in congestion from Exit 1 to the intersection of the Exit 36 ramps at the southern Pheasant Lane Mall entrance. Comparing the current average observed travel time with the forecasted travel time using a new Exit 36 Southbound off ramp; a value of lost productivity was estimated and is shown in Table 5.8, below.

TABLE 5.8: TRIP COST SAVINGS COMPARISON

Average Delay in Min/Person-Trip	Avg. Person-Trip/Day	Rate \$/Hour⁴	Dollars/day	Dollars / year
6	3400	\$16.30	\$ 5,542.00	\$ 2,022,830.00

On an average day (including Saturday) it is estimated that vehicle from the north passing through the intersection of the Exit 36 ramps at the southern Pheasant Lane Mall entrance will save 6 minutes of travel time. A conservative estimate of one passenger per vehicle results in an annual savings of \$2 million dollars per year.

⁴ Source: TTI's 2011 URBAN MOBILITY REPORT Powered by INRIX Traffic Data, David Schrank, Tim Lomax, Bill Eisele, Texas Transportation Institute The Texas A&M University System <http://mobility.tamu.edu> - September 2011



F. MIDDLESEX ROAD

Traffic Volume Analysis

Future travel forecasts for 2022 No Build and Build Scenarios for Middlesex Road were developed by NMCOG using the latest available information on population and employment. Table 5.9 summarizes the forecast volumes which compares the estimated change in traffic between the 2022 Build and No Build Scenarios on Middlesex Road.

TABLE 5.9: MIDDLESEX ROAD 2022 TRAFFIC VOLUME COUNTS

Location	2022 No Build	2022 Build
Middlesex Road South of Bryant Lane	13,180	13,180
Middlesex Road north of Locust Avenue	14,860	14,502
Middlesex Road South of Route 3 Exit 36 Ramps	14,478	

Forecasted volumes along Middlesex Road remain fairly constant near the State line with the addition of the exit ramp in place. South of Locust Avenue, there is very little effect on Middlesex Road from the proposed Exit 36 Southbound Ramp. North of Locust Avenue, overall daily volumes remain constant due to the added capacity at Exit 36 and the lack of new development in Tyngsborough.

Middlesex Road Intersections Levels of Service

Table 5.10 shows the results of the LOS analysis comparing the 2022 No Build to the 2022 Build for each Middlesex Road intersection during peak periods. Because of the retail nature of the area in northern Tyngsborough, higher traffic volumes were noted during the mid-day rather than the early morning hours, as well as during the evening and Saturday peaks.



TABLE 5.10: MIDDLESEX ROAD 2022 LEVELS OF SERVICE

 **Morning Peak**

Location	Peak Time	2022 NB			2022 Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Middlesex Rd at TJ Maxx Plaza Entrance	11 a.m.-1 p.m.	14	0.64	B	15	0.69	B	1
Middlesex Rd at Locust Ave	11 a.m.-1 p.m.	12	0.73	B	12	0.73	B	0

 **Evening Peak**

Location	Peak Time	2022 NB			2022 Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Middlesex Rd at TJ Maxx Plaza Entrance	4-6 p.m.	12	0.53	B	12	0.52	B	0
Middlesex Rd at Locust Ave	4-6 p.m.	9	0.63	A	9	0.63	A	0

 **Saturday Peak**

Location	Peak Time	2022 NB			2022 Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Middlesex Rd at TJ Maxx Plaza Entrance	1-3 p.m.	36	1.25	D	43	1.30	D	7
Middlesex Rd at Locust Ave	1-3 p.m.	33	1.27	C	35	1.29	C	2



Middlesex Road Level of Service Analysis

A comparison of the 2022 Build and 2022 No Build Scenarios shows that intersection operations for the weekday peak periods on Middlesex Road will benefit from signal timing changes ensuring acceptable levels of service continue into the future. In each scenario, the intersections function during the weekday peak with little overall intersection delay. During the Saturday peak, traffic volumes will begin to exceed capacity at the TJ Maxx Plaza entrance, as well as at the Locust Avenue intersection eastbound approach. Under both the Build and No Build Scenarios, overall intersection traffic operations will remain at acceptable levels. At the Middlesex Road/TJ Maxx Plaza, eastbound turning movements begin to see unacceptable delays in the future condition. This condition is mainly due to projected increased volumes on the mainline in 2022. Optimizing the signal timing and coordination with other nearby traffic signals would serve to improve this approach and the overall intersection operation. Locust Avenue will experience poor levels of service on the eastbound approach under both scenarios in 2022. The intersection operating conditions would improve by optimizing the traffic signal timing and phasing to handle the higher traffic volumes under the future condition.



G. KENDALL ROAD / ROUTE 113

Traffic Volume Comparison

Future travel forecasts for the 2022 No Build and Build Scenarios for Kendall Road/ Route 113 were developed by NMCOG using the latest available information on population and employment. Table 5.11 summarizes the forecast volumes which compare the estimated change in traffic between the Build and No Build Scenarios.

TABLE 5.11: KENDALL ROAD/ROUTE 113 TRAFFIC VOLUME COUNTS – 2022 NO BUILD VS. BUILD

Location	2022 No Build	2022 Build
Route 113 East of Locust Avenue	13,535	13,297
Cummings Road South of Route 113	2,710	2,710
Locust Avenue North of Route 113	3,210	2,973
Route 113 East of Route 3 Exit 35 NB Ramps	8,475	8,475

Kendall Road/Route 113 Traffic Volume Analysis

Kendall Road/Route 113 is considered a commuter oriented corridor with limited commercial activity between Route 3 and Tyngsborough Center. Traffic volumes are forecast to remain highest during the weekday peaks when motorists are traveling to and from work. The 2022 forecast traffic volumes indicate that Kendall Road will carry more traffic west of the Exit 35 interchange (heading toward the direction of Dunstable), than to the east (headed toward Tyngsborough Town Center). Minor roads located off Route 113, including Cummings Road and Locust Avenue, will experience relatively low traffic volumes and daily traffic will not be affected by the addition of a new ramp. East of Locust Avenue, there is a small drop in volume, mainly due to the motorists using Exit 35 to access the Pheasant Lane Mall area.

Kendall Road/Route 113 Turning Movement Counts

A comparison of the 2022 Build and 2022 No Build Scenarios shows little change in intersection operations for the weekday peak periods along the Route 113 corridor. Because this roadway is more commuter oriented rather than retail focused, the AM peak was counted (rather than the mid-day peak), in addition to the evening and Saturday peaks. As shown in Table 5.12, a LOS analysis was undertaken for each Kendall Road/Route 113 intersection based on turning movement counts collected during peak periods and projected to 2022.



TABLE 5.12: KENDALL ROAD/ROUTE 113 2022 LEVELS OF SERVICE

 Morning Peak

Location	Peak Time	2022 No Build			2022 Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Rte 113 (Kendall Rd) at Locust Ave*	7-9 a.m.	35	0.36	D	35	0.36	F	0
Rte 113 (Kendall Rd) at Cummings St*	7-9 a.m.	34	0.44	D	34	0.44	F	0
Rte 113 (Kendall Rd) at Middlesex Rd	7-9 a.m.	72	1.28	E	72	1.28	F	0

 Evening Peak

Location	Peak Time	No Build			2022 Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Rte 113 (Kendall Rd) at Locust Ave	4-6 p.m.	54	1.72	F	54	1.72	F	0
Rte 113 (Kendall Rd) at Cummings St	4-6 p.m.	35	0.60	D	35	0.60	D	0
Rte 113 (Kendall Rd) at Middlesex Rd	4-6 p.m.	65	1.14	E	65	1.14	E	0

 Saturday Peak

Location	Peak Time	No Build			2022 Build			Change Delay
		Delay	V/C	LOS	Delay	V/C	LOS	
Rte 113 (Kendall Rd) at Locust Ave	1-3 p.m.	34	0.62	D	33	0.60	D	-1
Rte 113 (Kendall Rd) at Cummings St	1-3 p.m.	16	0.12	C	15	0.12	C	-1
Rte 113 (Kendall Rd) at Middlesex Rd	1-3 p.m.	112	2.65	F	112	2.65	F	0



Kendall Road 2022 Level of Service Analysis

A comparison of the 2022 Build to 2022 No Build Scenarios shows that intersection delays will be most acute at the Kendall Road and Middlesex Road intersection during the Saturday peak. Estimates show increasing delay at Kendall and Middlesex Road in 2022 without the construction of an Exit 36 Southbound off ramp. The Kendall Road/Middlesex Road intersection will see very high volumes of traffic as it provides access to the only Merrimack River crossing in Tyngsborough. Thus any traffic moving from Route 3 to the northeast side of Tyngsborough, Dracut, Hudson, NH, or even parts of Lowell will continue to pass through this intersection. The proposed Exit 36 Southbound ramp does not affect this intersection in that any benefits would be neutralized by background increases of volumes of traffic flowing through the intersection.

Operations at all intersections along Kendall Road deteriorate slightly in the 2022 No Build Scenario during the morning and evening peaks. Because of the commuter oriented nature of Kendall Road, the most notable change at Kendall Road and Locust Ave will occur in the evening peak, where delay will nearly double and future traffic volumes will exceed capacity. Because this is a stop controlled intersection, delay is reported based on the most delayed movement through the intersection. In this case movement in the future left turns from Locust Avenue to Kendall Road eastbound will be most impacted.



VI. Future Land Use Conditions

A. INTRODUCTION

The construction of an Exit 36 southbound ramp provides opportunities for the municipalities of Tyngsborough and Nashua to address needed improvements to existing infrastructure in the study area, including investments in transit, pedestrian and bicycle amenities as well as aesthetic upgrades. These improvements will ensure that the study area remains accessible for all transportation system users.

Additionally, as discussed in the Existing Condition chapters of this report, the Exit 36 Study Area is a major source of economic development in both the municipalities of Nashua and Tyngsborough. While the Nashua side of the study area is largely built out in many areas, redevelopment opportunities provide a venue to increase tax receipts. Careful land use planning will ensure that the area remains a significant producer of economic output and jobs for many years to come. In concert with transportation and aesthetic enhancements, both the economic productivity and livability of the study area can be enhanced in future years.

B. NASHUA LAND USE OPPORTUNITIES

The development of a southbound Exit 36 off ramp will provide additional opportunities for redevelopment and reinvestment, leading to the future build out and development of the remaining parcels in the Nashua portion of the project study area.

From an economic development perspective, South Nashua has proven resilient in attracting and sustaining a diverse economy. Vacancy rates are very low and are anticipated to remain low into the future. Home to a thriving retail environment promoted by real estate companies as “the number one retail corridor in New Hampshire” (Loopnet), South Nashua also boasts a significant collection of major employers and high technology companies, including BAE Systems, Intel, United Health Group, and Oracle. AspenTech, a supplier of software for manufacturing companies, opened a major research and development center in the area in October 2012.

While a great deal of study area in Nashua is built out, several new development and redevelopment opportunities do exist. Nashua officials have identified several major parcels as of significant future economic development value, as shown in Map 6.1 and described below.

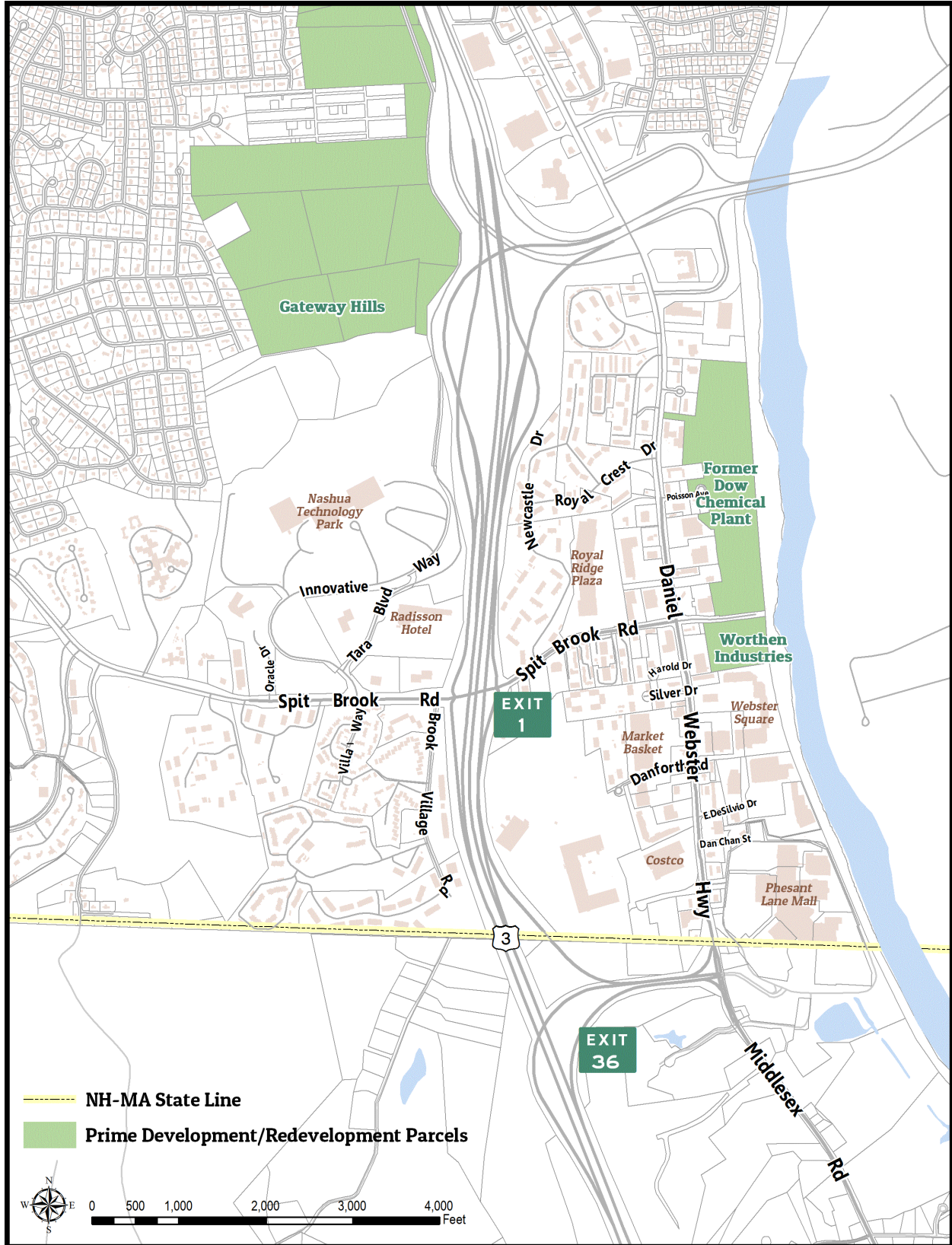
The former 41 acre Dow Chemical site at the east end of Spit Brook Road has long been of interest to developers. The site is the largest vacant parcel to the east of the F.E. Everett Turnpike in the Nashua



portion of the study area, and has been considered as a potential site for a commuter rail station. Several major developments have been proposed for the vacant site, including one proposal for a 'lifestyle center' consisting of commercial and residential uses, but none have come to fruition. Nashua officials are confident that the size of the parcel, its rail access, and its location between Daniel Webster Highway and the Merrimack River will continue to make it attractive for prospective development. Nashua officials believe that the parcel will become more marketable for development with the installation of an Exit 36 southbound ramp due to improved accessibility to the site from reduced congestion levels at Exit 1. The land value of the parcel was assessed at \$20.9 million in 2013.



MAP 6.1: FUTURE ECONOMIC DEVELOPMENT/REDEVELOPMENT - NASHUA



The Worthen Industries site immediately across the street from the Dow Chemical site at 3 Spit Brook Road has also been identified as of significant redevelopment potential. Nashua officials believe that the site would be very attractive for mixed-use development should commuter rail service be extended to the Dow Chemical site. Worthen Industries, a manufacturer of adhesives, coatings and laminated products, currently maintains its corporate headquarters at the site. The parcel is approximately 9.3 acres and was assessed at \$3.2 million in 2013 (\$2.17 million in land value and \$1.05 million in building value).

Finally, Gateway Hills, a major mixed-use project currently under development, makes up the single largest parcel of undeveloped land in the Nashua portion of the study area. The development, comprising approximately 240 acres, is proposed to accommodate industrial, commercial and residential uses. An extended-stay hotel has also been proposed for part of the site. The John Flatley Co. is the development company spearheading the project. A commercial development has already been developed along Spit Brook Road while 384 units of multi-family housing off of Innovative Way are under construction. A 105-room Homewood Suites by Hilton Hotel was approved by the Nashua Planning Board in February 2014. Developers hope to make industrial research and development uses the target of future phases of the project.

Additionally, while all parcels located directly along Daniel Webster Highway have already been developed, it is important to note that much of this development is made up of one-story retail uses and surface parking facilities. Future redevelopment with multi-level structures and tiered parking facilities would allow Nashua city planners take advantage of better access provided by the Exit 36 Southbound Project.

C. TYNGSBOROUGH LAND USE OPPORTUNITIES

Vision for Middlesex Road

Middlesex Road serves as the primary gateway into Tyngsborough from both the north and south. Although land uses along the corridor are principally commercial, the area around the Town Center contains some outstanding views of the Merrimack River. While there is a significant cluster of retail establishments near the Nashua line, and the beginnings of a commercial node near the Town Center, commercial activity along the remainder of the corridor is limited. Middlesex Road from the Town Center north to the New Hampshire state line is viewed by the Town as a future commercial corridor, with a special focus on restaurant development. As discussed below, the construction of sewer infrastructure would be advantageous in terms of attracting this type of “Restaurant Row” style



development. One competitive advantage for Tyngsborough in this regard stems from Massachusetts' favorable meal tax rate when compared with New Hampshire.

Land Use and Economic Development Issues

This section of the Middlesex Road corridor has been targeted by the Town for future commercial development. With the construction of an Exit 36 southbound ramp, access to this area would be primarily be from the north. Therefore, the impact of increased development on the community as a whole, including the town's residential areas, would be relatively limited.

Vacancy rates among commercial developments along Middlesex Road are relatively high, particularly in T.J. Maxx Plaza, and expanded access from the north may make this portion of Middlesex Road more attractive from an economic development perspective. Several parcels within the Tyngsborough portion of the study area have been identified as having development/redevelopment potential, as shown on Map 6.2. Collectively these parcels comprise approximately 123 acres, as outlined in Table 6.1 below.

TABLE 6.1: TYNGSBOROUGH STUDY AREA PARCELS WITH DEVELOPMENT/REDEVELOPMENT POTENTIAL

Address	Parcel I.D. Number	Parcel Size (acres)	Zoning Classification
298 Middlesex Road	20-40	2.00	B3
304 Middlesex Road	19-1A	2.97	B3/I1
306 Middlesex Road	19-1B	0.30	B3
324 Middlesex Road	19-5	15.86	B3/I1
347 Middlesex Road	19-9	11.09	B3
352 Middlesex Road	19-7	6.72	B3/1
371 Middlesex Road	12-40	.92	B3
406 Middlesex Road	11-2	25.00	B3/I1
409 Middlesex Road	11-24	0.83	B3
451 Middlesex Road	11-17	0.94	B3
80 Locust Avenue	12-35-1	2.06	B3
Route 3 (limited frontage on Middlesex Road)	12-29A	54.93	I1
		Total	123.62

There are several parcels located along the corridor which are currently split-zoned, i.e., these parcels lies within both the B-3 and I-1 districts (304, 324, 352 and 406 Middlesex Road). Properties such as these, that are likely to be developed or redeveloped in the future, may require zoning changes in order

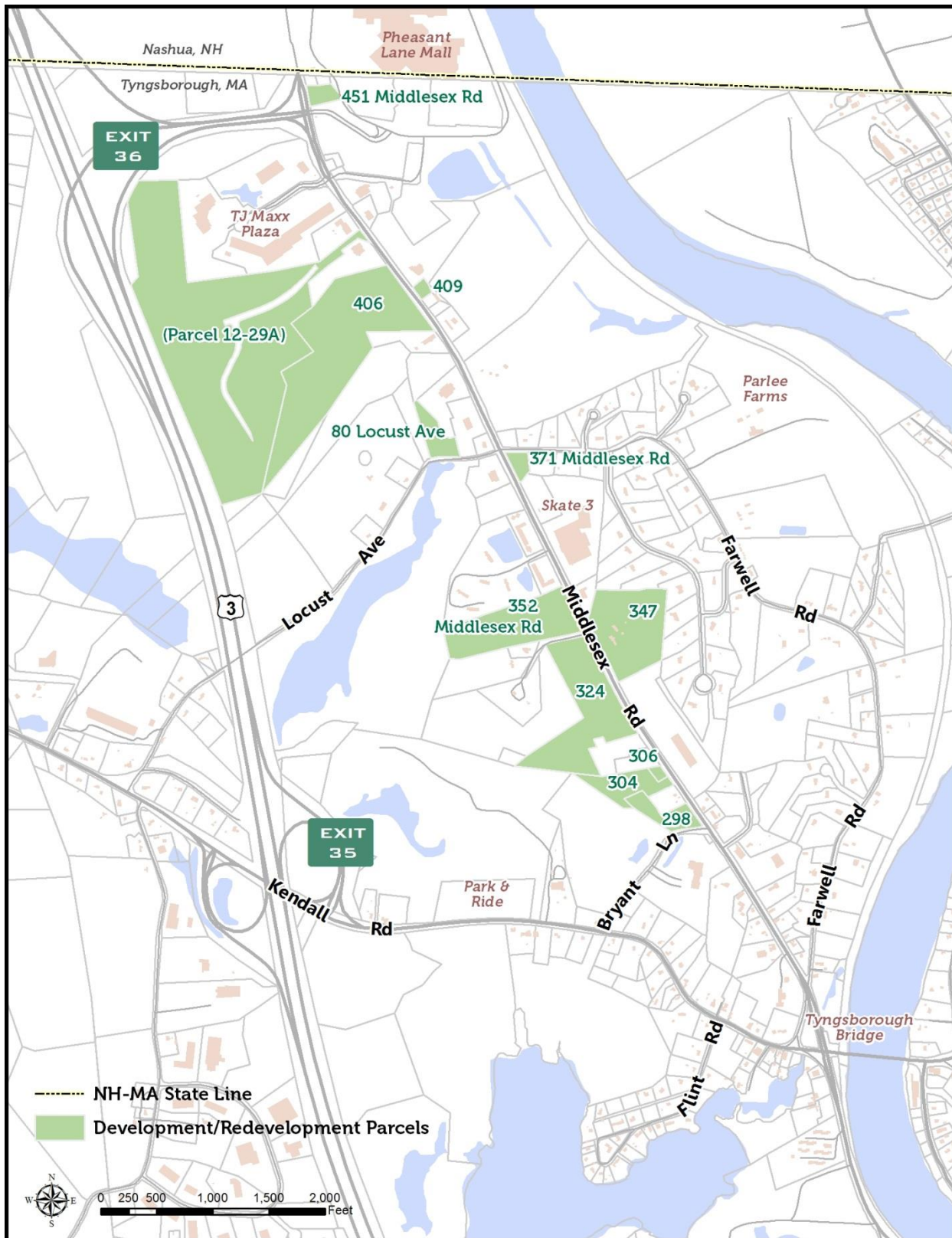


to reconcile the proposed use with the zoning designation. To better position the community from an economic development perspective, the Town should consider addressing this issue pre-emptively, in order to ensure the highest and best use of these properties.

In addition to the proposed Exit 36 project, there are other transportation initiatives under discussion which may impact future land use. In 2002, MassDOT completed *The New Tyngsborough Bridge Transportation Study* which evaluated fourteen alternative alignments for siting a second river crossing in Tyngsborough. The study evaluated the potential land use and development impacts of each alternative. Two alternatives emerged from the study for future consideration. These alternatives will be more closely examined during the environmental review process. Alternative 5/6 is located just south of the existing Tyngsborough Bridge, and Alternative 14 is proposed in the vicinity of the Pheasant Lane Mall.



MAP 6.2: FUTURE ECONOMIC DEVELOPMENT/REDEVELOPMENT - TYNGSBOROUGH



In terms of Alternative 5/6, the study found that commercial and industrial uses would be attracted to the new bridge access road on the west side of the river. The land in this area is already appropriately zoned to accommodate such uses. The study further noted that there may be a need to reconfigure some parcels and to modify the zoning to account for land taken for construction of the access road.

In examining Alternative 14, the study found that approximately five undeveloped parcels east of the Pheasant Lane Mall parking lot would be impacted. The new access road would have a moderate impact on commercial and industrial development within this part of the study area. While the location of the proposed second river crossing has not been definitively decided, the Tyngsborough Board of Selectmen previously voted to endorse Alternative 5/6.

While zoning can be viewed as the intent of the community, market forces often determine what actually gets built. In the past, the Town has discussed creating design guidelines for future economic development projects proposed along the Middlesex Road Corridor, from Bryants Lane north to the state line. The Tyngsborough Economic Development Plan (2006) recommended the creation of a Corridor Overlay District and corresponding design guidelines to encourage the development and redevelopment of vacant and underutilized properties along the corridor in a manner that ensures that the visual quality of the corridor is preserved or enhanced. This would be accomplished through design guidelines that address signage, parking lot layout, location and design, landscaping, architectural character, lighting and access control. In 2007, NMCOG assisted the Town in creating the draft Middlesex Road Design Guidelines for future development that stated the following goals:

- “The accommodation of motor vehicles should seek a balance between the needs of the automobile and the pedestrian; and
- Development should be integrated into the corridor and the immediate context through roadway connections, sidewalks, landscaping, connecting outdoor spaces, land use transition and compatibility, and building scale and character.”

The Tyngsborough Economic Development Plan also recommended that the Town participate in the state’s Economic Development Incentive Program (EDIP). This program is administered by the Massachusetts Office of Business Development (MOBD) and is overseen by the Economic Assistance Coordinating Council (EACC). The EDIP reflects a partnership between the community, private business and state government in order to create jobs, expand the local tax base, and bring in new revenues. Under this partnership, the community works closely with the private business on a three-step process: establishing an Economic Target Area (ETA), identifying and establishing an Economic Opportunity Area (EOA), and approving Certified Projects within an EOA.



As discussed in greater detail below, lack of infrastructure represents the greatest challenge to encouraging economic development within the Tyngsborough section of the study area. The financing of infrastructure improvements does not have to rest entirely on the municipal budget and rate payers. In Massachusetts, programs such as District Improvement Financing (DIF) and MassWorks are options that the Town could explore for addressing infrastructure improvements that are needed to accommodate planned economic development projects.

Wastewater Management Infrastructure

Tyngsborough's wastewater management system was first developed in the 1970s and has continued to grow through subsequent decades. The Town has an existing sewer system that serves approximately one-third of the community. Wastewater flows generated in Tyngsborough are received and treated at the Lowell Regional Wastewater Utility via connections with Chelmsford, Dracut and Lowell. The lack of sewer infrastructure is a significant impediment to economic development in the Tyngsborough portion of the study area. Bahama Breeze presently obtains sewer service through a private agreement with the Pheasant Lane Mall, and the Olive Garden and TJ Maxx Plaza have private septic systems.

The Town has engaged in conversations with the City of Nashua relative to providing additional sewer service along the Middlesex Road Corridor. A study completed in by the Town in June 2006 concluded that the option of entering into an Intermunicipal Agreement (IMA) with the City of Nashua is feasible from a technical and environmental perspective.

Water Infrastructure

Public water service currently serves approximately thirty percent of the Town. The remaining seventy percent of the town is served by on-site private wells. Within the Town of Tyngsborough, three water districts operate a total of five water distribution systems that access various supply sources in neighboring communities, including Dracut, Chelmsford, Lowell and Nashua. Management of the community's water supply infrastructure, and related contractual agreements, is relatively complex. The largest water distribution network is comprised of three separate water systems and operated by the Tyngsborough Water District (TWD). The TWD is the only town-based provider of public water, which is supplied through the communities of Dracut and Lowell, and through the Pennichuck Water Works Corporation of Nashua.

Water service along the northern section of Middlesex Road is provided by Pennichuck Water Works Corporation. There is a need for water service from Applewood Plaza to the intersection of Farwell Road and Locust Avenue. The 2003 Tyngsborough Comprehensive Water Resources Management Plan



(CWRMP) analyzed future water demand for the Town based upon past water use and anticipated future development. The report noted that the forecasts are complicated by the fact that the town has so many different water supply systems and sources. The CWRMP concluded that the TWD's IMA's with Lowell, Dracut and the Pennichuck Water Works Corporation appear to contain sufficient capacity for future growth. The report further stated that any growth in the existing water system would likely be driven by the need to service individual development projects.

Short-term Economic Development - 'In the Pipeline'

Initial site work has been undertaken to develop a site behind the TJ Maxx Plaza at 422 Middlesex Road. This property contains fifty acres and is zoned Limited Industrial. An access roadway and utilities have been installed and the site is being marketed. Currently, there are no other known development proposals along the Tyngsborough portion of the corridor.

D. PASSENGER RAIL AND EXIT 36 SOUTHBOUND

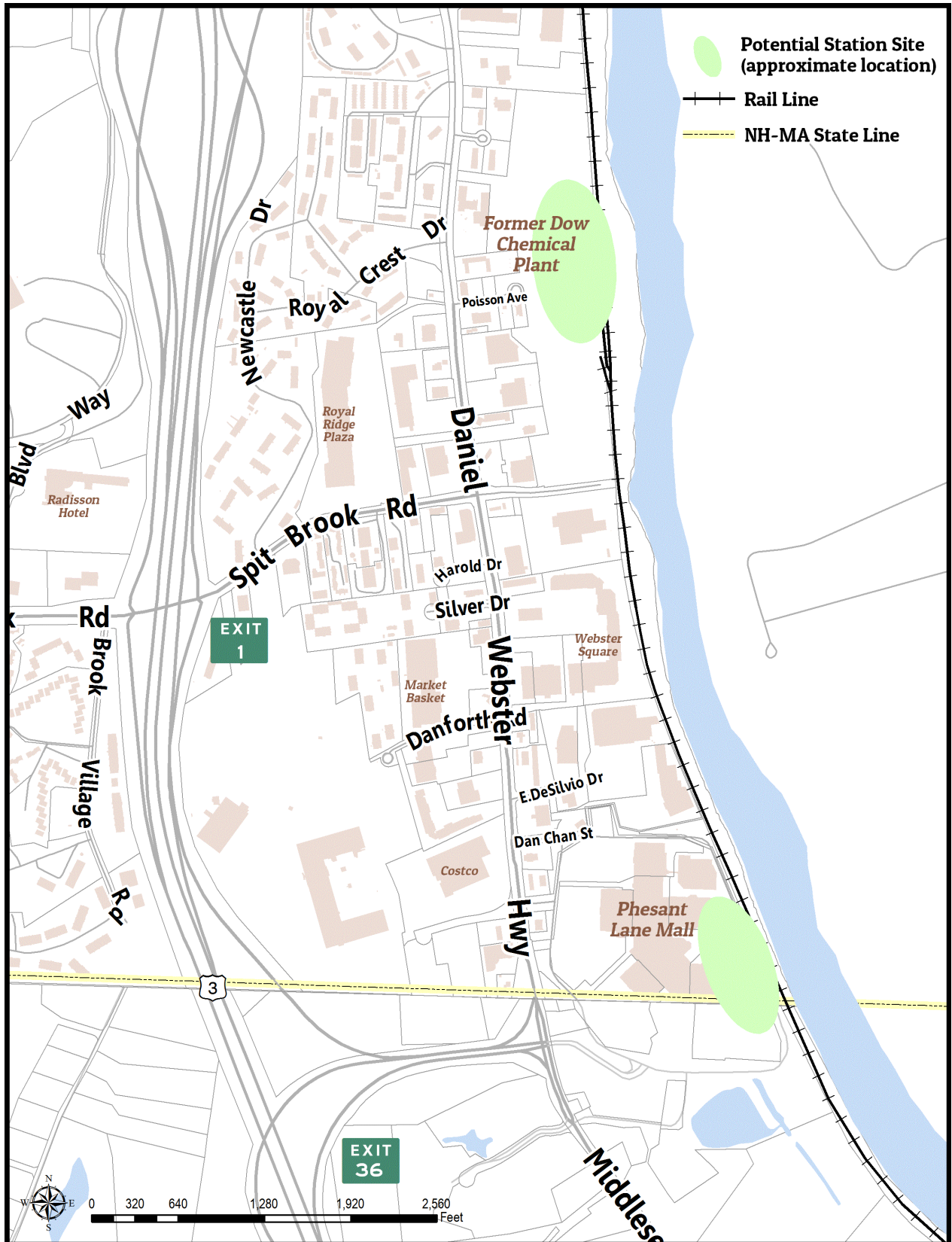
The idea of expanding commuter rail service from Boston to Southern New Hampshire, via an extension of the Lowell MBTA line, has long been discussed in the region. The New Hampshire Rail Transit Authority, charged with overseeing the potential development of commuter rail in New Hampshire, was formed via state legislation in 2007. The proposed 'Capitol Corridor' extension linking the New Hampshire cities of Nashua, Manchester and Concord to Boston via the Lowell commuter rail line is currently the subject of a feasibility study. The draft feasibility study includes rail and bus options and has identified two sites in South Nashua/Tyngsborough as potential rail station locations. Access to each of these locations will be influenced by the decision to build Exit 36 Southbound.

2 East Spit Brook Road/Dow Chemical

In South Nashua, the former Dow Chemical site has been identified as a potential station location. Located at 2 East Spit Brook Road, this 40+ acre parcel has been considered a likely location for a rail station since 2006. Regional highway access to the station would be available from Exit 1, Spit Brook Road, off the F.E. Everett Turnpike (U.S. Route 3). Poisson Avenue could provide alternative access at the northern end of the parcel and East Spit Brook Road provides access on the southern end of the site. There are currently no buildings on the site and environmental remediation is complete, with groundwater monitoring efforts continuing.



MAP 6.3: SOUTH NASHUA/TYNGSBOROUGH POTENTIAL RAIL STATION LOCATIONS



This proposed station location is not dependent upon an Exit 36 Southbound off ramp. However with an Exit 36 Southbound off ramp in place, this location would benefit from reduced congestion along Spit Brook Road and Daniel Webster Highway. In 2022 with the proposed Exit 36 Southbound off ramp in place, 24-hour traffic volumes are expected to be reduced by an average of 9% on Spit Brook Road and an average of 20% along Daniel Webster Highway. This reduction in traffic volume afforded by a new Exit 36 Southbound ramp mitigates some of the traffic impact that is associated with a commuter oriented rail or multimodal facility. Further, the retail nature of the study area results in later peak hour conditions. As a result, it is anticipated that most of the traffic generated by a passenger rail/intermodal facility will occur outside of the retail oriented peak periods with limited impact on the peak period commuter traffic congestion in the area.

Finally, the former Dow Chemical property is located within walking or bicycling distance of up to 5,900 residential units. The relative close proximity and dense development make it feasible to consider Transit Oriented Development at this location. The City may want to consider zoning changes or an overlay district to capitalize on this opportunity. In addition, a number of potential pedestrian and bicycle improvements could be considered to enhance access to this location via non-motorized modes.

Pheasant Lane Mall/State Line

A second location under consideration in the draft Capitol Corridor Feasibility study is in the vicinity of the Pheasant Lane Mall at the Nashua Tyngsborough line. The proposed station would straddle the Massachusetts and New Hampshire State line. The rail platform and station would be located between the Merrimack River and the Pheasant Lane Mall property.

The effectiveness of a rail and intermodal facility at this location largely depends upon the development and construction of an Exit 36 southbound off ramp. The construction of the Exit 36 Southbound off ramp would provide direct access into the Pheasant Lane Mall property and rail/intermodal facility. A number of issues, in addition to the construction of Exit 36 Southbound off ramp, are currently being evaluated in the Capitol Corridor Feasibility study. These include parking for rail passengers, coordination with Simon Properties, and tying into the available water and sewer infrastructure.

This site offers limited opportunity for pedestrian access as the majority of the residential development is more than one mile away and the lack of infrastructure makes non-motorized travel difficult. Therefore access to this facility will be largely by private automobile. However, the development of Exit 36 Southbound will provide opportunity for local and regional transit to serve this site efficiently. As stated previously, it is anticipated that the traffic generated by a passenger rail/intermodal facility will



occur outside of the retail oriented morning and afternoon peak periods, resulting in limited impact on the commuter peak period congestion in the area.

Policymakers may wish to construct the station in such a way as to support future transit-oriented development, a popular development style that should attract additional ridership. With this location straddling the state line opportunity for interstate cooperation and collaboration on (TOD) developments should be explored.

While the prospect of commuter rail in the study area remains uncertain, potential traffic generation should be integrated in to the design of an Exit 36 south ramp. Accessibility to the proposed station locations is important to minimize later infrastructure improvements necessary should commuter rail be extended.

E. ACCESS MANAGEMENT OPPORTUNITIES

Access management techniques are designed to reduce congestion and the frequency of accidents between turning and through traffic. By controlling the location, number, spacing, and design of access points to adjacent developments the reduction in congestion from Exit 36 southbound off ramp can be further enhanced. In areas like South Nashua, where development density is high and many minor streets and parking facilities feed directly onto the main arterials, implementing access management strategies can improve intersection performance and through volumes while also improving conditions for pedestrians and cyclists by reducing conflicts with vehicle traffic.

Nashua Cross-Connections Opportunities

Cross-connections between commercial sites provide motorists and pedestrians with the ability to travel between developments without needing to access, and place additional traffic burdens on, the main corridors in the study area. Existing cross connections are relatively well developed in the study area. The best connections are located on the east side of Daniel Webster Highway, while more limited options are available on the west side of the corridor.

A series of access roads link the Pheasant Lane Mall north to Webster Square. It is notable however that the access road does not extend north to Spit Brook Road. Map 4 shows the existing cross connections between developments west of the Daniel Webster Highway and highlights the gap between Webster Square and East Spit Brook Road. This is the most significant gap in the cross connection network of the study area, because it forces motorists through the already congested Daniel Webster Highway / Spit Brook Road intersection in order to access retail destinations north of Spit Brook Road.



An extensive series of interconnecting driveways on the east side of Daniel Webster Highway north of the Spit Brook Road intersection provide the opportunity to travel from Spit Brook Road north past Harold Drive and Silver Drive to access Adventure Way (formerly Poisson Avenue). This series of access points are not conspicuously located or identified and many motorists may be unaware of their existence.

It's important to note that the Dow Chemical property, located between Spit Brook Road and Adventure Way, is one of the largest vacant parcels in the study area. Several unsuccessful development proposals have been presented for this location in past years, and it is foreseeable that some form of development at the site will occur. When the site is developed, cross connections should be considered linking Spit Brook Road and Adventure Way to provide a more intuitive and accessible alternative to the existing cross connection network.

Cross connections are much more limited on the west side of Daniel Webster Highway. On the west side of Daniel Webster Highway and north of Spit Brook Road, a number of internal connections are available between Barnes and Noble, numerous small shopping centers and the Royal Ridge Mall. However, south of Spit Brook Road the connections are disjointed, as they are not conspicuously located, difficult to access or entirely absent. The most notable gap is between Silver Drive at the Lui-Lui Restaurant and the Market Basket Shopping Center.

Tyngsborough Access Management

Tyngsborough's land use profile is significantly divergent from South Nashua in that development is of a much less dense nature and several vacant parcels still line the Middlesex Road corridor. This, combined with the fact that traffic on Middlesex Road is significantly lighter than levels on Daniel Webster Highway, makes issues of cross-connections somewhat less acute for the community. However, as the Middlesex Road corridor continues to develop, such issues may become more salient.

Middlesex Road businesses and users of the corridor would benefit from the adoption of access management policies by the town for any new developments along the corridor. Developing and implementing effective strategies to improve safety for all users of the transportation network requires the proper driveway design, location and the number of curb cuts should be minimized. The 2007 Draft Design Guidelines for Middlesex Road state that:

- “The means of access to a site should be that which effectively minimizes the creation of new intersections and individual site access locations. Toward that end, curb cuts for parking lots should be minimized through shared entrances and exits, where appropriate. Access easements may be utilized to allow legal use of shared driveways over properties under separate ownership.”



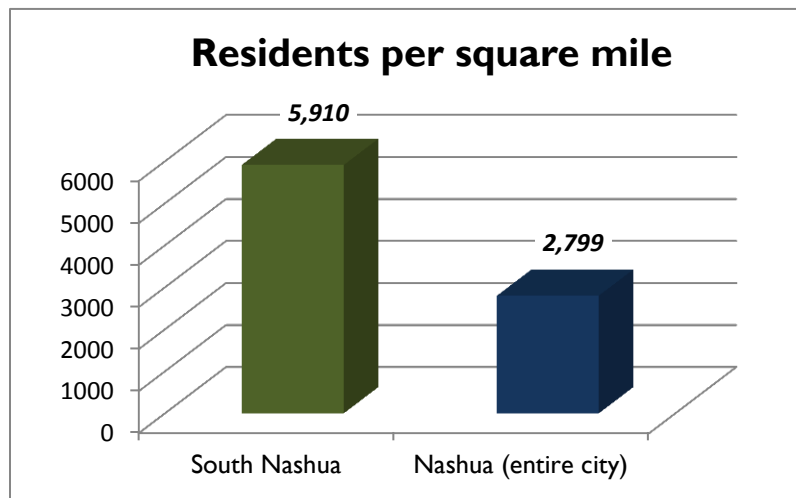
- “Whenever possible, access driveways between adjacent properties under the same or different ownership should be provided in order to minimize travel and congestion along the corridor.”

Regardless of whether the Town chooses to formally adopt the design guidelines in the future, the Planning Board and other permitting bodies should strive to reduce and consolidate curb cuts along the Corridor, through the site plan review process or other appropriate regulatory means as are available and appropriate.

F. BICYCLE, PEDESTRIAN, TRANSIT OPPORTUNITIES

As indicated in the Future Traffic Conditions analysis section of this document, an Exit 36 southbound off ramp has the potential to significantly reduce traffic volumes along portions of Spit Brook Road and Daniel Webster Highway. It is expected that 24 hour traffic volumes could be reduced by as much as 20%. Further reductions in volume and subsequent congestion may also be achievable with additional investments in bicycle, pedestrian and transit infrastructure.

TABLE 6.2: RESIDENTS PER SQUARE MILE



The Nashua portion of the study area accommodates more than 5,900 residents per square mile most of whom live within walking distance of retail and commercial amenities as well as a potential future rail/intermodal facility. By

2022 up to an additional 800 residents are expected in the Gateway Hills Development. These residents are also within reasonable walking or bicycling distance of the amenities on Daniel Webster Highway. Reduced traffic volumes along the study area’s major arterials resulting from Exit 36 Southbound is a first step in making non-motorized travel more appealing for those living in the area.

Travel demand model data analysis suggests that there are 27,000 trips per day that are less than 2 miles in length that originate and end in the Nashua portion of the study area. Improved pedestrian and bicycling infrastructure will aid in shifting short distance trips to non-motorized modes further reducing congestion in the study area.



Opportunities for Expanded Pedestrian Facilities

The existing conditions section of this study identified a number of deficiencies in the infrastructure needed to support non-motorized travel. High traffic volumes, lack of connectivity and obstructions all discourage pedestrian activity.

Approximately 5900 people live in and around the study area. According to the 2010 U.S. Census, approximately 800 people live in the area south of Spit Brook Road and west of Daniel Webster Highway. An additional 2,220 people live in the area north of Spit Brook Road, west of Daniel Webster Highway and east of the F.E. Everett Turnpike. Finally, approximately 2,500 people live west of the F.E. Everett Turnpike, and south of Spit Brook Road. Although the study area is primarily thought of as a retail corridor, there are a significant number of residents whose needs must also be considered.

Focusing on the residential developments closest to the retail and commercial locations, a number of opportunities exist to improve the safety of non-motorized travel as well as the aesthetics of the area. The 800 people living south of Spit Brook Road need safe access across Daniel Webster Highway in the vicinity of Spit Brook and Danforth Roads. Currently access across Daniel Webster Highway is extremely challenging for pedestrians. To facilitate these movements, pedestrian bridges could be constructed over Daniel Webster Highway as shown in Map 6.4. The priority location would be at the intersection of Spit Brook Road and Daniel Webster Highway, with a second potential location at the intersection of Danforth Road and Daniel Webster Highway. These two locations, as well as those on the following list, would require pedestrian actuated signals and crosswalks improvements:

- Adventure Way and Daniel Webster Highway
- Silver Drive and Daniel Webster Highway
- Dan Chan Street and Daniel Webster Highway
- Pheasant Lane and Daniel Webster Highway
- Southernmost Pheasant Lane Mall / TJX Plaza entrance in Tyngsborough
- Royal Crest entrance and Spit Brook Road
- Royal Ridge Mall Entrance and Spit Brook Road

This list includes all major intersections along Daniel Webster Highway and Spit Brook Road in the study area with the exception of the intersection of Middlesex Road and the Exit 36 on and off ramps. The traffic volumes at this intersection will be the highest in the study area and therefore pedestrian traffic will be directed to adjacent intersections.

Sidewalk improvements are also needed throughout the study area. The main pedestrian facility limitations are due to abruptly ending sidewalks, obstructions from utilities and signage, and narrow



widths. Another limitation is the high value of the land which can limit private property owner's interest in using their land for public improvements. The key sidewalks improvements are described below and are shown on Map 4.

East side of Daniel Webster Highway

- The sidewalks from Webster Square south to Zimmerman's should be widened and improved to Americans with Disabilities Act (ADA) standards.

West side of Daniel Webster Highway

- The sidewalks in front of the former Pier 1 Imports building and Barnes and Noble need widening and require removal of obstructions. These sites have a green area in front that could accommodate a meandering sidewalk. In addition, there is a green space between both sites which, with the coordination of property owners, may be an ideal site for a pedestrian area with benches and public art.
- The sidewalks between the Lui Lui Restaurant and Danforth Road require the removal of obstructions and should be widened and improved to ADA standards.
- The sidewalks between Chili's Restaurant and Costco should be widened and improved to ADA standards.

Internal Pedestrian Connections

Pedestrian connections could be further improved through public/private partnerships whereby additional pedestrian improvements are made internally to sites. For instance, private properties could create well-defined safe walking paths between parking areas and store entrances, while also creating paths between adjacent sites.



INTERNAL PEDESTRIAN



This sidewalk and landscaping provides a safe and appealing walkway between parking areas and the building entrance.

ADJACENT PEDESTRIAN



This shaded walkway provides safe and appealing access between adjacent sites.



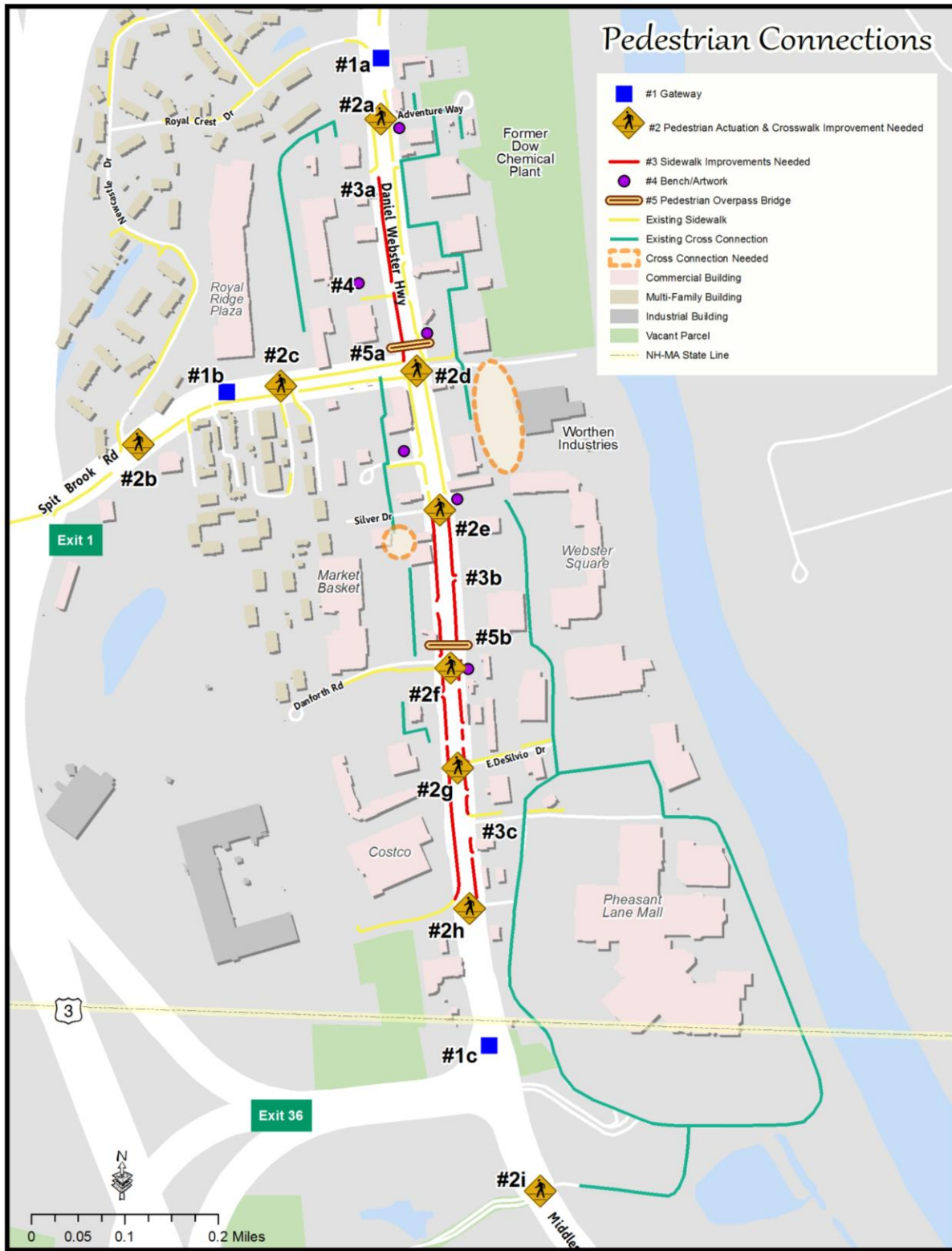
This sidewalk network includes a pedestrian refuge area with seating and shade trees on private property.



This sidewalk provides access between adjacent sites without having to access the main roadway.



MAP 6.4: PEDESTRIAN IMPROVEMENTS





In Tyngsborough, sidewalks, crosswalks and pedestrian signals are needed to facilitate pedestrian travel from the TJ Maxx Plaza across Middlesex Road to the Pheasant Lane Mall. Ideally, pedestrian and aesthetic improvements should be made along Middlesex Road from the state line to the Town Center, as funding and resources are made available.

Opportunities for Expanded Bicycle Facilities

With the majority of the construction for the Exit 36 Southbound project taking place in Massachusetts, an opportunity exists to address bicycling facilities in the project area. According to MassDOT engineering directive E-14-001, on arterial or collector roadways that allow bicycles, bicycle lanes or shoulders wide enough to accommodate bicycles must be provided on both sides of the roadway. The minimum shoulder width or bicycle lane must be five (5) feet in width. Currently, there are no bicycle facilities along Middlesex Road in Tyngsborough.

MassDOT will require that improvements to the Exit 36 study area within Massachusetts provide bicycle accommodations. In Tyngsborough, the focus is to bring more economic development opportunities into the area. By providing new bicycle and pedestrian facilities, visitors to the area would have a choice of transportation options along Middlesex Road and Kendall Road when accessing local businesses. With numerous transportation options available, both residential and commercial development would benefit from decreased vehicular traffic volume.

On the New Hampshire side of the border the Spit Brook Road and Daniel Webster Highway Corridors have inconsistent shoulder width, numerous curb cuts, multiple lanes and turning lanes. These attributes, combined with the high traffic volumes tend to discourage all but the most experienced bicyclists.

Unlike MassDOT, NHDOT does not require specific improvements to accommodate bicycling as part of highway improvement projects. However, under the Exit 36 Southbound Build Scenario both the Daniel Webster Highway and Spit Brook Road corridors are forecast to experience significant reductions in 24 hour traffic volumes. The reduction in volume provides opportunity to actively incorporate bicycle travel on Spit Brook Road and Daniel Webster Highway.

Travel demand model forecasts estimate 24-hour traffic volume will be reduced by as much as 20% on Daniel Webster Highway and approximately 10% on Spit Brook Road, potentially allowing for reduced width of travel lanes and providing an opportunity for striped bicycle lanes. As bicyclists will be traveling on arterial roads streets, travel can be safer by providing bike lanes. Bike lanes:

- Support and encourage bicycling as a means of transportation.
- Help define road space and promote a more orderly flow of traffic.



- Encourage bicyclists to ride in the correct direction, with the flow of traffic.
- Give bicyclists a clear place to be so they are not tempted to ride on the sidewalk.
- Remind motorists to look for cyclists when turning or opening car doors.
- Signal motorists that cyclists have a right to the road.
- Reduce the chance that motorists will stray into cyclists' path of travel.
- Make it less likely that passing motorists swerve toward opposing traffic.
- Decrease the stress level of bicyclists riding in traffic.

Additional opportunities to improve bicycle travel will include working with private property owners to establish off road bicycle facilities connecting retail commercial and residential properties on each side of the study area corridors.

Any bicycle improvements approaching the state line should be coordinated with to ensure consistency and continuity for the cyclists.

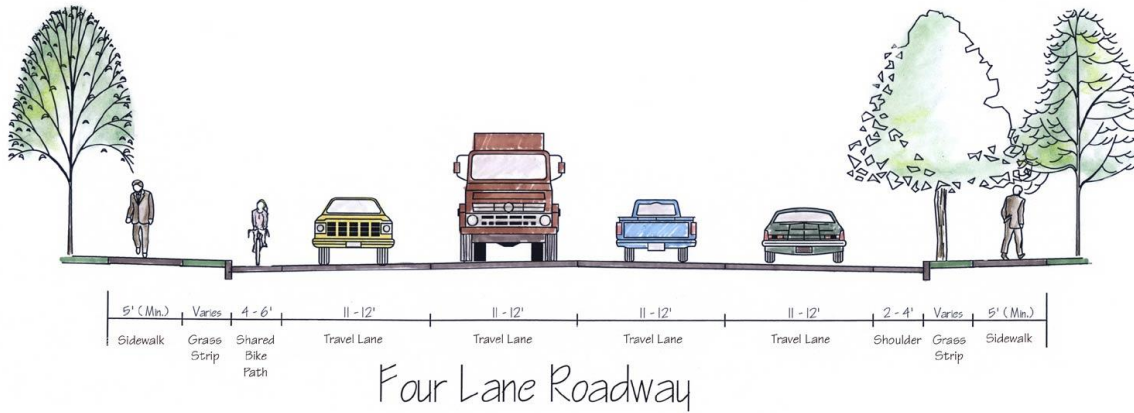
Streetscaping

Streetscaping can greatly enhance the walkability of an area. Ideally sidewalks should be separated from travel lanes by grassy strips known as esplanades. However, this type of retrofit can be extremely difficult in established commercial areas with limited existing right of way. As opportunities arise this ideal may be implemented, but instead the focus needs to be placed on changes that can be made in the built environment in Nashua. However, in Tyngsborough, where there is much less development, has an opportunity to create a boulevard effect as shown in the images on the following page. The following is a list of implementation measures that have the potential to significantly impact the study area:

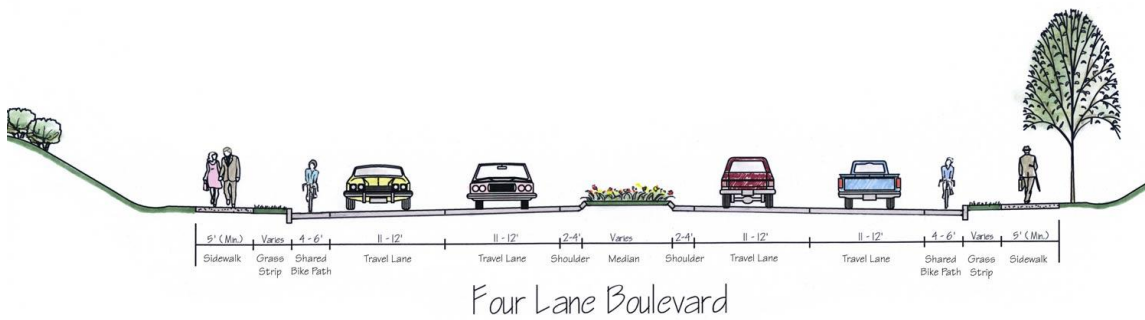
- Erect South Nashua Retail District Banners located in Nashua from Adventure Way on Daniel Webster Highway extending south to the state line and from Exit 1 on Spit Brook Road extending east to the intersection with Daniel Webster Highway.
- Erect Restaurant District Banners located in Tyngsborough along Middlesex Road from Bryant Lane extending north to the state line.
- Create Gateways east of Exit 1 on Spit Brook Road; near Adventure Way, and at the state line on Daniel Webster Highway.
- Establish Pedestrian pockets possibly including benches, artwork, lighting, shade trees or landscaping.
- Install additional decorative bus shelters, if space and demand allows.



- Create pedestrian refuge islands as part of crosswalks network where space permits at appropriate intersections.



, <http://www.circeis.org/exhibits.html>.



South of Locust Avenue on Middlesex Road, there is an opportunity to enhance safety for pedestrians and bicyclists by designating separate facilities for each mode of travel. The wider shoulders and right of way allow for installation of a bike lane and sidewalk on each side of Middlesex Road. Vehicles travelling along Middlesex Road are moving at average speeds of 40-50 mph, a significant difference in vehicular and bicycle speed. This is a safety concern for bicyclists and the major reason that a bike lane should be installed along the side of the roadway instead of having bicycles share the road.

North of Locust Avenue, the roadway widens to two lanes in each direction. At this point, a widened shoulder on each side would serve bicyclists well. If the right of way does not allow for sidewalks and increased shoulder widths, bicyclists would need to share the road with vehicles and sidewalks should be installed.

Sidewalks are missing along a large segment of Kendall Road. Currently there are sidewalk facilities around Tyngsborough Center and the Tyngsborough Bridge, as well as near the Route 3 overpass west towards Locust Avenue. The expansion of the sidewalk network to connect Route 3, the Route 113 Park and Ride Lot, the Town Offices/Library, and Town Center should be completed. Appropriate design guidelines and ADA accessibility standards must be followed when constructing any type of pedestrian and bicycle facility.

The smaller local roadways, Locust Avenue and Farwell Road, currently do not have sidewalks or bicycle facilities. Because these are Town owned roadways, they do not have to conform to the MassDOT guidelines for providing facilities for alternative users of the transportation system. The Town of Tyngsborough will need to decide if it is appropriate to provide bicycle/pedestrian facilities along these roadways.

Opportunities for Expanded Transit Service

The construction of an Exit 36 Southbound ramp should help facilitate stronger transit connections in the study area. Should a commuter rail facility be constructed, access to the facility at either of the potential locations discussed, would be significantly improved with the construction of the Exit 36 Southbound ramp. At the Pheasant Lane Mall site direct access would be improved and at the Dow Chemical site reduced congestion, at Exit 1 and Spit Brook Road would improve travel for commuters. Both sites allow for the potential for transit-oriented development, though the size of the Dow Chemical site provides a much larger development footprint.

Additionally, the construction of the ramp would provide transit bus riders with more direct access to commercial and residential destinations in the study area, a location that is already a significant source of Nashua Transit System trips. Reduced congestion along Spit Brook Road and Daniel Webster Highway



will allow buses to more efficiently provide service to the area, reducing overall travel time and perhaps allowing for increased service frequency.

Nashua Transit System provides service from downtown Nashua to the study area, via Routes 6 and 6A. These routes currently traverse Main Street and East Dunstable Road to reach Spit Brook Road and ultimately the Pheasant Lane Mall before embarking on return trips to the Nashua Transit Center in Downtown Nashua. The system allows 30 minutes for the outbound trip to the Pheasant Lane Mall and 20 minutes for the return trip back to the transit center along Daniel Webster Highway and Main Street. These travel times are particularly difficult to maintain during the congested holiday season when travel to retail destinations peaks in south Nashua.

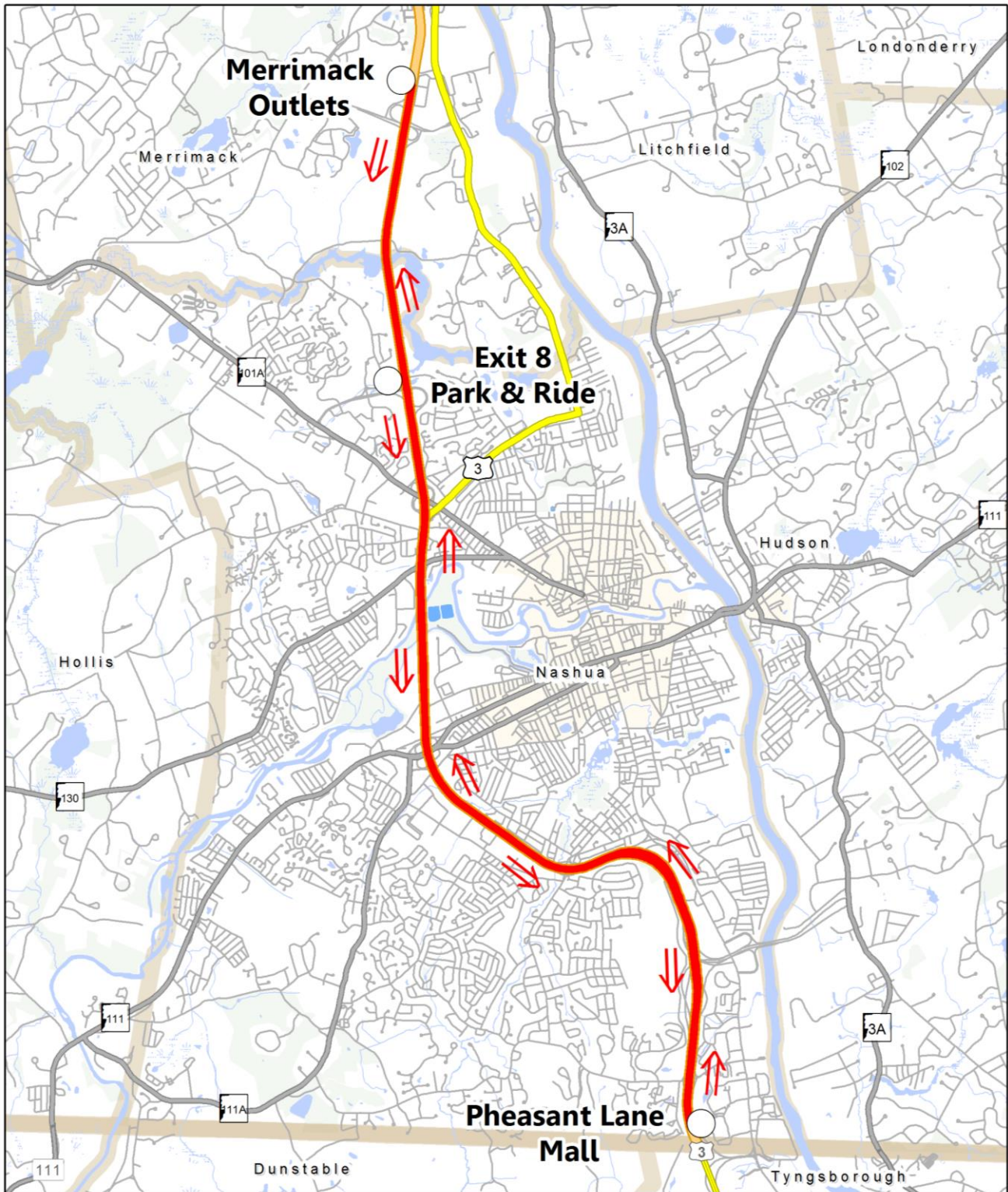
The construction of the ramp would allow for an express option directly linking the system's Downtown transit center with the study area via the F.E. Everett Turnpike. For the first time, NTS riders would be able to access the mall directly from the turnpike via an Exit 36 southbound ramp. This option would allow for a significantly expedited trip to the study area (and the current route's ultimate destination), reducing outbound trips from 30 minutes to approximately 11 minutes. Return trips would also benefit from the construction of a ramp due to decreased congestion along Daniel Webster Highway. Providing an express option would allow for a 63 percent reduction in the outbound travel time and as much as a 46 percent reduction in the route's entire roundtrip travel time.

In addition, NTS could also offer an additional express service between the Merrimack Outlets at Exit 10, the Exit 8 Park and Ride, and the Pheasant Lane Mall via the new off ramp. Again, during the peak holiday season this would provide for an alternative option of parking at the Exit 8 facility with direct access to both the Pheasant Lane Mall and the Merrimack Outlets.

The improved bus service travel times in the study area, as discussed above, would create the ideal conditions for a retail circulator service. Initially the circulator could operate one or more shuttles during the holiday retail season. The first option would involve travel along Daniel Webster Highway between northern Tyngsborough and Adventure Way in Nashua. The second option consist of a loop from the Pheasant Lane Mall north along Daniel Webster Highway, west on Spit Brook Road, south along the F.E. Everett Turnpike and returning to the mall via the new Exit 36 Southbound off ramp. This second route option will travel through the heavily residential portion of the study area, providing an alternative travel options for reaching numerous retail establishments in south Nashua and northern Tyngsborough.



MAP 6.5: FUTURE EXPRESS SERVICE BETWEEN EXIT 36, EXIT 8 AND EXIT 10



Phase 1 Route	Interstate	State Route	Waterbody
Route Direction	US Highway	Local Road	Conserved Land
Proposed Bus Stop		Community Center	

0 0.5 1 2 Miles

Maps prepared by the Nashua Regional Planning Commission are for planning purposes only. NRPC uses data gathered from multiple sources at various scales of accuracy. No warranties, expressed or implied, are provided for the data herein its use, or its interpretation.

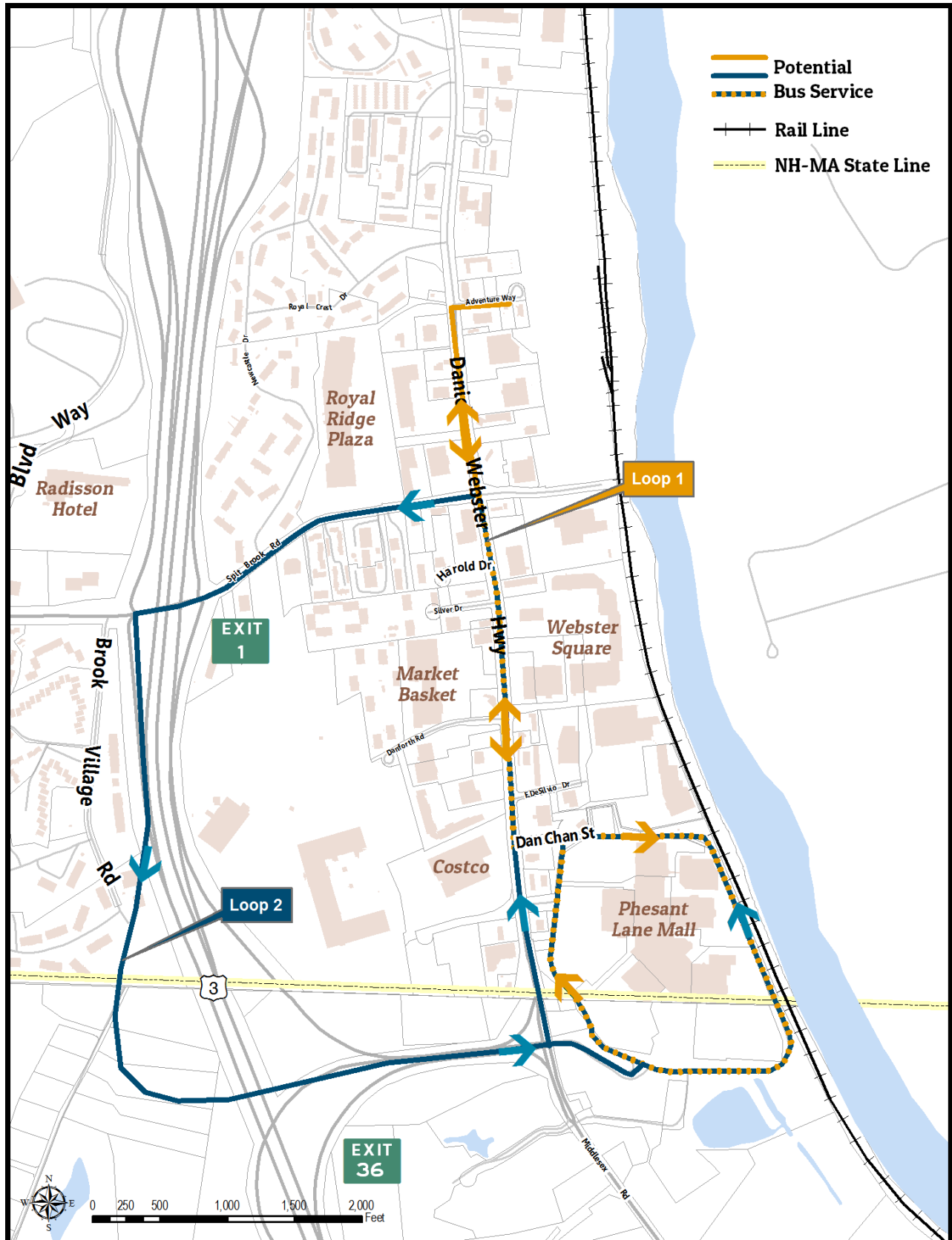
NTS
Nashua Transit System

NRPC

Date Saved: 7/17/2013 12:06:30 PM
Document Path: J:\GIS\Projects2012\Exit 36\ProjectUpdate0613\PlanMaps.mxd



MAP 6.6: FUTURE CIRCULATOR SERVICE IN SOUTH NASHUA VIA EXIT 36



If successful, these services could be expanded to peak retail times throughout the year. This type of service would allow shoppers to park once and simply ride the circulator for door to door service at numerous retail and restaurant establishments.

Additionally, even without an express option, NTS Routes 6 and 6A would benefit from the exit ramp construction due to reduced congestion levels on Spit Brook Road and Daniel Webster Highway. This benefit would prove particularly valuable during Saturday peaks when traffic volumes in the area reach their highest levels.

Finally, the exit ramp construction would help make additional expansion of transit bus service in the study area viable, including long identified gaps in service. For example, the NTS and the transit provider servicing Tyngsborough, the Lowell Regional Transit Authority (LRTA), both provide service skirting the state border, but there is no direct link allowing for transfers between the two systems. LRTA provides service to Ayotte's Market in Hudson, NH (the closest regular route it offers in proximity to the study area), while NTS service extends as far south as the Pheasant Lane Mall. The addition of an Exit 36 Southbound ramp would aid in bridging that service gap, by making extensions of those routes more feasible.



VII. Conclusion and Recommendations

Traffic volumes, travel demand model output and field observations have validated the anecdotal information provided by travelers destined for commercial and retail businesses along the southern segment of the D.W Highway and northern Middlesex Road. There is, and will continue to be, a high volume of traffic travelling east on Spit Brook Road and turning right (southbound) on Daniel Webster Highway.

The construction of the southbound off ramp at Exit 36 will result substantially reduce traffic volumes on Spit Brook Road east of the F.E. Everett Turnpike and Daniel Webster Highway, by providing an efficient and direct alternative for travelers seeking to access the Pheasant Lane Mall and other retail and commercial land uses along southern D. W. Highway and northern reaches of Middlesex Road. The 24-hour traffic volumes are forecast to drop by an average of 9 percent on Spit Brook Road east of the F.E. Everett Turnpike, and by an average of 20 percent on D.W. Highway south of Spit Brook Road.

With the forecasted reduction in total traffic volume, intersection operations along Spit Brook Road and D.W. Highway will improve, resulting in reduced queuing and delay during the peak periods. The greatest benefit is likely to be realized during the Saturday peak period, when traffic volumes are at their highest. It is recommended that future signal timing and pedestrian phasing be optimized to maximize the benefit of constructing Exit 36S.

Time spent waiting in congestion along Spit Brook Road and Daniel Webster Highway is costly in terms of lost productivity. On an average weekday, it is estimated that vehicle trips from the north passing through the intersection of the Exit 36 ramps at the southern Pheasant Lane mall entrance will realize up to 7 minutes of travel time savings by using a new Exit 36S off ramp. Using data from the Texas Transportation Institute a conservative estimate of one passenger per vehicle, an annual savings of \$2 Million per year is expected through the elimination of lost productivity. Additionally, the construction of the Exit 36 S off ramp will reduce fuel consumption.

Comparing current travel times from Exit 1 to the intersection of the Exit 36 ramps at the southern Pheasant Lane mall entrance with travel time estimates under the Build Scenario shows a typical weekday time savings of approximately 7 minute per vehicle. Based on travel time, average speed, and fuel economy data, and an estimated fuel cost of \$3.75 gallon the construction of Exit 36S could save as much as \$333,000 per year in wasted fuel.

The fuel savings realized by developing Exit 36 also contributes to a reduction on Carbon Dioxide (CO₂) emissions. CO₂ is a greenhouse gas and is widely accepted as a contributor to climate change.



With Exit 36S constructed, conservative estimates place fuel savings in the range of 89,000 gallons per year, with a corresponding reduction in CO2 emissions of 1.8 Million pounds per year.

A. CONCLUSION:

The Exit 36 S off ramp significantly improves operating conditions along the major roads in the study area, by relieving traffic congestion and delay, reducing greenhouse gas emissions, improving travel times, and decreasing lost productivity. The project enhances the effectiveness of public transportation and supports future passenger rail service. The southbound ramp and related improvements will provide more efficient access to services, area business establishments, and local and regional job centers. The proposed improvements will also generate opportunities for sustainable growth and serve as a catalyst for future economic development and community investment. The bi-state aspect of the project provides exceptional opportunities for innovative financing, interstate cooperation and coordination, and public/private partnerships. With an estimated year of construction cost approaching \$21M, it is recommended that Massachusetts and New Hampshire officials continue to collaborate and advance the project by building political and community support, and pursuing multiple funding options for environmental permitting, right of way acquisition, engineering, design and construction.

B. RECOMMENDATIONS

Optimize signal timing to maximize intersection operations for the Build Scenario traffic volumes

- Consider coordinating signals at the Exit 36 Ramps with the City of Nashua System on D.W. Highway
- The construction of the Exit 36S off-ramp and the potential reuse of the TJ Maxx Plaza, as well as the development potential of parcel 12-29A to the south, warrants analysis and investigation of possible intersection improvements and coordination of the signal at the TJ Maxx Plaza.
- In order to maximize the benefits of constructing an Exit 36S ramp, adjustments to the traffic signal system will be required along Spit Brook Road and D.W. Highway Corridors. Each intersection in the network should be evaluated as part of the environmental review process and engineering/design of the new off ramp.

Facilitate vehicular movement between developments to further reduce volume on study area corridors

- Complete the cross connection network between parcels on both sides of the DW Highway. Improve signage and increase awareness of the cross connection network.



- Consider developing and formalizing a parallel corridor, as recommended in the DW Highway/ Spit Brook Road Corridor Study⁵. Primary benefits of this connection will be to reduce the volume of traffic accessing and exiting Daniel Webster Highway. A more direct parallel corridor will reduce the number of trips accessing the Daniel Webster Highway and likely reduce accident rates within the retail parcels.

Create a safe and appealing environment for pedestrians and bicycles.

- The Exit 36S off ramp will lead to a reduction in traffic volumes throughout the study area resulting in an improved environment for pedestrian and bicycle travel.
- Sidewalk improvements are needed throughout the study area to address substandard width and numerous obstructions that do not meet ADA standards. Priority stretches include:

East side of Daniel Webster Highway

- The sidewalks from Webster Square south to Zimmerman's should be widened and improved to Americans with Disabilities Act (ADA) standards.
- Investigate feasibility of a multi-use bicycle facility parallel to the Merrimack River and rail line

West side of Daniel Webster Highway

- The sidewalks in front of the former Pier 1 Imports building and Barnes and Noble need widening and require removal of obstructions. These sites have a green area in front that could accommodate a meandering sidewalk. In addition, there is a green space between both sites which, with the coordination of property owners, may be an ideal site for a pedestrian area with benches and public art.
- The sidewalks between the Lui Lui Restaurant and Danforth Road require the removal of obstructions and should be widened and improved to ADA standards.
- The sidewalks between Chili's Restaurant and Costco should be widened and improved to ADA standards.
- Create an internal pedestrian network through private properties in the study area.
 - Consider public private partnerships to establish an internal pedestrian network connecting businesses along Daniel Webster Highway.

⁵ Daniel Webster Highway and Spit Brook Road Corridor Study FINAL DRAFT, Rizzo Associates A Tetra Tech Company. Submitted to: City of Nashua, New Hampshire June 10, 2002



- When opportunities arise in redevelopment or new development work with property owners to create well defined pedestrian access within sites between parking areas and store fronts as well as between adjacent sites.
- Facilitate safe pedestrian access across D.W. Highway.
 - Construction a pedestrian bridge over D.W. Highway at Spit Brook Road with a second possible location at Danforth Road.
 - Install pedestrian actuated signals and crosswalk improvements at:
 - Spit Brook Road and Daniel Webster Highway
 - Danforth Road and Daniel Webster Highway
 - Adventure Way and Daniel Webster Highway
 - Silver Drive and Daniel Webster Highway
 - Dan Chan Street and Daniel Webster Highway
 - Pheasant Lane and Daniel Webster Highway
 - Southernmost Pheasant Lane Mall / TJX Plaza entrance in Tyngsborough
 - Royal Crest entrance and Spit Brook Road
 - Royal Ridge Mall Entrance and Spit Brook Road
- As land is developed along Middlesex Road include pedestrian and bicycle facilities to allow alternative means of access.

Improve availability, connectivity and efficiency of transit service in the project area.

- The construction of the ramp will provide transit riders with more direct access to commercial and residential destinations in the study area, which are currently a significant source of Nashua Transit System trips. Reduced congestion along Spit Brook Road and Daniel Webster Highway will allow buses to more efficiently provide service to the area, reducing trip lengths and perhaps allowing for increased service frequency.
- The construction of the ramp will allow for an express transit option directly linking the Merrimack Outlets, and Exit 8 Park and Ride lot with the study area via the F.E. Everett Turnpike.
- Nashua Transit System could reconsider implementing the proposed Daniel Webster Highway Circulator Service. As originally proposed, the circulator would feature bus service along the Daniel Webster Highway from Adventure Avenue to the Pheasant Lane Mall. The route, intended to service the many retail outlets along the corridor, would run on Saturdays and during other periods, when retail traffic is high, particularly during the holiday shopping season. The significant conglomeration of retail activity in the area makes it attractive for retail trip



chaining. The addition of an Exit 36S off ramp would result in reduced congestion, allow improved access to the area and greatly reduce transit headways.

- Exit 36S will help facilitate additional expansions to transit service in the study area to address long standing gaps in service.. For example, the Nashua Transit System and the Lowell Regional Transit Authority (LRTA) provide service skirting the state border. LRTA provides service to Ayotte’s Market in Hudson, NH, while NTS service extends as far south as the Pheasant Lane Mall. The addition of an Exit 36 southbound ramp would aid in bridging that service gap, by reducing headways and making extensions of those routes more feasible.

Facilitates and enhances the possible extension of passenger rail service.

- The effectiveness of a passenger rail and intermodal facility near the Pheasant Lane Mall largely depends upon the development and construction of an Exit 36 southbound off ramp. A new Exit 36S off ramp will provide direct access for passenger rail users and allow for quick and efficient bus service connections via the Nashua Transit System.
- The Dow Chemical site would benefit from the ramp construction through reduced congestion on Spit Brook Road. This site is also in close proximity to dense multifamily residential developments. The reduced traffic volumes on Spit Brook Road and Daniel Webster Highway will increase the likelihood of individuals accessing the proposed station using non-motorized means of transportation.

It is recommended that the City of Nashua and Town of Tyngsborough work cooperatively and consider land use and zoning changes to support the proposed intermodal facility and TOD type development.

C. IMPLEMENTATION STRATEGY

The findings of this study document substantial benefits to both Tyngsborough and Nashua. The proposed ramp will result in significant improvements to traffic conditions in Nashua, and will support existing businesses as well as important statewide initiatives such as passenger rail. In Tyngsborough, improved transportation accessibility will result in greatly enhanced economic development opportunities along Middlesex Road.

The footprint of a future Exit 36S off ramp will lay almost exclusively within Massachusetts. With the significant benefits that the project brings to New Hampshire, it is important that leadership in both states work cooperatively to advance the project. A project of this magnitude will require multiple funding sources. The following steps will need to be taken to advance the project:



- Local and regional leaders must cooperatively seek support of State Executive Branch and present the benefits of the project.
- Begin early coordination with Massachusetts Department of Environmental Protection and the Massachusetts Natural Heritage Program
- Determine the relationship between Exit 36S and Passenger Rail
- State and local officials will need to work jointly with the Federal delegation from both States to identify funding sources to support the Environmental Permitting, Engineering, Design, Right of Way, and Construction costs. Sources may include:
 - Federal Highway Administration (STP, CMAQ, Interstate Maintenance, National Highway System, Bridge funding)
 - TIGER grant funding
 - Federal Transit Administration
 - EDA Public Works funding
 - State and Local Matching funds
 - Private developer contributions
 - Transit Oriented Development – Massachusetts Funding sources
- Add the project to the Northern Middlesex Council of Governments and Nashua Regional Planning Commission Transportation Improvement Programs
- Initiate the Environmental permitting process, Engineering, Design and Right of Way Acquisition.
 - Cost of Environmental and Engineering study estimated to be \$2.1 M
 - Duration of permitting and Design is estimated to be 2 - 3 years
- Construct the Exit 36S off ramp
 - Preliminary cost estimate \$16M (in 2014 dollars)
 - Construction duration approximately 2 years



Appendix 1

VHB Technical Memo Exit 36 Ramps



Vanasse Hangen Brustlin, Inc.

Two Bedford Farms Drive, Suite 200
Bedford, New Hampshire 03110
603 391-3900

Memorandum

To: Tim Roache
NRPC
Assistant Director

Date: July 16, 2014

Project No.: 52320.00

From: Peter Clary, PE
Project Manager

Re: Exit 36S Transportation Community
Planning System Preservation Project
Nashua, NH / Tyngsborough, MA

Project Background

Vanasse Hangen Brustlin, Inc. (VHB) has been hired to assist Nashua Regional Planning Commission (NRPC) and Northern Middlesex Council of Governments (NMCOG) in assessing the effectiveness of a southbound off-ramp at Exit 36 on the F.E. Everett Turnpike, near the New Hampshire and Massachusetts border. The overall study will evaluate traffic flows and potential economic benefits to businesses in the area and provide a planning analyses relative to the development of a new southbound off-ramp. The funding for this project was secured through the Transportation, Community and Systems Preservation Program (TCSP) under a contract with the NH Department of Transportation.

VHB's primary task within the scope of work includes providing a conceptual layout and a planning-level cost estimate for the proposed Exit 36 southbound off-ramp. In developing the conceptual layout, VHB has coordinated with NRPC and NMCOG to create an aerial base plan, has conducted a traffic review and analysis for the 2022 Saturday peak hour condition, and met with NRPC and NMCOG throughout the development of the ramp layout. The following summarizes the work completed.

Existing Conditions

The Exit 36 area has the following challenging characteristics that will influence the development of the Exit 36 southbound off-ramp and the associated improvements along Daniel Webster Highway and Middlesex Road.

- The west side of Route 3 is heavily forested and has significant hill that appears to be primarily ledge
- The Danforth Road neighborhood is also on the west side and consists of approximately 15 residences. This neighborhood is located between Exit 1 and Exit 36 where it is set back about 600' and 2,100' from the existing southbound barrel on the northern and southern ends, respectively.

- The east side of Route 3 is considerably lower than the west side. The west side has a substantial wetlands system within the Exit 36 ramp system and from the eastern edge of the northbound barrel and northbound off-ramp to the rear of the developments along Middlesex Road.
- The proximity of Exit 1 to Exit 36 is approximately 0.7 miles, with the Exit 1 southbound on-ramp merge being approximately 1,500' from the Exit 36 southbound on-ramp bridge over Route 3.
- The Daniel Webster Highway and Middlesex Road corridor is a heavily developed retail corridor with the Pheasant Lane Mall being a significant regional destination.

Traffic

VHB has provided traffic analysis for the NRPC in support of the development of a conceptual layout and planning-level cost estimate for the proposed Exit 36 southbound off-ramp. The proposed off-ramp will provide a new access for southbound travelers along the F.E. Everett Turnpike in New Hampshire to the “front door” of the Pheasant Lane Mall at the New Hampshire/Massachusetts State Line. The NRPC and NMCOG acquired traffic data and developed No-Build and Build, current and future traffic analysis conditions, which formed the foundation for collaboration and concept preparation. VHB was tasked with providing concept plans for the future southbound off-ramp, as well as identifying geometric changes necessary at the major signalized intersections along Daniel Webster Highway/Middlesex Road in the immediate area of the interchange, including the TJ Maxx/Pheasant Lane Mall, Exit 36/Pheasant Lane Mall, and Costco/Pheasant Lane Mall.

VHB acquired the Synchro 8 files from the NRPC and NMCOG, and was tasked with focusing on developing geometries and signal operational adjustments to allow the Saturday 2022 traffic patterns to function at a Level of Service (LOS) D or better. The two separate models were combined into a new file and set to NH state coordinates. The existing timings and geometries for all intersections along Daniel Webster Highway and Middlesex Road were confirmed before any adjustments were made. All three project intersections were altered to be coordinated across the state-line for phases 2 and 6, and set to cycle lengths of 120 seconds.

The 2022 Saturday peak hour analysis results indicate that the intersection of Daniel Webster Highway and Costco/Pheasant Lane requires timing adjustments only, to attain an intersection LOS C (no geometric changes). The intersection of Middlesex Road and the Exit 36 ramps/Pheasant Lane Mall would require the construction of physical improvements to provide three left-turn lanes, two through lanes, and a right-turn lane from the off-ramps, as well as two through lanes, a left-turn lane and a right-turn lane from the Pheasant Lane Mall exit. The northbound approach of Middlesex Road from Massachusetts would require a redistribution of lanes, changing a through lane into a left turn lane; no changes are needed for the geometry of Middlesex Road southbound at this intersection. The intersection of Middlesex Road and TJ Maxx Plaza/Pheasant Lane Mall is expected to require several adjustments, including constructing an additional lane on the Pheasant Lane Mall exit, repurposing of

existing lanes for the TJ Maxx Plaza exit, and rephrasing of the traffic signal to attain LOS D operations.

A weave analysis was completed to determine if the proposed Exit 36 southbound off-ramp could be located in close proximity to the Exit 1 southbound on-ramp. The resulting weave analysis confirmed that the proposed conceptual layout of the Exit 36 southbound off-ramp would operate at an acceptable level of service for the Saturday 2022 peak hour.

Highway

The development of the highway layout for the proposed off-ramp began with developing several tissue level concepts that located the proposed Exit 36 southbound off-ramp either north of or south of the existing Exit 36 southbound on-ramp. These concepts were developed to meet current standards for a minimum of 30 MPH design speed with a maximum superelevation of 6%. The development of these concepts in conjunction with the supporting traffic analysis was completed at a planning level with the understanding that additional engineering is required to advance the concept into preliminary design and permitting.

The concepts that extended south of the southbound on-ramp were considerably longer, would require more Right-of-Way acquisition, and would have significantly more wetland impacts. For these reasons, these alternatives were dismissed from further consideration. The loop ramp concept selected for further development can be seen on Figure 1 with the other concepts featured on Figure 2.

The selected loop ramp concept includes the following improvements:

- Minor widening of the southbound barrel to accommodate an auxiliary weave lane between the Exit 1 southbound on-ramp and the Exit 36 southbound off-ramp
- A new curbed loop ramp that aligns the southbound off-ramp traffic to travel over Route 3
- A new bridge over existing Route 3
- A new bridge over the existing Exit 36 southbound on-ramp
- A new curbed ramp that connects the bridges to the intersection at Middlesex Road
- The new curbed ramp merges with the existing Exit 36 northbound off-ramp and is widened to support the proposed lane use

The proposed improvements along Daniel Webster Highway, Middlesex Road, and the intersecting roadways were developed based on the traffic analysis. The conceptual layout was developed utilizing the average and maximum queue lengths to accommodate traffic and the existing roadway features. The signals at the ramps intersection and the TJ Maxx Plaza will require replacement to accommodate the improvements. Figure 1 – Proposed

Improvements Overview, attached, depicts the conceptual plan as well as the associated resource impacts.

Concept Layout Impacts

Environmental Resources

The anticipated wetlands shown on the conceptual plan were obtained through available information from the City of Nashua and the Massachusetts Department of Environmental Protection. The anticipated wetlands impacts for the proposed concept have been approximated to be 1.3 acres. The identification and development of impacts to all environmental resources will be completed in the future to a level commensurate with a planning study and preliminary design.

Right-of-Way

The existing approximate Right-of-Way has been obtained through available information from the City of Nashua and NMCOG. The anticipated amount of Right-of-Way acquisitions for the proposed improvements is 10 acres. The majority of the acquisitions are for the loop ramp area with additional strip takings required along Daniel Webster Highway and Middlesex Road. The establishment of a higher level Right-of-Way and property lines is required in the future for a planning study and preliminary design.

Utilities

There are several above and below ground utilities in the area as observed through our field visit. The improvements along Middlesex Road are estimated to impact approximately 10 utility poles. Impacts to underground utilities are expected with the associated widening of Middlesex Road. However, the magnitude of these impacts has not been determined for this study.

Cost

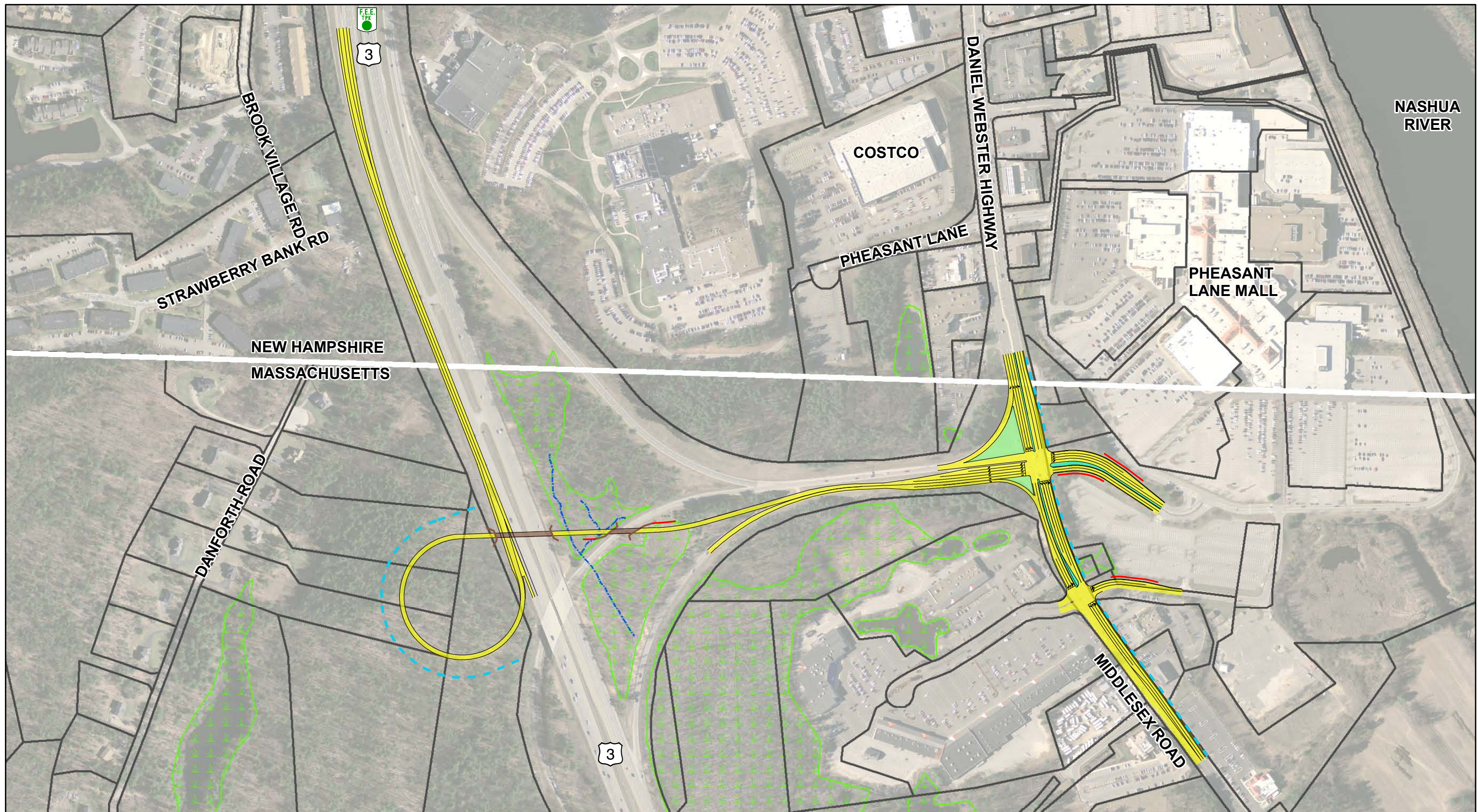
The cost associated with the design, permitting, and construction for the above mentioned improvements has been estimated at a macro-level based on the limited information available for this study. The location of the loop ramp is anticipated to be in an area of significant ledge and has been estimated accordingly. The cost is in 2014 dollars based on NHDOT unit prices and is attached as Figure 2. The overall project cost is estimated at \$16,000,000 and is broken down as follows:

Construction	\$14,000,000
Design and Permitting	\$2,000,000
Right-of-Way	TBD












The Right-of-Way acquisition costs for the approximate 10 acres of impact have not been included at this time and will need to be considered on future project costs.

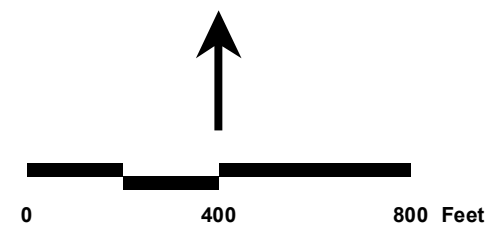
Summary

VHB has coordinated with NRPC and NMCOG to develop a conceptual plan and cost estimate for inclusion in the Exit 36 southbound off-ramp study. The plan and estimate are based on limited geographic details and limited engineering sufficient to confirm that a new off-ramp is feasible. The conceptual plan proposes a new Exit 36 southbound off-ramp, including two new bridges, that provides additional access to the Daniel Webster Highway and Middlesex Road, in the area near the border between New Hampshire and Massachusetts. In addition to the new ramp, widening to Daniel Webster Highway, Middlesex Road and the major intersecting driveways into the Pheasant Lane Mall is required. The proposed improvements anticipate impacts to the wetlands, Right-of-Way, and utilities. The estimated construction, design and permitting cost is \$16,000,000, with Right-of-Way costs to be determined in the future.



Legend

- | | | | | | |
|---|-------------------|---|---|---|---|
|  | Proposed Pavement |  | Proposed Bridge Abutment |  | Approximate Wetland Resource Area
(Wetland Impact = 1.3 Acres) |
|  | Proposed Bridge |  | Proposed Travel Lanes |  | Stream (Approximately 520 Linear Feet of Impact) |
|  | Proposed Island |  | Proposed ROW (10.0 Acres of Acquisition Needed) |  | Assessor's Tax Parcels |
|  | Proposed Grass |  | Proposed Retaining Wall | | |

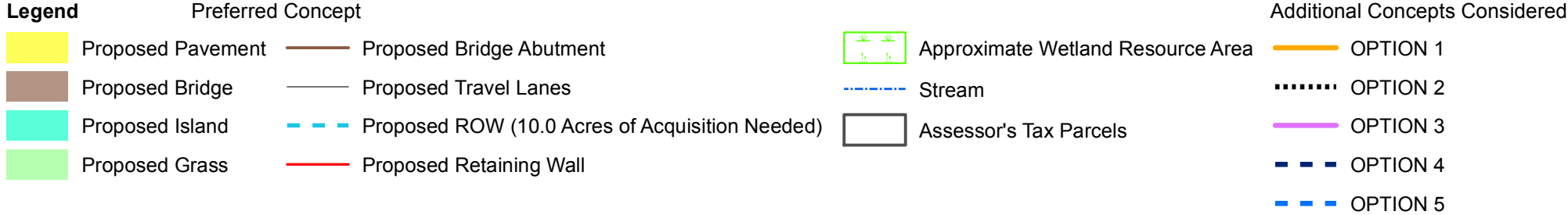
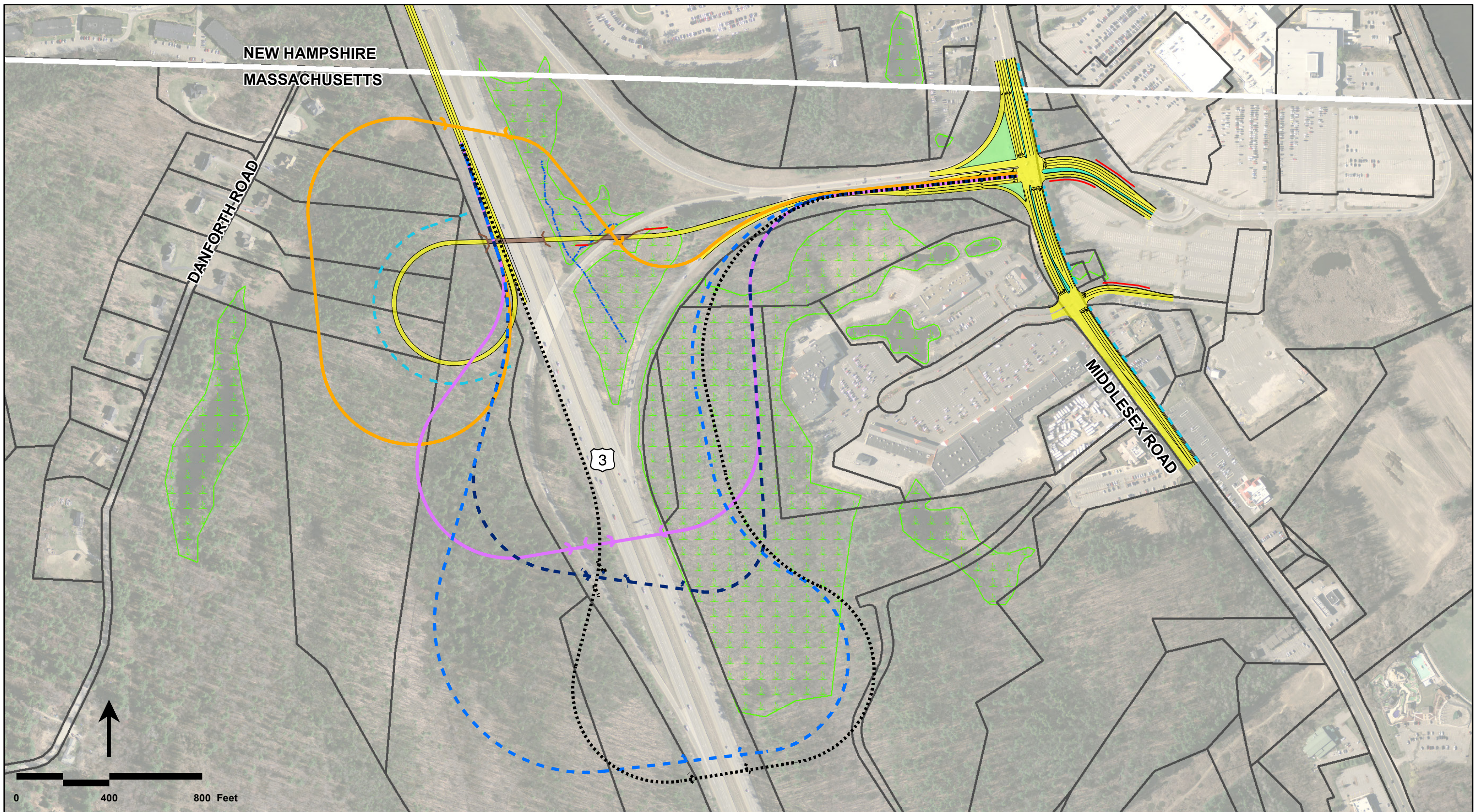


VHB Vanasse Hangen Brustlin, Inc.

Figure 1 - Proposed Improvements Overview

Exit 36S Transportation Community
Planning System Preservation Project





VHB Vanasse Hangen Brustlin, Inc.

Figure 2: Additional Concepts Considered

Exit 36S Transportation Community Planning System Preservation Project



Appendix 2

Level of Service (LOS) Summary Spreadsheets

Level of Service Summary: Exit 36 Study 2032 Conditions

Location	AM/Midday			PM Peak			Saturday		
	Peak Intersection Delay	AM/Midday Max V/C Ratio	AM/Midday Peak LOS	Intersection Delay	PM Max V/C Ratio	PM Peak LOS	Peak Intersection Delay	Saturday Max V/C Ratio	Saturday Peak LOS
Rte 113 (Kendall Rd) at Locust Ave*	50.9	0.50	F	167.2	1.13	F	55.4	0.79	F
Rte 113 (Kendall Rd) at Cummings St*	56.3	0.63	F	88.2	0.93	F	17.3	0.15	C
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) SB Ramps	3.6	0.36	A	9.7	0.64	A	8.7	0.6	A
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) NB Ramps*	46.4	0.63	E	127.8	1.00	F	26.9	0.31	C
Rte 113 (Kendall Rd) at Middlesex Rd	103.9	1.48	F	88.1	1.30	F	139.3	2.95	F
Middlesex Rd at Locust Ave	13.0	0.78	B	8.9	0.65	A	67.3	1.66	E
Middlesex Rd at TJ Maxx Plaza Entrance	16.3	0.74	B	12.4	0.55	B	81.9	1.87	F
Middlesex Rd at Exit 36 Ramps	73.8	1.99	E	101.1	1.14	F	300.2	3.03	F
Spit Brook Rd at Oracle Dr	3.4	0.65	A	14.6	0.87	B			
Spit Brook Rd at Tara Boulevard	567.0	3.13	F	807.6	4.26	F			
Spit Brook Rd at Rte 3 (Exit 1) SB Ramps	67.6	1.36	E	334.3	1.60	F	50.5	1.20	D
Spit Brook Rd at Rte 3 (Exit 1) NB Ramps	25.8	0.85	C	228.2	1.92	F	23.3	0.78	C
Spit Brook Rd at Newcastle Dr	20.6	0.59	C	41.0	0.85	D	21.1	0.64	C
Spit Brook Rd at Royal Ridge Dr	41.8	1.07	D	18.8	0.77	B	21.7	0.77	C
Spit Brook Rd at Daniel Webster Highway	28.5	0.81	C	25.3	0.75	C	35.0	0.79	D
Daniel Webster Highway at Silver Dr	24.7	0.82	C	26.7	0.83	C	67.1	0.97	E
Daniel Webster Highway at Danforth Rd	57.3	1.19	E	49.7	1.06	D	165.3	1.52	F
Daniel Webster Highway at Dan Chan Rd	19.7	0.58	B	21.8	0.61	C	34.0	1.00	C
Daniel Webster Highway at Pheasant Ln	120.4	3.64	F	22.4	0.87	C	91.6	2.81	F

*Unsignalized Intersections. LOS based on minor street movements.

Level of Service Summary: Exit 36 Study 2022 No Build Conditions

Location	AM/Midday			PM Peak			Saturday Peak		
	AM/Midday Peak Intersection Delay	AM/Midday Max V/C Ratio	AM/Midday Peak LOS	PM Peak Intersection Delay	PM Max V/C Ratio	PM Peak LOS	Saturday Peak Intersection Delay	Saturday Max V/C Ratio	Saturday Peak LOS
Rte 113 (Kendall Rd) at Locust Ave*	34.9	0.36	D	53.7	1.72	F	33.9	0.62	D
Rte 113 (Kendall Rd) at Cummings St*	33.8	0.44	D	34.7	0.60	D	15.6	0.12	C
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) SB Ramps	3.4	0.33	A	8.8	0.6	A	8.4	0.59	A
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) NB Ramps*	32.0	0.49	D	119.1	0.98	F	23.4	0.25	C
Rte 113 (Kendall Rd) at Middlesex Rd	72.4	1.28	E	65.0	1.14	E	112.2	2.65	F
Middlesex Rd at Locust Ave	11.8	0.73	B	8.5	0.63	A	33.3	1.27	C
Middlesex Rd at TJ Maxx Plaza Entrance	14.1	0.64	B	12.1	0.53	B	36.3	1.25	D
Middlesex Rd at Exit 36 Ramps	33.7	1.46	C	25.4	1.03	C	113.6	2.24	F
Spit Brook Rd at Oracle Dr	5.2	0.74	A	16.9	0.40	B			
Spit Brook Rd at Tara Boulevard	216.1	3.57	F	329.6	2.51	F			
Spit Brook Rd at Rte 3 (Exit 1) SB Ramps	33.2	0.86	C	111.3	1.14	F	28.4	0.85	C
Spit Brook Rd at Rte 3 (Exit 1) NB Ramps	22.7	0.76	C	98.4	1.29	F	20.9	0.80	C
Spit Brook Rd at Newcastle Dr	24.0	0.62	C	41.6	0.86	D	25.6	0.76	C
Spit Brook Rd at Royal Ridge Dr	18.2	0.73	B	17.9	0.75	B	21.1	0.76	C
Spit Brook Rd at Daniel Webster Highway	30.5	0.81	C	26.9	0.77	C	49.0	0.93	D
Daniel Webster Highway at Silver Dr	24.0	0.75	C	22.9	0.81	C	44.0	0.98	D
Daniel Webster Highway at Danforth Rd	64.3	1.10	E	54.8	1.04	D	160.7	1.41	F
Daniel Webster Highway at Dan Chan Rd	28.3	0.79	C	26.4	0.75	C	32.8	0.81	C
Daniel Webster Highway at Pheasant Ln	33.0	1.24	C	21.3	0.76	C	64.1	2.54	E

*Unsignalized Intersections. LOS based on minor street movements.

Level of Service Summary: Exit 36 Study 2032 No Build Conditions

Location	AM/Midday			PM Peak			Saturday		
	Peak Intersection Delay	AM/Midday Max V/C Ratio	AM/Midday Peak LOS	Intersection Delay	PM Max V/C Ratio	PM Peak LOS	Peak Intersection Delay	Saturday Max V/C Ratio	Saturday Peak LOS
Rte 113 (Kendall Rd) at Locust Ave*	51.1	0.50	F	160.4	1.11	F	55.4	0.79	F
Rte 113 (Kendall Rd) at Cummings St*	52.3	0.60	F	73.9	0.88	F	17.3	0.15	C
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) SB Ramps	3.6	0.36	A	9.8	0.64	A	8.7	0.60	A
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) NB Ramps*	45.6	0.63	E	119.1	0.98	F	26.8	0.31	D
Rte 113 (Kendall Rd) at Middlesex Rd	94.5	1.41	F	88.3	1.30	F	139.3	2.95	F
Middlesex Rd at Locust Ave	12.9	0.78	B	8.9	0.65	A	44.3	1.36	D
Middlesex Rd at TJ Maxx Plaza Entrance	15.1	0.69	B	12.7	0.56	B	61.7	1.68	E
Middlesex Rd at Exit 36 Ramps	57.7	2.02	E	37.8	1.37	D	173.3	3.07	F
Spit Brook Rd at Oracle Dr	6.5	0.80	A	68.8	1.15	E			
Spit Brook Rd at Tara Boulevard	541.6	4.28	F	778.1	4.32	F			
Spit Brook Rd at Rte 3 (Exit 1) SB Ramps	52.2	1.14	D	382.7	1.70	F	54.1	1.24	D
Spit Brook Rd at Rte 3 (Exit 1) NB Ramps	29.2	0.81	C	219.6	1.97	F	24.1	0.78	C
Spit Brook Rd at Newcastle Dr	27.1	0.62	C	44.2	0.89	D	23.2	0.69	C
Spit Brook Rd at Royal Ridge Dr	20.5	0.73	C	18.0	0.76	B	22.1	0.77	C
Spit Brook Rd at Daniel Webster Highway	37.6	0.98	C	28.4	0.82	C	50.4	1.00	D
Daniel Webster Highway at Silver Dr	23.7	0.78	C	22.8	0.84	C	53.2	1.16	D
Daniel Webster Highway at Danforth Rd	76.2	1.11	E	59.2	1.07	E	198.3	1.54	F
Daniel Webster Highway at Dan Chan Rd	29.7	0.81	C	28.7	0.77	C	35.7	0.84	D
Daniel Webster Highway at Pheasant Ln	33.1	1.31	C	21.5	0.78	C	68.2	3.00	E

*Unsignalized Intersections. LOS based on minor street movements.

US Route 3/ FE Everett Turnpike Interchange Levels of Service

2022 No Build Conditions

Morning/Mid Day Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Route 113 (Kendall Road) at Route 3 (Exit 35) SB ramps	7-9 a.m.	3.4	0.33	A
Route 113 (Kendall Road) at Route 3 (Exit 35) NB ramps	7-9 a.m.	32.0	0.49	D
Middlesex Road at Exit 36 Ramps	11-1 p.m.	33.7	1.46	C
Spit Brook Road at Route 3 (Exit 1) SB Ramps	12-2 p.m.	33.2	0.86	C
Spit Brook Road at Route 3 (Exit 1) NB Ramps	12-2 p.m.	22.7	0.76	C

Evening Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Route 113 (Kendall Road) at Route 3 (Exit 35) SB ramps	4-6 p.m.	8.8	0.6	A
Route 113 (Kendall Road) at Route 3 (Exit 35) NB ramps	4-6 p.m.	119.1	0.98	F
Middlesex Road at Exit 36 Ramps	4-6 p.m.	25.4	1.03	C
Spit Brook Road at Route 3 (Exit 1) SB Ramps	4-6 p.m.	111.3	1.14	F
Spit Brook Road at Route 3 (Exit 1) NB Ramps	4-6 p.m.	98.4	1.29	F

Saturday Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Route 113 (Kendall Road) at Route 3 (Exit 35) SB ramps	1-3 p.m.	8.4	0.59	A
Route 113 (Kendall Road) at Route 3 (Exit 35) NB ramps	1-3 p.m.	23.4	0.25	C
Middlesex Road at Exit 36 Ramps	1-3 p.m.	113.6	2.24	F
Spit Brook Road at Route 3 (Exit 1) SB Ramps	1-3 p.m.	28.4	0.85	C
Spit Brook Road at Route 3 (Exit 1) NB Ramps	1-3 p.m.	20.9	0.80	C

2032 No Build Conditions

Morning/Mid Day Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Route 113 (Kendall Road) at Route 3 (Exit 35) SB ramps	7-9 a.m.	3.6	0.36	A
Route 113 (Kendall Road) at Route 3 (Exit 35) NB ramps	7-9 a.m.	45.6	0.63	E
Middlesex Road at Exit 36 Ramps	11-1 p.m.	57.7	2.02	E

Evening Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Route 113 (Kendall Road) at Route 3 (Exit 35) SB ramps	4-6 p.m.	9.8	0.64	A
Route 113 (Kendall Road) at Route 3 (Exit 35) NB ramps	4-6 p.m.	119.1	0.98	F
Middlesex Road at Exit 36 Ramps	4-6 p.m.	37.8	1.37	D
Spit Brook Road at Route 3 (Exit 1) SB Ramps	4-6 p.m.	382.7	1.70	F
Spit Brook Road at Route 3 (Exit 1) NB Ramps	4-6 p.m.	219.6	1.97	F

Saturday Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Route 113 (Kendall Road) at Route 3 (Exit 35) NB ramps	1-3 p.m.	26.8	0.31	D
Middlesex Road at Exit 36 Ramps	1-3 p.m.	173.3	3.07	F
Spit Brook Road at Route 3 (Exit 1) SB Ramps	1-3 p.m.	54.1	1.24	D
Spit Brook Road at Route 3 (Exit 1) NB Ramps	1-3 p.m.	24.1	0.78	C

Build conditions deteriorate Middlesex rd at Exit 36 ramps in all conditions.
Build conditions improve Spit Brook Rd at Rte 3 SB Ramps during weekday peak hours but deteriorates on Saturdays.

2022 Build Conditions

Morning/Mid Day Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Route 113 (Kendall Road) at Route 3 (Exit 35) SB ramps	7-9 a.m.	3.4	0.33	A
Route 113 (Kendall Road) at Route 3 (Exit 35) NB ramps	7-9 a.m.	32.0	0.49	E
Middlesex Road at Exit 36 Ramps	11-1 p.m.	54.3	1.53	D
Spit Brook Road at Route 3 (Exit 1) SB Ramps	12-2 p.m.	28.2	0.91	C
Spit Brook Road at Route 3 (Exit 1) NB Ramps	12-2 p.m.	20.2	0.73	C

Evening Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Route 113 (Kendall Road) at Route 3 (Exit 35) SB ramps	4-6 p.m.	8.8	0.60	A
Route 113 (Kendall Road) at Route 3 (Exit 35) NB ramps	4-6 p.m.	61.7	0.74	F
Middlesex Road at Exit 36 Ramps	4-6 p.m.	47.9	1.31	D
Spit Brook Road at Route 3 (Exit 1) SB Ramps	4-6 p.m.	83.1	1.04	F
Spit Brook Road at Route 3 (Exit 1) NB Ramps	4-6 p.m.	102.8	1.27	F

Saturday Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Route 113 (Kendall Road) at Route 3 (Exit 35) SB ramps	1-3 p.m.	8.0	0.57	A
Route 113 (Kendall Road) at Route 3 (Exit 35) NB ramps	1-3 p.m.	22.2	0.24	C
Middlesex Road at Exit 36 Ramps	1-3 p.m.	280.7	2.31	F
Spit Brook Road at Route 3 (Exit 1) SB Ramps	1-3 p.m.	67.1	1.35	E
Spit Brook Road at Route 3 (Exit 1) NB Ramps	1-3 p.m.	20.0	0.73	B

2032 Build Conditions

Morning/Mid Day Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Route 113 (Kendall Road) at Route 3 (Exit 35) SB ramps	7-9 a.m.	3.6	0.36	A
Route 113 (Kendall Road) at Route 3 (Exit 35) NB ramps	7-9 a.m.	46.4	0.63	E
Middlesex Road at Exit 36 Ramps	11-1 p.m.	73.8	1.99	E

Evening Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Route 113 (Kendall Road) at Route 3 (Exit 35) SB ramps	4-6 p.m.	9.7	0.64	A
Route 113 (Kendall Road) at Route 3 (Exit 35) NB ramps	4-6 p.m.	127.8	1.00	F
Middlesex Road at Exit 36 Ramps	4-6 p.m.	101.1	1.14	F
Spit Brook Road at Route 3 (Exit 1) SB Ramps	4-6 p.m.	334.3	1.60	F
Spit Brook Road at Route 3 (Exit 1) NB Ramps	4-6 p.m.	228.2	1.92	F

Saturday Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Route 113 (Kendall Road) at Route 3 (Exit 35) NB ramps	1-3 p.m.	26.9	0.31	C
Middlesex Road at Exit 36 Ramps	1-3 p.m.	300.2	3.03	F
Spit Brook Road at Route 3 (Exit 1) SB Ramps	1-3 p.m.	50.5	1.20	D
Spit Brook Road at Route 3 (Exit 1) NB Ramps	1-3 p.m.	23.3	0.78	C

Change	
Intersection Delay	V/C Ratio

-	-
-	-
(20.60)	(0.07)
5.00	(0.05)
2.50	0.03

-	-
57.40	0.24
(22.50)	(0.28)
28.20	0.10
(4.40)	0.02

0.40	0.02
1.20	0.01
(167.10)	(0.07)
(38.70)	(0.50)
0.90	0.07

-	-
(0.80)	-
(16.10)	0.03

0.10	-
(8.70)	(0.02)
(63.30)	0.23
48.40	0.10
(8.60)	0.05

(0.10)	-
(126.90)	0.04
3.60	0.04
0.80	-

Spit Brook Road Intersections Levels of Service

2022 No Build Conditions

Morning/Mid Day Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Spit Brook Road at Oracle Drive	7-9 a.m.	5.2	0.74	A
Spit Brook Road at Tara Boulevard	7-9 a.m.	216.1	3.57	F
Spit Brook Road at Route 3 (Exit 1) SB Ramps	11-1 p.m.	33.2	0.86	C
Spit Brook Road at Route 3 (Exit 1) NB Ramps	11-1 p.m.	22.7	0.76	C
Spit Brook Road at Newcastle Drive	11-1 p.m.	24.0	0.62	C
Spit Brook Road at Royal Ridge Drive	11-1 p.m.	18.2	0.73	B
Spit Brook Road at Daniel Webster Highway	11-1 p.m.	30.5	0.81	C

Evening Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Spit Brook Road at Oracle Drive	4-6 p.m.	16.9	0.40	B
Spit Brook Road at Tara Boulevard	4-6 p.m.	329.6	2.51	F
Spit Brook Road at Route 3 (Exit 1) SB Ramps	4-6 p.m.	111.3	1.14	F
Spit Brook Road at Route 3 (Exit 1) NB Ramps	4-6 p.m.	98.4	1.29	F
Spit Brook Road at Newcastle Drive	4-6 p.m.	41.6	0.86	D
Spit Brook Road at Royal Ridge Drive	4-6 p.m.	17.9	0.75	B
Spit Brook Road at Daniel Webster Highway	4-6 p.m.	26.9	0.77	C

Saturday Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Spit Brook Road at Oracle Drive				
Spit Brook Road at Tara Boulevard				
Spit Brook Road at Route 3 (Exit 1) SB Ramps	1-3 p.m.	28.4	0.85	C
Spit Brook Road at Route 3 (Exit 1) NB Ramps	1-3 p.m.	20.9	0.80	C
Spit Brook Road at Newcastle Drive	1-3 p.m.	25.6	0.76	C
Spit Brook Road at Royal Ridge Drive	1-3 p.m.	21.1	0.76	C
Spit Brook Road at Daniel Webster Highway	1-3 p.m.	49.0	0.93	D

2032 No Build Conditions

Morning/Mid Day Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Spit Brook Road at Oracle Drive	7-9 a.m.	6.5	0.80	A
Spit Brook Road at Tara Boulevard	7-9 a.m.	541.6	4.28	F
Spit Brook Road at Route 3 (Exit 1) SB Ramps	11-1 p.m.	52.2	1.14	D
Spit Brook Road at Route 3 (Exit 1) NB Ramps	11-1 p.m.	29.2	0.81	C
Spit Brook Road at Newcastle Drive	11-1 p.m.	27.1	0.62	C
Spit Brook Road at Royal Ridge Drive	11-1 p.m.	20.5	0.73	C
Spit Brook Road at Daniel Webster Highway	11-1 p.m.	37.6	0.98	C

Evening Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Spit Brook Road at Oracle Drive	4-6 p.m.	68.8	1.15	E
Spit Brook Road at Tara Boulevard	4-6 p.m.	778.1	4.32	F
Spit Brook Road at Route 3 (Exit 1) SB Ramps	4-6 p.m.	382.7	1.70	F
Spit Brook Road at Route 3 (Exit 1) NB Ramps	4-6 p.m.	219.6	1.97	F
Spit Brook Road at Newcastle Drive	4-6 p.m.	44.2	0.89	D
Spit Brook Road at Royal Ridge Drive	4-6 p.m.	18.0	0.76	B
Spit Brook Road at Daniel Webster Highway	4-6 p.m.	28.4	0.82	C

Saturday Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Spit Brook Road at Oracle Drive				
Spit Brook Road at Tara Boulevard				
Spit Brook Road at Route 3 (Exit 1) SB Ramps	1-3 p.m.	54.1	1.24	D
Spit Brook Road at Route 3 (Exit 1) NB Ramps	1-3 p.m.	24.1	0.78	C
Spit Brook Road at Newcastle Drive	1-3 p.m.	23.2	0.69	C
Spit Brook Road at Royal Ridge Drive	1-3 p.m.	22.1	0.77	C
Spit Brook Road at Daniel Webster Highway	1-3 p.m.	50.4	1.00	D

2022 Build Conditions

Morning/Mid Day Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Spit Brook Road at Oracle Drive	7-9 a.m.	2.8	0.58	A
Spit Brook Road at Tara Boulevard	7-9 a.m.	175.8	2.00	F
Spit Brook Road at Route 3 (Exit 1) SB Ramps	11-1 p.m.	28.2	0.91	C
Spit Brook Road at Route 3 (Exit 1) NB Ramps	11-1 p.m.	20.2	0.73	C
Spit Brook Road at Newcastle Drive	11-1 p.m.	19.8	0.57	B
Spit Brook Road at Royal Ridge Drive	11-1 p.m.	31.8	0.99	C
Spit Brook Road at Daniel Webster Highway	11-1 p.m.	27.8	0.77	C

Evening Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Spit Brook Road at Oracle Drive	4-6 p.m.	10.5	0.75	A
Spit Brook Road at Tara Boulevard	4-6 p.m.	341.6	2.49	F
Spit Brook Road at Route 3 (Exit 1) SB Ramps	4-6 p.m.	83.1	1.04	F
Spit Brook Road at Route 3 (Exit 1) NB Ramps	4-6 p.m.	102.8	1.27	F
Spit Brook Road at Newcastle Drive	4-6 p.m.	38.4	0.84	D
Spit Brook Road at Royal Ridge Drive	4-6 p.m.	18.7	0.76	B
Spit Brook Road at Daniel Webster Highway	4-6 p.m.	25.3	0.75	C

Saturday Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Spit Brook Road at Oracle Drive				
Spit Brook Road at Tara Boulevard				
Spit Brook Road at Route 3 (Exit 1) SB Ramps	1-3 p.m.	67.1	1.35	E
Spit Brook Road at Route 3 (Exit 1) NB Ramps	1-3 p.m.	20.0	0.73	B
Spit Brook Road at Newcastle Drive	1-3 p.m.	21.5	0.66	C
Spit Brook Road at Royal Ridge Drive	1-3 p.m.	19.2	0.76	B
Spit Brook Road at Daniel Webster Highway	1-3 p.m.	41.8	0.95	D

2032 Build Conditions

Morning/Mid Day Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Spit Brook Road at Oracle Drive	7-9 a.m.	3.4	0.65	A
Spit Brook Road at Tara Boulevard	7-9 a.m.	567.0	3.13	F
Spit Brook Road at Route 3 (Exit 1) SB Ramps	11-1 p.m.	67.6	1.36	E
Spit Brook Road at Route 3 (Exit 1) NB Ramps	11-1 p.m.	25.8	0.85	C
Spit Brook Road at Newcastle Drive	11-1 p.m.	20.6	0.59	C
Spit Brook Road at Royal Ridge Drive	11-1 p.m.	41.8	1.07	D
Spit Brook Road at Daniel Webster Highway	11-1 p.m.	28.5	0.81	C

Evening Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Spit Brook Road at Oracle Drive	4-6 p.m.	14.6	0.87	B
Spit Brook Road at Tara Boulevard	4-6 p.m.	807.6	4.26	F
Spit Brook Road at Route 3 (Exit 1) SB Ramps	4-6 p.m.	334.3	1.60	F
Spit Brook Road at Route 3 (Exit 1) NB Ramps	4-6 p.m.	228.2	1.92	F
Spit Brook Road at Newcastle Drive	4-6 p.m.	41.0	0.85	D
Spit Brook Road at Royal Ridge Drive	4-6 p.m.	18.8	0.77	B
Spit Brook Road at Daniel Webster Highway	4-6 p.m.	25.3	0.75	C

Saturday Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Spit Brook Road at Oracle Drive				
Spit Brook Road at Tara Boulevard				
Spit Brook Road at Route 3 (Exit 1) SB Ramps	1-3 p.m.	50.5	1.20	D
Spit Brook Road at Route 3 (Exit 1) NB Ramps	1-3 p.m.	23.3	0.78	C
Spit Brook Road at Newcastle Drive	1-3 p.m.	21.1	0.64	C
Spit Brook Road at Royal Ridge Drive	1-3 p.m.	21.7	0.77	C
Spit Brook Road at Daniel Webster Highway	1-3 p.m.	35.0	0.79	D

Change	
Intersection Delay	V/C Ratio
2.40	0.16
40.30	1.57
5.00	(0.05)
2.50	0.03
4.20	0.05
(13.60)	(0.26)
2.70	0.04

6.40	(0.35)
(12.00)	0.02
28.20	0.10
(4.40)	0.02
3.20	0.02
(0.80)	(0.01)
1.60	0.02

-	-
-	-
(38.70)	(0.50)
0.90	0.07
4.10	0.10
1.90	-
7.20	(0.02)

3.10	0.15
(25.40)	1.15
(15.40)	(0.22)
3.40	(0.04)
6.50	0.03
(21.30)	(0.34)
9.10	0.17

54.20	0.28
(29.50)	0.06
48.40	0.10
(8.60)	0.05
3.20	0.04
(0.80)	(0.01)
3.10	0.07

-	-
-	-
3.60	0.04
0.80	-
2.10	0.05
0.40	-
15.40	0.21

Spit Brook Rd improves on Saturday peaks with the new ramp in place and Tara Blvd weekday traffic not present. Tara Blvd adds a lot of pressure to the Exit1 ramps during the weekday peak hours but it would be much worse without an Exit 36 ramp in place to move some shopping traffic off Spit brook Rd.

Daniel Webster Highway Intersections Levels of Service

2022 No Build Conditions

Morning/Mid Day Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Spit Brook Rd at Daniel Webster Highway	11-1 p.m.	30.5	0.81	C
Daniel Webster Highway at Silver Dr	11-1 p.m.	24.0	0.75	C
Daniel Webster Highway at Danforth Rd	11-1 p.m.	64.3	1.10	E
Daniel Webster Highway at Dan Chan Rd	11-1 p.m.	28.3	0.79	C
Daniel Webster Highway at Pheasant Ln	11-1 p.m.	33.0	1.24	C

Evening Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Spit Brook Rd at Daniel Webster Highway	4-6 p.m.	26.9	0.77	C
Daniel Webster Highway at Silver Dr	4-6 p.m.	22.9	0.81	C
Daniel Webster Highway at Danforth Rd	4-6 p.m.	54.8	1.04	D
Daniel Webster Highway at Dan Chan Rd	4-6 p.m.	26.4	0.75	C
Daniel Webster Highway at Pheasant Ln	4-6 p.m.	21.3	0.76	C

Saturday Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Spit Brook Rd at Daniel Webster Highway	1-3 p.m.	49.0	0.93	D
Daniel Webster Highway at Silver Dr	1-3 p.m.	44.0	0.98	D
Daniel Webster Highway at Danforth Rd	1-3 p.m.	160.7	1.41	F
Daniel Webster Highway at Dan Chan Rd	1-3 p.m.	32.8	0.81	C
Daniel Webster Highway at Pheasant Ln	1-3 p.m.	64.1	2.54	E

2032 No Build Conditions

Morning/Mid Day Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Spit Brook Rd at Daniel Webster Highway	11-1 p.m.	37.6	0.98	C
Daniel Webster Highway at Silver Dr	11-1 p.m.	23.7	0.78	C
Daniel Webster Highway at Pheasant Ln	11-1 p.m.	33.1	1.31	C

Evening Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Spit Brook Rd at Daniel Webster Highway	4-6 p.m.	28.4	0.82	C
Daniel Webster Highway at Silver Dr	4-6 p.m.	22.8	0.84	C
Daniel Webster Highway at Danforth Rd	4-6 p.m.	59.2	1.07	E
Daniel Webster Highway at Dan Chan Rd	4-6 p.m.	28.7	0.77	C

Saturday Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Spit Brook Rd at Daniel Webster Highway	1-3 p.m.	50.4	1.00	D
Daniel Webster Highway at Silver Dr	1-3 p.m.	53.2	1.16	D
Daniel Webster Highway at Danforth Rd	1-3 p.m.	198.3	1.54	F
Daniel Webster Highway at Dan Chan Rd	1-3 p.m.	35.7	0.84	D
Daniel Webster Highway at Pheasant Ln	1-3 p.m.	68.2	3.00	E

2022 Build Conditions

Morning/Mid Day Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Spit Brook Rd at Daniel Webster Highway	11-1 p.m.	27.8	0.77	C
Daniel Webster Highway at Silver Dr	11-1 p.m.	25.0	0.80	C
Daniel Webster Highway at Danforth Rd	11-1 p.m.	54.3	1.08	D
Daniel Webster Highway at Dan Chan Rd	11-1 p.m.	19.5	0.53	C
Daniel Webster Highway at Pheasant Ln	11-1 p.m.	87.4	2.61	F

Evening Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Spit Brook Rd at Daniel Webster Highway	4-6 p.m.	25.3	0.75	C
Daniel Webster Highway at Silver Dr	4-6 p.m.	26.4	0.82	C
Daniel Webster Highway at Danforth Rd	4-6 p.m.	46.6	0.98	D
Daniel Webster Highway at Dan Chan Rd	4-6 p.m.	21.1	0.53	C
Daniel Webster Highway at Pheasant Ln	4-6 p.m.	22.7	0.77	C

Saturday Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Spit Brook Rd at Daniel Webster Highway	1-3 p.m.	41.8	0.95	D
Daniel Webster Highway at Silver Dr	1-3 p.m.	52.8	0.94	D
Daniel Webster Highway at Danforth Rd	1-3 p.m.	127.8	1.41	F
Daniel Webster Highway at Dan Chan Rd	1-3 p.m.	30.5	0.88	C
Daniel Webster Highway at Pheasant Ln	1-3 p.m.	81.1	2.55	F

2032 Build Conditions

Morning/Mid Day Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Spit Brook Rd at Daniel Webster Highway	11-1 p.m.	28.5	0.81	C
Daniel Webster Highway at Silver Dr	11-1 p.m.	24.7	0.82	C
Daniel Webster Highway at Pheasant Ln	11-1 p.m.	120.4	3.64	F

Evening Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Spit Brook Rd at Daniel Webster Highway	4-6 p.m.	25.3	0.75	C
Daniel Webster Highway at Silver Dr	4-6 p.m.	26.7	0.83	C
Daniel Webster Highway at Danforth Rd	4-6 p.m.	49.7	1.06	D
Daniel Webster Highway at Dan Chan Rd	4-6 p.m.	21.8	0.61	C

Saturday Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Spit Brook Rd at Daniel Webster Highway	1-3 p.m.	35.0	0.79	D
Daniel Webster Highway at Silver Dr	1-3 p.m.	67.1	0.97	E
Daniel Webster Highway at Danforth Rd	1-3 p.m.	165.3	1.52	F
Daniel Webster Highway at Dan Chan Rd	1-3 p.m.	34.0	1.00	C
Daniel Webster Highway at Pheasant Ln	1-3 p.m.	91.6	2.81	F

Change	
Intersection	V/C Ratio
2.70	0.04
(1.00)	(0.05)
10.00	0.02
8.80	0.26
(54.40)	(1.37)
1.60	0.02
(3.50)	(0.01)
8.20	0.06
5.30	0.22
(1.40)	(0.01)
7.20	(0.02)
(8.80)	0.04
32.90	-
2.30	(0.07)
(17.00)	(0.01)
9.10	0.17
(1.00)	(0.04)
(87.30)	(2.33)
3.10	0.07
(3.90)	0.01
9.50	0.01
6.90	0.16
15.40	0.21
(13.90)	0.19
33.00	0.02
1.70	(0.16)
(23.40)	0.19

Middlesex Road Intersections Levels of Service

2022 No Build Conditions

Morning/Mid Day Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Middlesex Rd	11-1 p.m.	72.4	1.28	E
Middlesex Rd at Locust Ave	11-1 p.m.	11.8	0.73	B
Middlesex Rd at TJ Maxx Plaza Entrance	11-1 p.m.	14.1	0.64	B
Middlesex Rd at Exit 36 Ramps	11-1 p.m.	33.7	1.46	C

Evening Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Middlesex Rd	4-6 p.m.	65.0	1.14	E
Middlesex Rd at Locust Ave	4-6 p.m.	8.5	0.63	A
Middlesex Rd at TJ Maxx Plaza Entrance	4-6 p.m.	12.1	0.53	B
Middlesex Rd at Exit 36 Ramps	4-6 p.m.	25.4	1.03	C

Saturday Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Middlesex Rd	1-3 p.m.	112.2	2.65	F
Middlesex Rd at Locust Ave	1-3 p.m.	33.3	1.27	C
Middlesex Rd at TJ Maxx Plaza Entrance	1-3 p.m.	36.3	1.25	D
Middlesex Rd at Exit 36 Ramps	1-3 p.m.	113.6	2.24	F

2032 No Build Conditions

Morning/Mid Day Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Middlesex Rd	11-1 p.m.	94.5	1.41	F
Middlesex Rd at Locust Ave	11-1 p.m.	12.9	0.78	B
Middlesex Rd at TJ Maxx Plaza Entrance	11-1 p.m.	15.1	0.69	B

Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Middlesex Rd	4-6 p.m.	88.3	1.30	F
Middlesex Rd at Locust Ave	4-6 p.m.	8.9	0.65	A
Middlesex Rd at TJ Maxx Plaza Entrance	4-6 p.m.	12.7	0.56	B
Middlesex Rd at Exit 36 Ramps	4-6 p.m.	37.8	1.37	D

Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Middlesex Rd	1-3 p.m.	139.3	2.95	F
Middlesex Rd at Locust Ave	1-3 p.m.	44.3	1.36	D
Middlesex Rd at TJ Maxx Plaza Entrance	1-3 p.m.	61.7	1.68	E
Middlesex Rd at Exit 36 Ramps	1-3 p.m.	173.3	3.07	F

2022 Build Conditions

Morning/Mid Day Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Middlesex Rd	11-1 p.m.	72.4	1.28	F
Middlesex Rd at Locust Ave	11-1 p.m.	11.8	0.73	B
Middlesex Rd at TJ Maxx Plaza Entrance	11-1 p.m.	15.1	0.69	B
Middlesex Rd at Exit 36 Ramps	11-1 p.m.	54.3	1.53	D

Evening Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Middlesex Rd	4-6 p.m.	65.0	1.14	E
Middlesex Rd at Locust Ave	4-6 p.m.	8.5	0.63	A
Middlesex Rd at TJ Maxx Plaza Entrance	4-6 p.m.	11.7	0.52	B
Middlesex Rd at Exit 36 Ramps	4-6 p.m.	47.9	1.31	D

Saturday Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Middlesex Rd	1-3 p.m.	112.2	2.65	F
Middlesex Rd at Locust Ave	1-3 p.m.	34.8	1.29	C
Middlesex Rd at TJ Maxx Plaza Entrance	1-3 p.m.	42.5	1.30	D
Middlesex Rd at Exit 36 Ramps	1-3 p.m.	280.7	2.31	F

2032 Build Conditions

Morning/Mid Day Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Middlesex Rd	11-1 p.m.	103.9	1.48	F
Middlesex Rd at Locust Ave	11-1 p.m.	13.0	0.78	B
Middlesex Rd at TJ Maxx Plaza Entrance	11-1 p.m.	16.3	0.74	B

Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Middlesex Rd	4-6 p.m.	88.1	1.30	F
Middlesex Rd at Locust Ave	4-6 p.m.	8.9	0.65	A
Middlesex Rd at TJ Maxx Plaza Entrance	4-6 p.m.	12.4	0.55	B
Middlesex Rd at Exit 36 Ramps	4-6 p.m.	101.1	1.14	F

Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Middlesex Rd	1-3 p.m.	139.3	2.95	F
Middlesex Rd at Locust Ave	1-3 p.m.	67.3	1.66	E
Middlesex Rd at TJ Maxx Plaza Entrance	1-3 p.m.	81.9	1.87	F
Middlesex Rd at Exit 36 Ramps	1-3 p.m.	300.2	3.03	F

Change	
Intersection	V/C Ratio
-	-
-	-
(1.00)	(0.05)
(20.60)	(0.07)
-	-
-	-
0.40	0.01
(22.50)	(0.28)
-	-
-	-
(1.50)	(0.02)
(6.20)	(0.05)
(167.10)	(0.07)
(9.40)	(0.07)
(0.10)	-
(1.20)	(0.05)
0.20	-
-	-
0.30	0.01
(63.30)	0.23
-	-
(23.00)	(0.30)
(20.20)	(0.19)
(126.90)	0.04

Middlesex at Exit 36 sees los decrease under the build condition.

The highest level of traffic on Middlesex Rd is on Saturday afternoons. TJ Maxx Plaza and Locust Ave sees some spillover from the Exit 36 intersection on weekends.

Route 113 (Kendall Road) Intersections Levels of Service

2022 No Build Conditions

Morning/Mid Day Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Locust Ave*	7-9 a.m.	34.9	0.36	D
Rte 113 (Kendall Rd) at Cummings St*	7-9 a.m.	33.8	0.44	D
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) SB Ramps	7-9 a.m.	3.4	0.33	A
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) NB Ramps*	7-9 a.m.	32.0	0.49	D
Rte 113 (Kendall Rd) at Middlesex Rd	7-9 a.m.	72.4	1.28	E

Evening Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Locust Ave*	4-6 p.m.	53.7	1.72	F
Rte 113 (Kendall Rd) at Cummings St*	4-6 p.m.	34.7	0.60	D
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) SB Ramps	4-6 p.m.	8.8	0.6	A
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) NB Ramps*	4-6 p.m.	119.1	0.98	F
Rte 113 (Kendall Rd) at Middlesex Rd	4-6 p.m.	65.0	1.14	E

Saturday Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Locust Ave*	1-3 p.m.	33.9	0.62	D
Rte 113 (Kendall Rd) at Cummings St*	1-3 p.m.	15.6	0.12	C
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) SB Ramps	1-3 p.m.	8.4	0.59	A
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) NB Ramps*	1-3 p.m.	23.4	0.25	C
Rte 113 (Kendall Rd) at Middlesex Rd	1-3 p.m.	112.2	2.65	F

2032 No Build Conditions

Morning/Mid Day Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Locust Ave*	7-9 a.m.	51.1	0.50	F
Rte 113 (Kendall Rd) at Cummings St*	7-9 a.m.	52.3	0.60	F
Rte 113 (Kendall Rd) at Middlesex Rd	7-9 a.m.	94.5	1.41	F

Evening Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Locust Ave*	4-6 p.m.	160.4	1.11	F
Rte 113 (Kendall Rd) at Cummings St*	4-6 p.m.	73.9	0.88	F
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) SB Ramps	4-6 p.m.	9.8	0.64	A
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) NB Ramps*	4-6 p.m.	119.1	0.98	F

Saturday Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Locust Ave*	1-3 p.m.	55.4	0.79	F
Rte 113 (Kendall Rd) at Cummings St*	1-3 p.m.	17.3	0.15	C
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) SB Ramps	1-3 p.m.	8.7	0.60	A
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) NB Ramps*	1-3 p.m.	26.8	0.31	D
Rte 113 (Kendall Rd) at Middlesex Rd	1-3 p.m.	139.3	2.95	F

2022 Build Conditions

Morning/Mid Day Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Locust Ave*	7-9 a.m.	34.9	0.36	D
Rte 113 (Kendall Rd) at Cummings St*	7-9 a.m.	33.8	0.44	D
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) SB Ramps	7-9 a.m.	3.4	0.33	A
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) NB Ramps*	7-9 a.m.	32.0	0.49	D
Rte 113 (Kendall Rd) at Middlesex Rd	7-9 a.m.	72.4	1.28	F

Evening Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Locust Ave*	4-6 p.m.	53.7	0.72	F
Rte 113 (Kendall Rd) at Cummings St*	4-6 p.m.	34.7	0.60	D
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) SB Ramps	4-6 p.m.	8.8	0.60	A
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) NB Ramps*	4-6 p.m.	61.7	0.74	F
Rte 113 (Kendall Rd) at Middlesex Rd	4-6 p.m.	65.0	1.14	E

Saturday Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Locust Ave*	1-3 p.m.	32.5	0.60	D
Rte 113 (Kendall Rd) at Cummings St*	1-3 p.m.	15.3	0.12	C
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) SB Ramps	1-3 p.m.	8.0	0.57	A
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) NB Ramps*	1-3 p.m.	22.2	0.24	C
Rte 113 (Kendall Rd) at Middlesex Rd	1-3 p.m.	112.2	2.65	F

2032 Build Conditions

Morning/Mid Day Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Locust Ave*	7-9 a.m.	50.9	0.50	F
Rte 113 (Kendall Rd) at Cummings St*	7-9 a.m.	56.3	0.63	F
Rte 113 (Kendall Rd) at Middlesex Rd	7-9 a.m.	103.9	1.48	F

Evening Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Locust Ave*	4-6 p.m.	167.2	1.13	F
Rte 113 (Kendall Rd) at Cummings St*	4-6 p.m.	88.2	0.93	F
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) SB Ramps	4-6 p.m.	9.7	0.64	A
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) NB Ramps*	4-6 p.m.	127.8	1.00	F

Saturday Peak				
Location	Peak Time	Intersection Delay	V/C Ratio	LOS
Rte 113 (Kendall Rd) at Locust Ave*	1-3 p.m.	54.5	0.79	F
Rte 113 (Kendall Rd) at Cummings St*	1-3 p.m.	17.3	0.15	C
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) SB Ramps	1-3 p.m.	7.8	0.6	A
Rte 113 (Kendall Rd) at Rte 3 (Exit 35) NB Ramps*	1-3 p.m.	26.9	0.31	C
Rte 113 (Kendall Rd) at Middlesex Rd	1-3 p.m.	139.3	2.95	F

Change	
Intersection Delay	V/C Ratio

-	-
-	-
-	-
-	-
-	-

-	1.00
-	-
-	-
57.40	0.24
-	-

1.40	0.02
0.30	-
0.40	0.02
1.20	0.01
-	-

0.20	-
(4.00)	(0.03)
(9.40)	(0.07)

(6.80)	(0.02)
(14.30)	(0.05)
0.10	-
(8.70)	(0.02)

0.90	-
-	-
0.90	-
(0.10)	-
-	-

Appendix 3

Key Intersections and Interchanges

Exit 36 Study Area

Key Intersections and Interchanges –Exit 36 Study Area

I. US ROUTE 3 NORTH/ F.E. EVERETT TURNPIKE INTERCHANGES

- F.E. Everett Turnpike at Spit Brook Road (Exit 1)

This diamond interchange connects to Spit Brook Road at two points (NB and SB) with traffic signals at each intersection with the surface street. The southbound off ramp approaches the Spit Brook Road intersection with two left turn lanes and one exclusive right turn lane. The southbound on ramp contains one lane merging at the highway. The northbound off ramp utilizes one left turn lane and one right turn lane. The northbound on ramp contains two all purpose lanes merging with the F.E .Everett Turnpike.

- Route 3 at Middlesex Road (Exit 36)

This interchange is a partial semi directional T interchange with all movements in place with the exception of the southbound off ramp. The interchange meets Middlesex Road at an actuated traffic signal just south of the Massachusetts/New Hampshire border at one of the Pheasant Lane Mall entranceways. This is the interchange where the southbound Route 3 off ramp is being proposed. The northbound off ramp approaches the intersection with one exclusive left turn lane, one shared left and through lane, one exclusive through lane, and one exclusive right turn lane separated by a median. The on ramp includes a right turn slip lane from southbound Daniel Webster Highway that yields to traffic coming from northbound Middlesex Road and the Pheasant Lane Mall.

- Route 3 at Route 113 (Kendall Road Exit 35)

This interchange is a version of a partial cloverleaf design connecting to Kendall Road at two points (NB and SB) with a traffic signal at the SB entrance and stop/yield control at the NB intersection.

2. KEY SPIT BROOK ROAD INTERSECTIONS

- Spit Brook Road/ Royal Ridge Drive

This is a 4-way signalized intersection. In the eastbound direction on Spit Brook Road there are 2 through travel lanes and one actuated left turn pocket. In the west bound direction on Spit Brook Road there is one through lane, a shared through/right turn lane, and one actuated left turn pocket. The southbound minor approach on Royal Ridge has separated dedicated right and left turn lanes. The northbound minor approach on Whitegate Drive has one shared lane for through, left, and right turning movements.

- Spit Brook Road/ Newcastle Drive/BAE Driveway

This is a 4-way signalized intersection. In the eastbound direction on Spit Brook Road there are 2 through travel lanes and an actuated left turn pocket. There is also a flared right turn lane onto the BAE

driveway. In the west bound direction there is one through lane, a shared through/right turn lane, and one actuated left turn pocket. The southbound minor approach on Newcastle Drive has shared right and left turn lanes. The northbound minor approach on the BAE driveway has a flared right turn lane onto eastbound Spit Brook Road, and dedicated left turn lane onto westbound Spit Brook Road.

- Spit Brook Road/ F.E. Everett Turnpike (Exit 1) NB Ramps

This is a 4-way signalized intersection. In the eastbound direction on Spit Brook Road there are 2 through travel lanes and an actuated double left turn pocket. In the westbound direction there are two through lanes, and a flared right turn lane onto the northbound F.E. Everett Turnpike on ramp. The northbound approach is from the F.E. Everett Turnpike Exit 1 northbound off ramp. It has separate right and left turn lanes. There is no southbound approach at this intersection.

- Spit Brook Road/ F.E. Everett Turnpike (Exit 1) SB Ramps

This is a 4-way signalized intersection. In the eastbound direction on Spit Brook Road there are 2 through travel lanes and a separate right turn pocket. In the westbound direction there are two through lanes, and an actuated left turn pocket onto southbound F.E. Everett Turnpike on ramp. The southbound approach is from the F.E. Everett Turnpike Exit 1 southbound off ramp. It has 2 dedicated right-turn lanes and one separate left turn lane. There is no northbound approach at this intersection.

- Spit Brook Road/ Brook Village Road

This is a 4-way signalized intersection. In the eastbound direction on Spit Brook Road there are 2 through lanes and 1 dedicated right turn lane. In the westbound direction there are 2 through lanes and 1 dedicated left turn pocket. The only movement allowed from northbound Brook Village Road is a right turn onto eastbound Spit Brook Road.

- Spit Brook Road/ Tara Boulevard

This is a 4-way signalized intersection. In the eastbound direction on Spit Brook Road there is 1 through lane and 1 actuated left turn lane. In the westbound direction there are 2 through lanes, 1 actuated left turn pocket, and a flared right turn lane onto Tara Boulevard. Northbound traffic on Villa Way uses a single, shared lane to go straight, left or right.

- Spit Brook Road/ Sapling Circle

This is a 3-way non-signalized intersection. In the eastbound direction on Spit Brook Road there is 1 through lane. In the westbound direction there are 2 through lanes and 1 left turn pocket onto southbound Sapling Circle. The westbound segment of this roadway narrows to 1 lane shortly after this intersection. Northbound traffic from Sapling Circle may turn left or right onto Spit Brook Road.

- Spit Brook Road/ Oracle Drive

This is a 3-way signalized intersection. In the eastbound direction on Spit Brook Road there is a shared through/ left turn lane. In the westbound direction there is a shared through/right turn lane. The southbound approach on Oracle Drive has dedicated right and left turn lanes. There is no northbound approach to this intersection.

3. KEY DW HIGHWAY INTERSECTIONS

- DW Highway/Pheasant Lane/Costco

This is a 4-way signalized intersection. In the northbound direction on Daniel Webster Highway there are 2 through travel lanes, one dedicated/actuated left turn pocket and a shared through/right turn lane. In the southbound direction there are 2 through travel lanes, a dedicated/actuated left turn pocket and a shared right turn/through lane. The westbound approach has separate dedicated right and left turn lanes. The eastbound approach has dedicated through, left and right turn lanes.

- DW Highway/ Dan Chan Street

This is a 3-way signalized intersection. In the northbound direction on Daniel Webster Highway there are 2 through travel lanes, one dedicated/actuated left turn pocket (for U-turns) and a shared through/right turn lane. In the southbound direction there are 2 through travel lanes, and 2 dedicated/actuated left turn pockets. The westbound approach has separate dedicated right and left turn lanes. There is no eastbound approach.

- DW Highway/East DeSilvio Drive

This is a non-signalized intersection. The northbound and southbound travel lanes are separated by a median. In the northbound direction on Daniel Webster Highway there are 2 through travel lanes and a shared through/right turn lane onto DeSilvio Drive. In the southbound direction there are 2 through travel lanes. The left-turn pockets for Dan Chan Street begin just north of DeSilvio Drive. The westbound approach only allows right turns onto northbound DW Highway because of the center median on DW Highway. The eastbound approach only allows right turns onto southbound DW Highway because of the center median.

- DW Highway/ Danforth Road

This is a 4-way signalized intersection. In the northbound direction on DW Highway there are 2 through travel lanes, one dedicated/actuated left turn pocket and a shared through/right turn lane. In the southbound direction there are 2 through travel lanes, a dedicated/actuated left turn pocket and a shared right turn/through lane. The westbound approach has a dedicated right turn lane and a shared left/through lane. The eastbound approach has 2 dedicated left and 1 right turn lane.

- DW Highway/Silver Drive

This is a 4-way signalized intersection. In the northbound direction on Daniel Webster Highway there are 2 through travel lanes, one dedicated/actuated left turn pocket and a shared through/right turn lane. In the southbound direction there are 2 through travel lanes, a dedicated/actuated left turn pocket and a shared right turn/through lane. The westbound approach has a dedicated right turn lane and a shared left/through lane. The eastbound approach has a shared left/through lane and a dedicated right turn lane.

- DW Highway/ Harold Drive

This is a 3-way non-signalized intersection. In the northbound direction on Daniel Webster Highway there are 2 through travel lanes and the beginning of 2 left turn pockets for the next intersection to the north. In the southbound direction there are 2 through travel lanes and a shared through/right turn lane. The eastbound approach from Harold Drive has a right turn lane. There is no westbound approach at this intersection.

- DW Highway/ Spit Brook Road

This is a 4-way signalized intersection. In the northbound direction on Daniel Webster Highway there are 2 through travel lanes, one dedicated/actuated left turn pocket and a shared through/right turn lane. In the southbound direction there are 2 through travel lanes, a dedicated/actuated left turn pocket and a shared right turn/through lane. The westbound approach has a dedicated right, left and through lanes. The eastbound approach has 2 dedicated right turn lanes, 1 dedicated left turn lane and a shared left/through lane.

4. KEY MIDDLESEX ROAD INTERSECTIONS

- Middlesex Road at Route 3 Exit 36 Ramps/Pheasant Lane Mall Entrance

This location forms an actuated signalized intersection for vehicles accessing the commercial area around the Pheasant Lane Mall, northern Tyngsborough, and southern Nashua. Currently, the only exit for Middlesex Road at this interchange is from northbound Route 3. Thus all traffic accessing Middlesex Road from Route 3 arrives from northbound direction. Vehicles accessing Route 3 from Middlesex Road have the option of going north or south on Route 3. The proposed southbound Route 3 ramp will flow into this intersection.

Middlesex Road northbound has one exclusive left turn lane, two exclusive through lanes, and one shared through/right turn lane. Middlesex Road southbound has one exclusive left turn lane and two exclusive through lanes. Right turning movements have a separate ramp just north of the intersection with yield control.

The Route 3 ramps heading eastbound currently have one exclusive left turn lane, one shared left turn/through lane, one exclusive through lane, and one exclusive right turn lane separated by an island with yield control. Leaving the mall, the configuration consists of one shared through/ right turn lane, and one shared through/left turn lane.

- Middlesex Road at TJ Maxx Plaza/Pheasant Lane Mall Entrance

This location is described as a four legged actuated signalized intersection with all turns allowed. Middlesex Road northbound has one exclusive left turn lane, one exclusive through lane, and a shared through/right turn lane. Middlesex Road southbound has one exclusive right turn lane, one exclusive through lane, and one shared through/left turn lane. The TJ Maxx Plaza road is an access road to a shopping plaza with various retail businesses along the access road. This road experiences the majority

of its traffic during the weekend when shopping is most prevalent. The eastbound approach configuration consists of one exclusive right turn lane and one shared through/left turn lane. The westbound approach to the intersection is an access road leading to the Pheasant Lane Mall. This approach consists on one lane for all movements.

- Middlesex Road at Locust Avenue

This location forms a four-legged actuated signalized intersection with all turns allowed. Middlesex Road consists of two lanes approaching the intersection from the south but expands to four lanes approximately 500 feet south of the intersection. Middlesex Road remains four lanes north of the intersection. Locust Avenue approaches the intersection from the southwest with a single lane configured for all turning movements. At the intersection, there is a diner and bank that add to vehicular traffic at the intersection. Farwell Road, a two lane local road approximately 20 feet wide, approaches the intersection from the east with one lane designated for all turning movements.

- Middlesex Road at Route 113 (Kendall Road)/Route 3A(Frost Road)

This location at the Tyngsborough Bridge near Town Center forms a four legged actuated signalized intersection with all turns allowed. Middlesex Road approaches the intersection from the north with one exclusive left turn lane, one exclusive through lane, and one shared through/right turn lane. From the south, Middlesex Road consists of one exclusive left turn lane, one exclusive through lane, and one exclusive right turn lane. The approach on Route 113/3A from the east crosses the Merrimack River on the Tyngsborough bridge. The approach consists of one exclusive left turn lane, and one shared through/right turn lane. Route 113 approaches from the west with exclusive left, through, and right turn lanes.

5. KEY ROUTE 113 (KENDALL ROAD) INTERSECTIONS

- Route 113 (Kendall Road) at Locust Avenue/Cummings Street

Located just west of the Route 3 Exit 35 interchange where Route 113 narrows to from four to two lanes, this intersection has stop control for minor street movements. The Route 113 approaches from each direction utilize one lane for all movements. However, shoulders are wide enough for vehicles to have enough room to go around turning vehicles at the intersection, as was noted occurring during data collection. Cummings Street and Locust Avenue form a split four legged intersection in that the two streets connect with Route 113 approximately 100 yards apart. Both Cummings Street and Locust Avenue have one lane approaches for all movements onto Route 113.

- Route 113 (Kendall Road) at Route 3 Exit 35 Southbound Ramps

This location forms an actuated signalized T intersection. On the approach from the south, the ramps split with left turning vehicles utilizing the traffic signal control and right turning vehicles using a slip ramp with yield control. From the east, Route 113 approaches with one exclusive through lane and one shared left turn/through lane. West of the intersection, Route 113 narrows to two lanes approaching

Locust Avenue. Route 113, approaching from the west, has an exclusive right turn lane and two through lanes.

- Route 113 (Kendall Road) at Route 3 Exit 35 Northbound Ramps

This location forms a T intersection with Stop control for vehicles turning left from the Route 3 ramps to eastbound Route 113. Yield control exists for right turning vehicles heading to westbound Route 113 from Route 3 northbound. Route 113 approaches the intersection from the east with an exclusive through lane and an exclusive right turn slip lane. From the west, Route 113 has one exclusive left turn lane and one exclusive through lane. On the overpass over Route 3, Route 113 expands to two travel lanes in each direction.