Master Plan Shared Goals

Based on this input, the following shared goals were established for the Route 20 Master Plan.

- Improve intersection and corridor safety
- Address existing congestion issues
- Provide capacity needed to support future traffic growth fueled by private development
- Address the lack of travel options

Existing Study Area Conditions

Demographics

Figure 7 shows the study corridor is contained within Census Tract 7391. Although block groups would have provided specific information of the population adjacent to Route 20, the most recent Census Data (2013-2017 American Community Survey (ACS) data) did not provide information in the block group level; thus, the census tract adjacent to Route 20 was evaluated instead. Additionally, to place local conditions and trends in the context of a larger geography, as well as help shed light on the study area's relationship to its surroundings, three geographic contexts were evaluated: Census Tract 7391, Shrewsbury, and Massachusetts.

POPULATION OVERVIEW

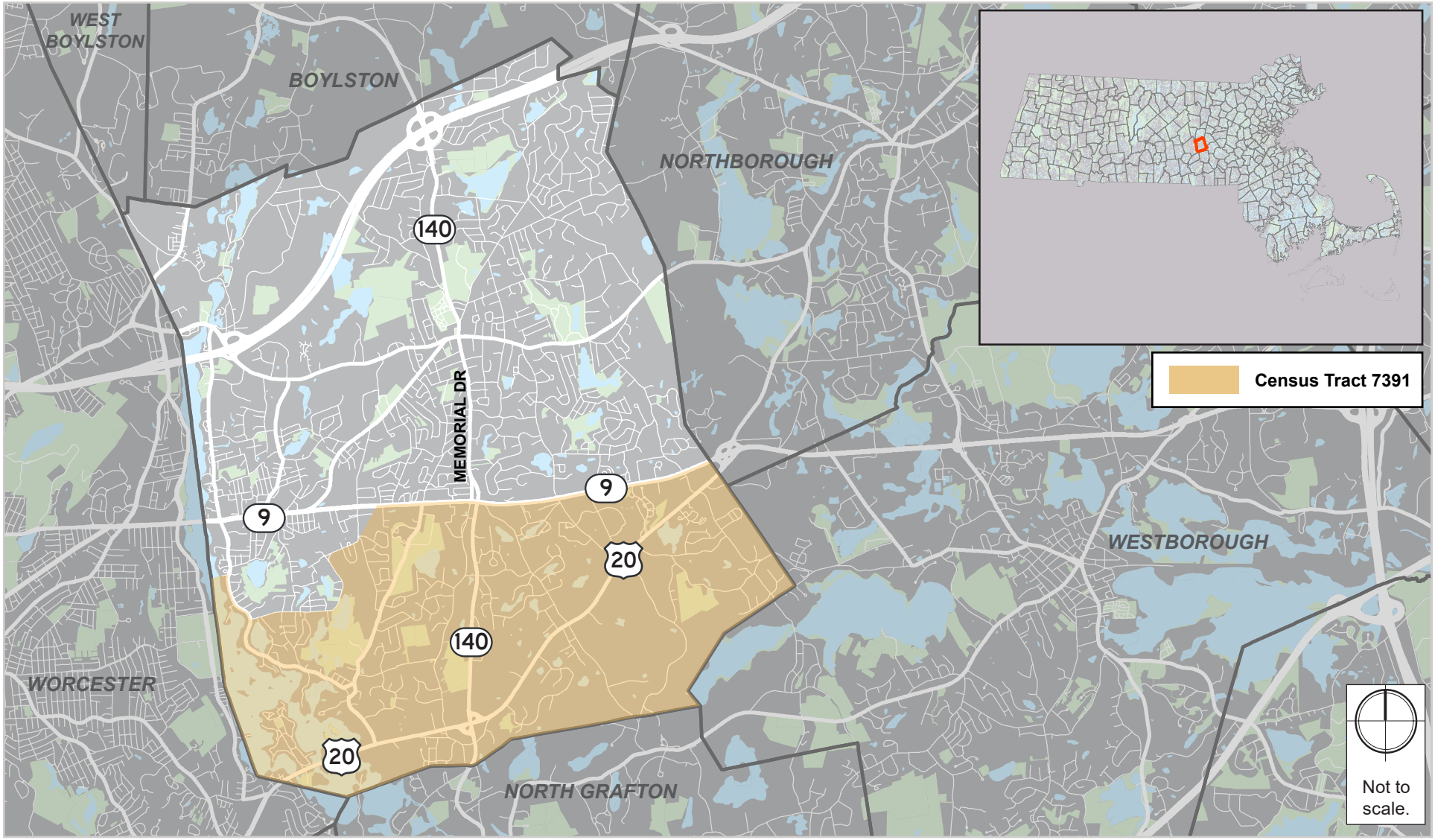
The current population of Shrewsbury is 36,716 and it is expected to grow further in the coming years as more people make Shrewsbury their home. As shown in **Table 2,** the Central Massachusetts Regional Planning Commission's (CMRPC) population projections estimate that the Town will add over 7,000 new residents by 2040, bringing the total population to 43,761.

Table 2. Shrewsbury Population Information

Year	Population	% Change
2000	31,640	-
2010	35,608	13%
2013-2017 ACS	36,716	3%
2020[2]	**38,906**	**6%**
2030	**42,090**	**8%**
2040	**13,671**	**4%**

[2] CMRPC Population Projections, www.cmrpc.org

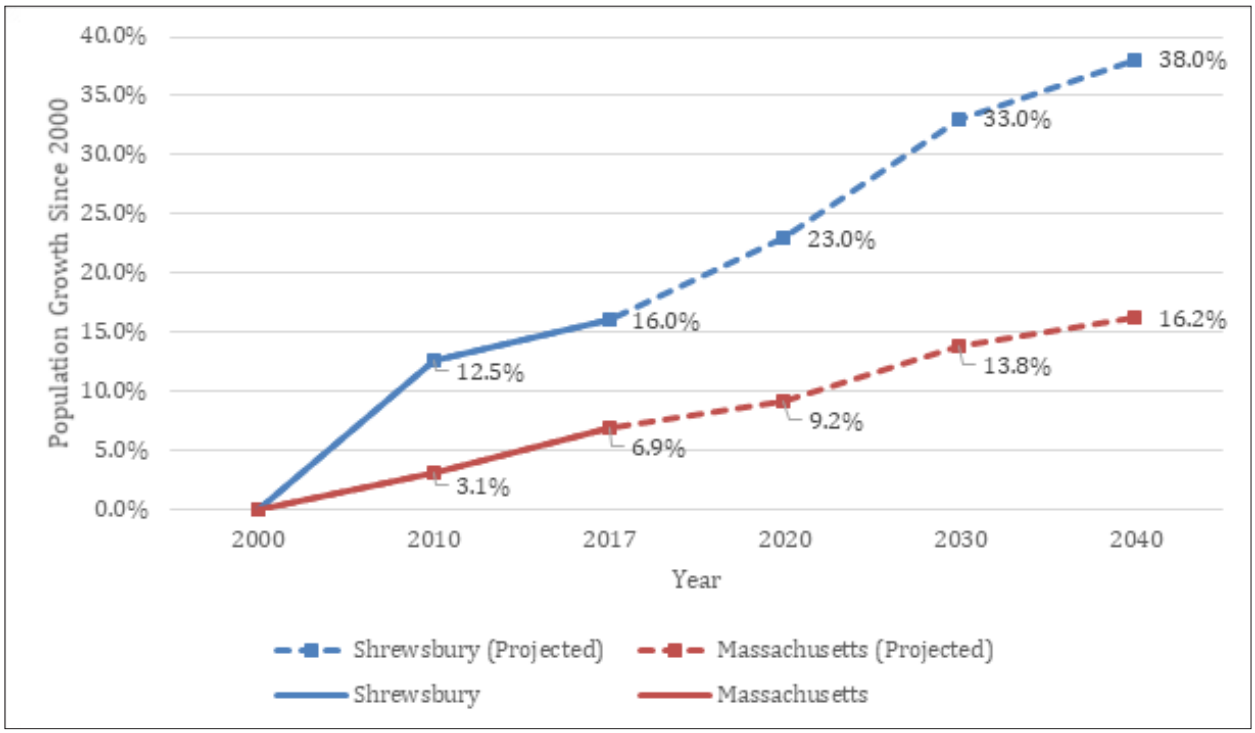
Figure 7. Study Area in Relation to the Region



Shrewsbury – Route 20 Corridor Improvements

As shown in **Figure 8**, the population in the Town of Shrewsbury has grown faster than the statewide average and growth is expected to outpace the Commonwealth's through 2040.

Figure 8. Comparison of Shrewsbury Population Growth Since 2000 to Massachusetts Population Growth (Actual and Estimated)

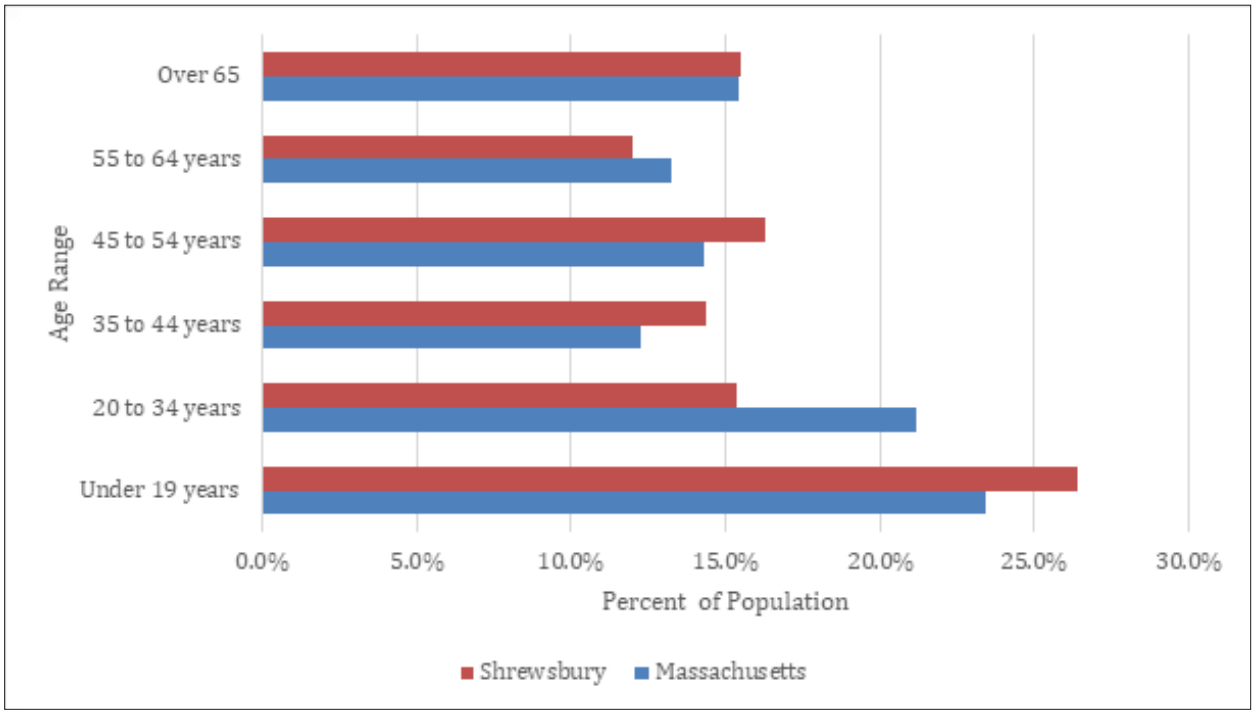


POPULATION AGE DISTRIBUTION

Figure 9 shows the comparison between age groups within Shrewsbury and Massachusetts. The Town of Shrewsbury has a higher percentage of residents under 19 years old and between the ages of 35 and 54, indicating that there are more families with children than in other parts of the Commonwealth. This increased presence of families with children is offset by the smaller percentage of young adults (ages 20 to 34 years) who only make up about 15% of Shrewsbury residents but represent 21% of all Massachusetts residents.

The total number of seniors (i.e., residents within the age group 65 years old and over) is similar to the statewide average and it continues to be the age group in Shrewsbury that is increasing in size the fastest, growing from 13.5% of the population in 2010 to 15.5% of the population in 2017. Unlike the senior population, the three age groups overrepresented in Shrewsbury (under 19 years, 35 to 44 years, and 45 to 54 years) have decreased as a share of the population since 2010.

Figure 9. Comparison of Age Distribution in 2017[3]



HOUSEHOLD CHARACTERISTICS

HOUSING SUPPLY

Between 2010 and 2017, housing units within Census Tract 7391, which encompasses most of the neighborhoods surrounding the study area, increased by 4.5% while the total number of housing units in the Town of Shrewsbury remained relatively the same. **Table 3** shows that the housing supply in the vicinity of Route 20 grew faster than in both the Town of Shrewsbury and the Commonwealth overall.

Table 3. Change in Housing Supply

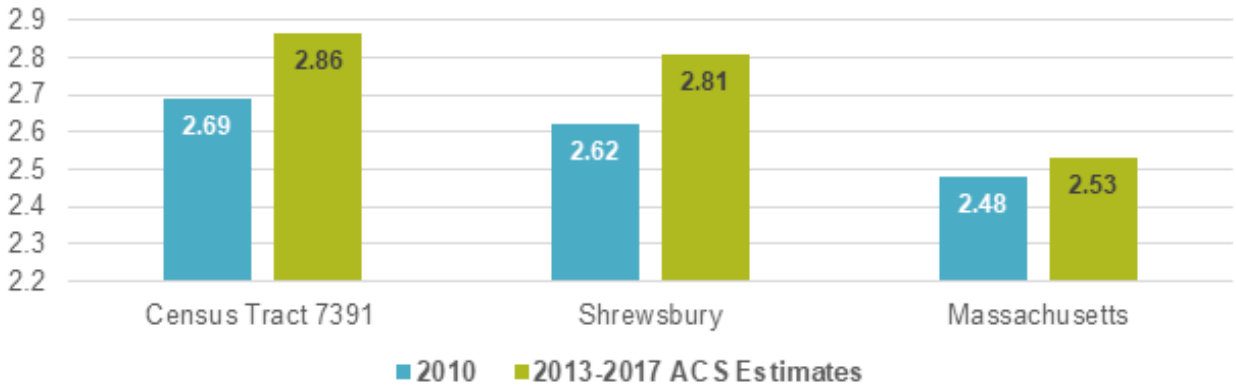
Year	Study Area (Census Tract 7391)	Shrewsbury	Massachusetts
2010	3,611	13,987	2,808,254
2017	3,774	13,958	2,864,989
% Change between 2010 and 2017	4.5%	-0.2%	2.0%

[3] U.S. Census Bureau, 2013-2017 American Community Survey 5-Year Estimates

HOUSEHOLD SIZE

Corresponding with the growth in population, Census Tract 7391 and Shrewsbury saw an increase in households from 2010 to 2017. Despite the significant decrease in population percent change from 2010 to 2017, the average household size in the neighborhoods around the study corridor (Census Tract 7391) and within the Town of Shrewsbury remained fairly consistent around 2.8 persons per household. Massachusetts has a lower household size average at 2.5 households (**Figure 10**).

Figure 10. Average Household Size



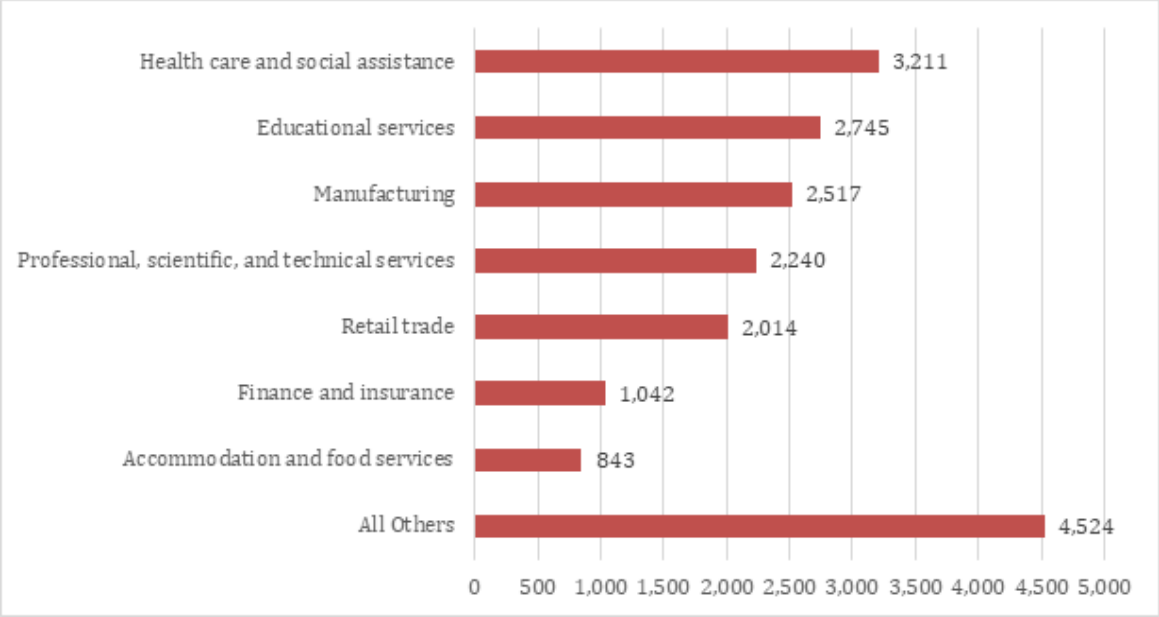
EMPLOYMENT

LABOR FORCE

Shrewsbury is very much impacted by the business mix and employment patterns of the regional economy. This is reflected in the types of jobs held by the most Shrewsbury residents in 2017 which included healthcare and social assistance, educational services, manufacturing, and professional, scientific, and technical services. **Figure 11** shows the total numbers of Shrewsbury residents employed in these fields.

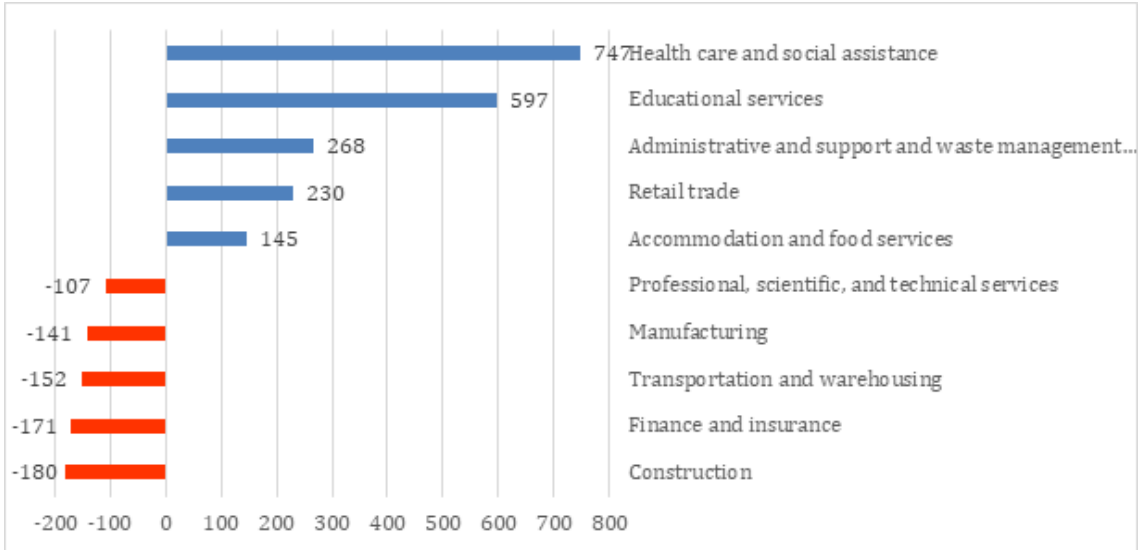
Most Shrewsbury residents are employed in healthcare and educational services, among others.

Figure 11. Shrewsbury Labor Force by Industry Sector, 2017[4,5]



The biggest change in employment numbers between 2010 and 2017 are shown in **Figure 12.** The healthcare social assistance along with educational services saw the largest numerical growth, while construction and finance and insurance saw the largest decline.

Figure 12. Changes in Labor Force Employment, 2010 to 2017

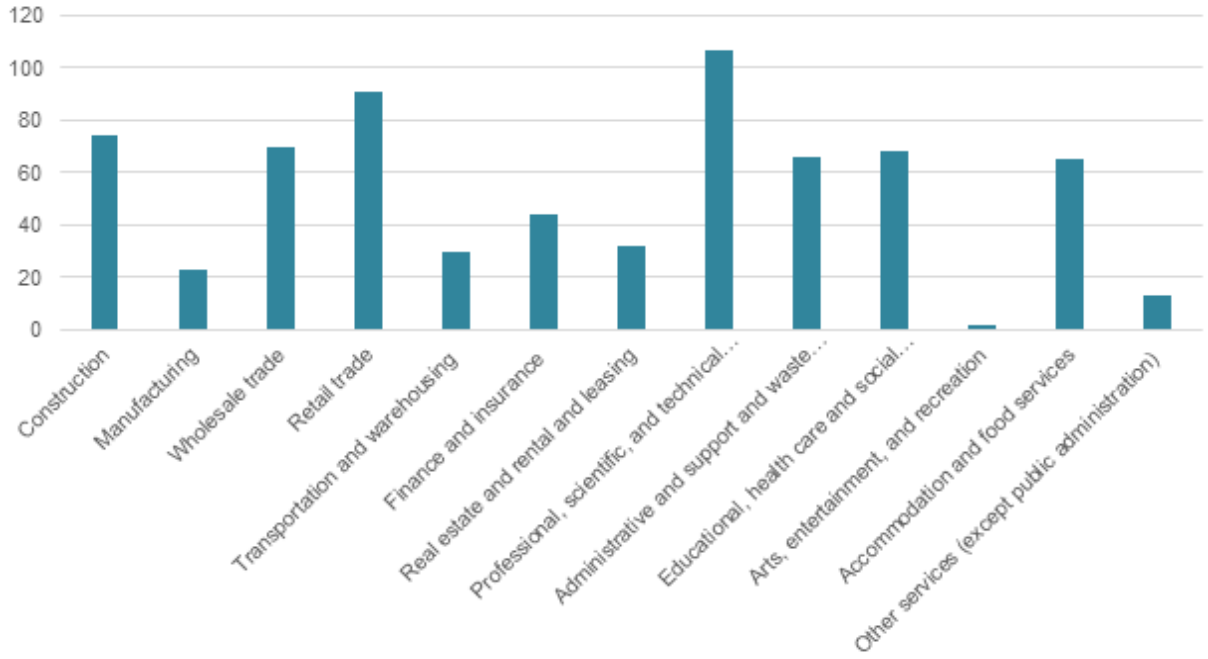


[4]U.S. Census Bureau, 2013-2017 American Community Survey 5-Year Estimates
[5]Agriculture, forestry, fishing, and mining (AFFM); Transportation, warehousing, and utilities (TWU); Finance, insurance, and real estate (FIRE); Professional, scientific, and management (PSM); Education and health services and social assistance (EHSA); Arts, entertainment, recreation, and food services (AERF)

MAJOR EMPLOYERS[6]

Figure 13 shows the distribution of industries that were present within the Town in 2012 and the types of employment sectors that were present in Shrewsbury. The top three industries that are in Shrewsbury are Professional, Scientific, and Technical Services (107 establishments); Retail Trade (91 establishments); and Construction (74 establishments). The three industries that are not as prevalent are Arts, Entertainment, and Recreation (2 establishments); Manufacturing (23 establishments); and Other Services (except Public Administration) (13 establishments).

Figure 13. Number of Firms with Paid Employees by Industry in Shrewsbury



The top three industries found within Shrewsbury almost mirrors the top industries that characterize Shrewsbury's labor force, with an exception to Educational, Healthcare, and Social Services. Although there are many Shrewsbury residents that are under the Education, Healthcare, and Social Services industry, it only ranks fifth in the highest number of employers within Shrewsbury (68 establishments).

Table 4 shows the number of paid employees in Shrewsbury that consists of full- and part-time employees, including salaried officers and executives of corporations, who were on the payroll during the pay period. Transportation and Warehousing showed to have the highest number of paid employees, followed by Retail Trade and Accommodation and Food Services, as well as Arts and Entertainment.

[6]Statistics for All U.S. Firms by Industry, Gender, Ethnicity, and Race for the U.S., States, Metro Areas, Counties, and Places: 2012

Table 4. Number of Paid Employees in Shrewsbury[7]

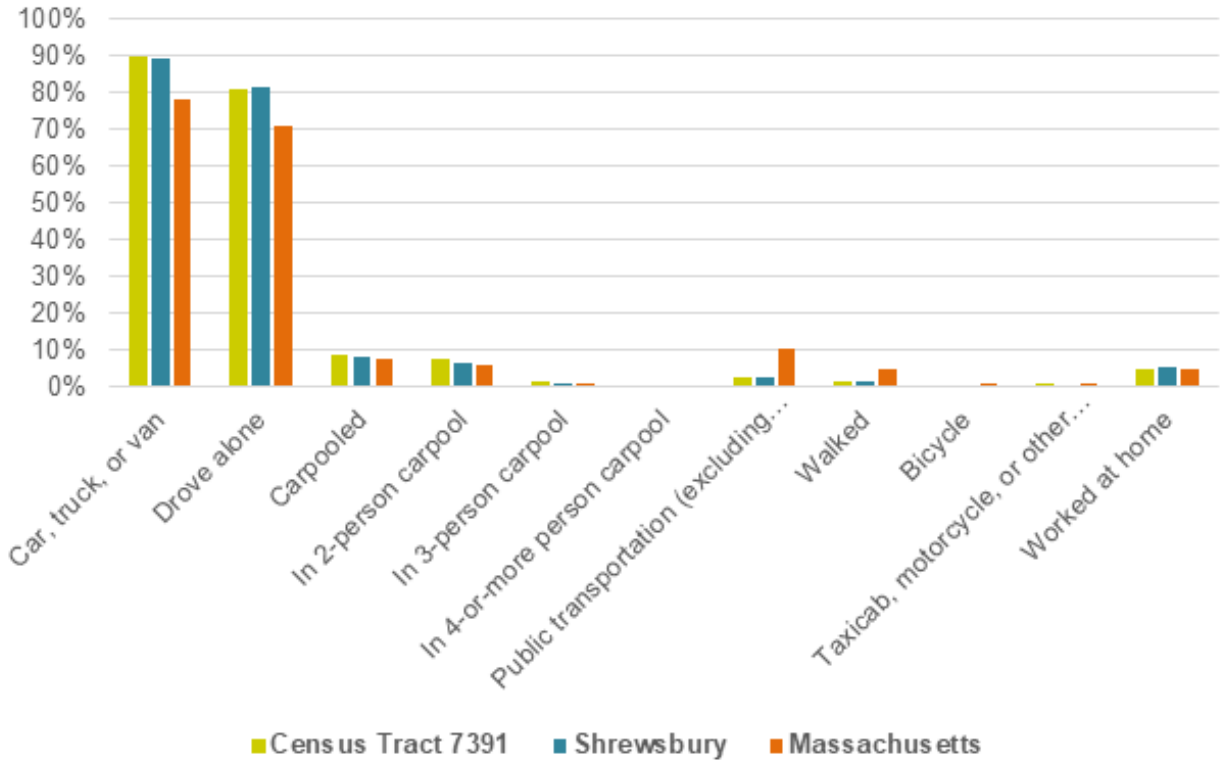
Industry	Number of Paid Employees
Construction	500 to 999
Manufacturing	747
Wholesale Trade	500-999
Retail Trade	1,654
Transportation and Warehousing	1,690
Finance and Insurance	490
Real Estate, Rental, Leasing	250 to 499
Professional, Scientific, Technical Services	507
Administrative and support, Waste Management, Remediation Services	500 to 999
Educational, Healthcare, Social Assistance	888
Arts, Entertainment, Recreation	20-99
Accommodation, Food Services	1,059
Other Services (except Public Administration)	100 to 249

MODE SPLIT IN SHREWSBURY

The available data from the ACS shown in **Figure 14** indicate that 81% of Shrewsbury residents drive alone to work each day, while 3% are utilizing some form of public transportation. Only 2% walk to work each day and even fewer are utilizing a bicycle (<1%). Census Tract 7391 has a similar pattern as Shrewsbury; the only difference is that this portion of Shrewsbury sees zero percent utilizing a bicycle. Shrewsbury's commuting pattern is slightly different than Massachusetts in that there is a smaller number of residents that drive alone and a larger number of residents walking and taking public transportation to work statewide.

[7]Statistics for All U.S. Firms by Industry, Gender, Ethnicity, and Race for the U.S., States, Metro Areas, Counties, and Places: 2012

Figure 14. Means of Transportation to Work[8]

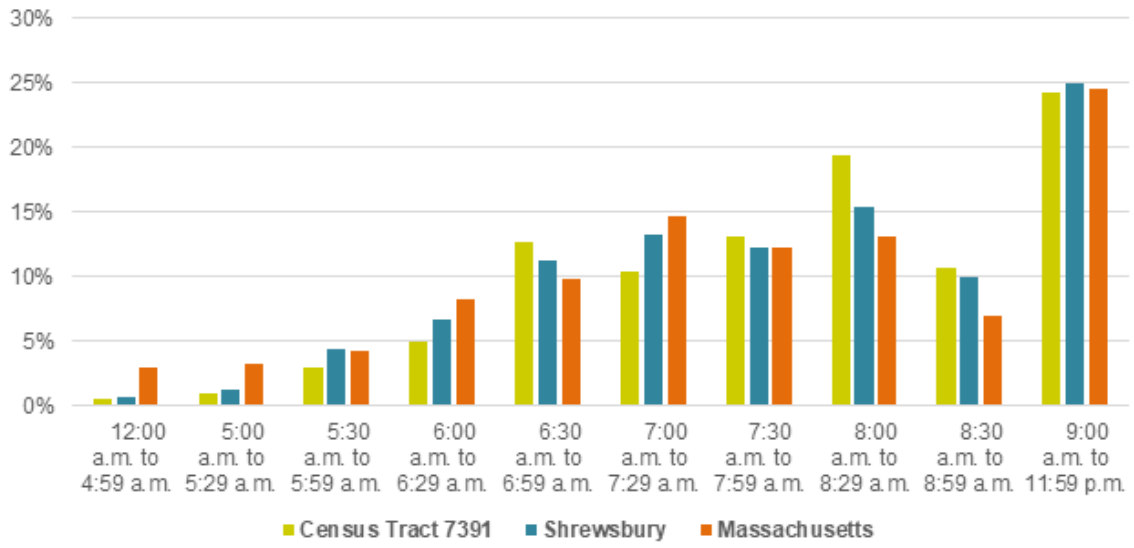


Data also shows that approximately 5% of Shrewsbury employed residents work from home. While ACS data are estimates from the Census, they may underestimate the number of employed residents working from home. As telecommuting and flex scheduling have become more commonplace among the amenity packages offered to employees, many more people have the option to work from home for at least some portion of the week.

Additionally, **Figure 15** shows that most residents leave between 9:00 a.m. and 12:00 p.m. to go to work. The most common time residents leave home to go to work is by 9:00 a.m. or later (both Shrewsbury and Census Tract 7391), a similar time frame that is seen for commuters in the rest of state. There are significantly more residents that leave work by 8:00 a.m. in Census Tract 7391 than in the Town or State.

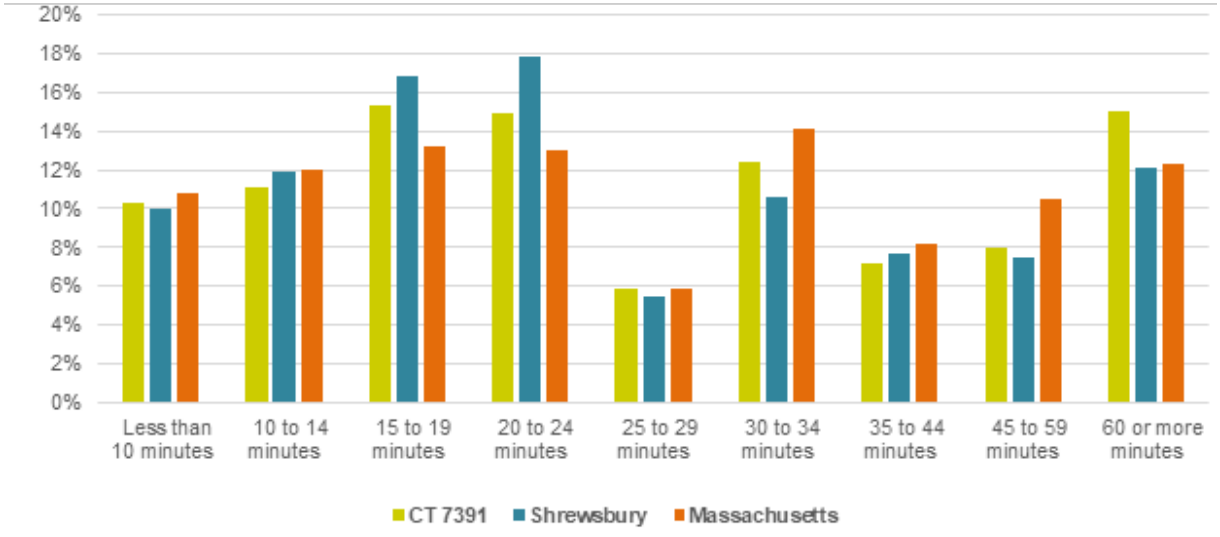
[8]U.S. Census Bureau, 2013-2017 American Community Survey 5-Year Estimates

Figure 15. Time Leaving Home to Go to Work



Travel time to work is an important element in evaluating transport costs since time savings are often an attractive benefit of transport improvement projects. Since single occupancy vehicle trips still represent most work trips in Census Tract 7391 and Shrewsbury, many Shrewsbury residents spend at least 15 to 24 minutes in traffic to get to work in the region (**Figure 16**). There is also a significant number of residents in Census Tract 7391 that spend 60 minutes or more to get to work, potentially time that is spent traveling east to the Greater Boston region. In general, commuters make travel decisions based on various factors, such as where they live and work, whether they own a car, and the value they place on their time cost, and comfort. Understanding these differences can reveal how land use and development patterns interact with the transportation system.

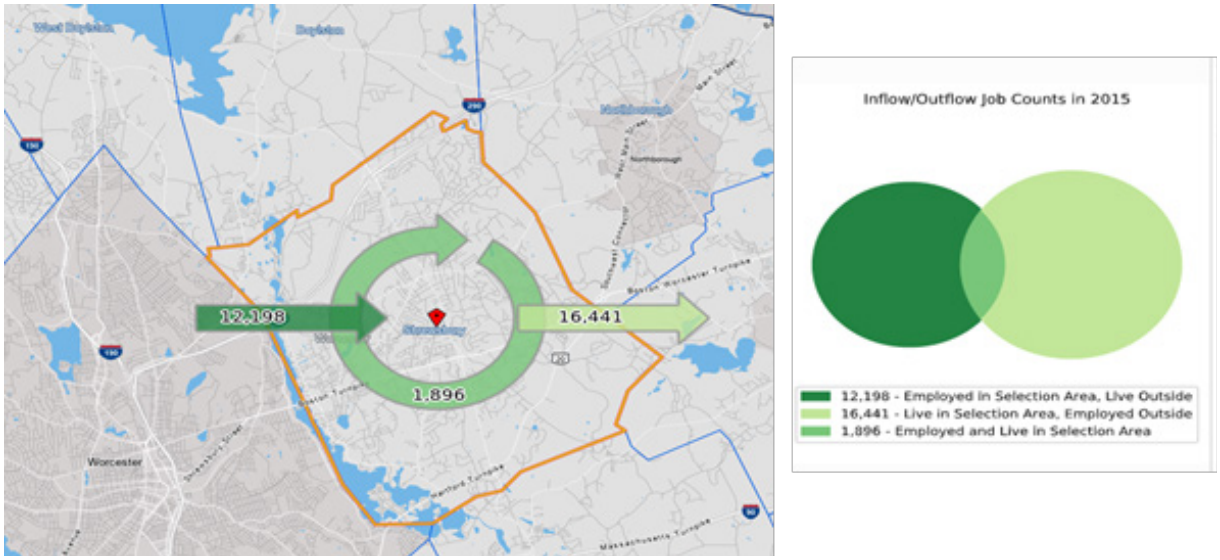
Figure 16. Travel Time to Work



COMMUTING FLOWS

There is a greater number of people who live in Shrewsbury but have jobs outside of the Town (**Figure 17**).

Figure 17. Inflow and Outflow of Jobs in Shrewsbury[9]



Residents who live and work in Shrewsbury are most likely working in the industries that have a high number of employees, such as Retail Trade or Transportation and Warehouse. Most residents who live in Shrewsbury but work outside the Town are probably commuting to jobs relating to Education, Healthcare, and Social Services or Arts and Entertainment. When you combine this analysis to OnTheMap's distance-direction analysis, you can see that a lot of Shrewsbury residents work within Worcester County, mainly in Worcester, and some clusters in Northborough, Westborough, Southborough, Marlborough, and Framingham. OnTheMap also shows that there are some residents that travel to Downtown Boston for work (**Figure 18**), supported by the ACS data showing a commuting duration of 60 minutes or more, especially within Census Tract 7391.

[9]OnTheMap

Figure 18. Where Residents are Commuting to for Work

Shrewsbury – Route 20 Corridor Improvements

Massachusetts Environmental Justice Populations

Environmental justice neighborhoods are the focus of Massachusetts's Executive Office of Energy and Environmental Affairs (EEA) Environmental Justice (EJ) Policy, which establishes EJ as an integral consideration in all EEA programs, to the extent applicable and allowable by law. The state recognizes various possible types of EJ groups that can be identified in Massachusetts: high minority, non-English speaking, and/or low-income populations[10].

As shown in **Figure 19**, pockets of the Town that exceeded environmental justice thresholds for high minority populations and high minority/limited English populations are adjacent to Turnpike Road. The quadrant of the Town bounded by Turnpike Road to the north, Memorial Drive to the west, Grafton Town border to the south, and Westborough to the east, consists of residents that are a minority or have limited English proficiencies. Minority right side of Hartford Pike, and Minority/English Isolation left side of Hartford Pike, both in between Memorial Drive and the Northborough Town Boundary. Shrewsbury does not have any block groups that fall under low-income populations. Shrewsbury's median household income is $100,640, whereas Massachusetts is $74,167[11].

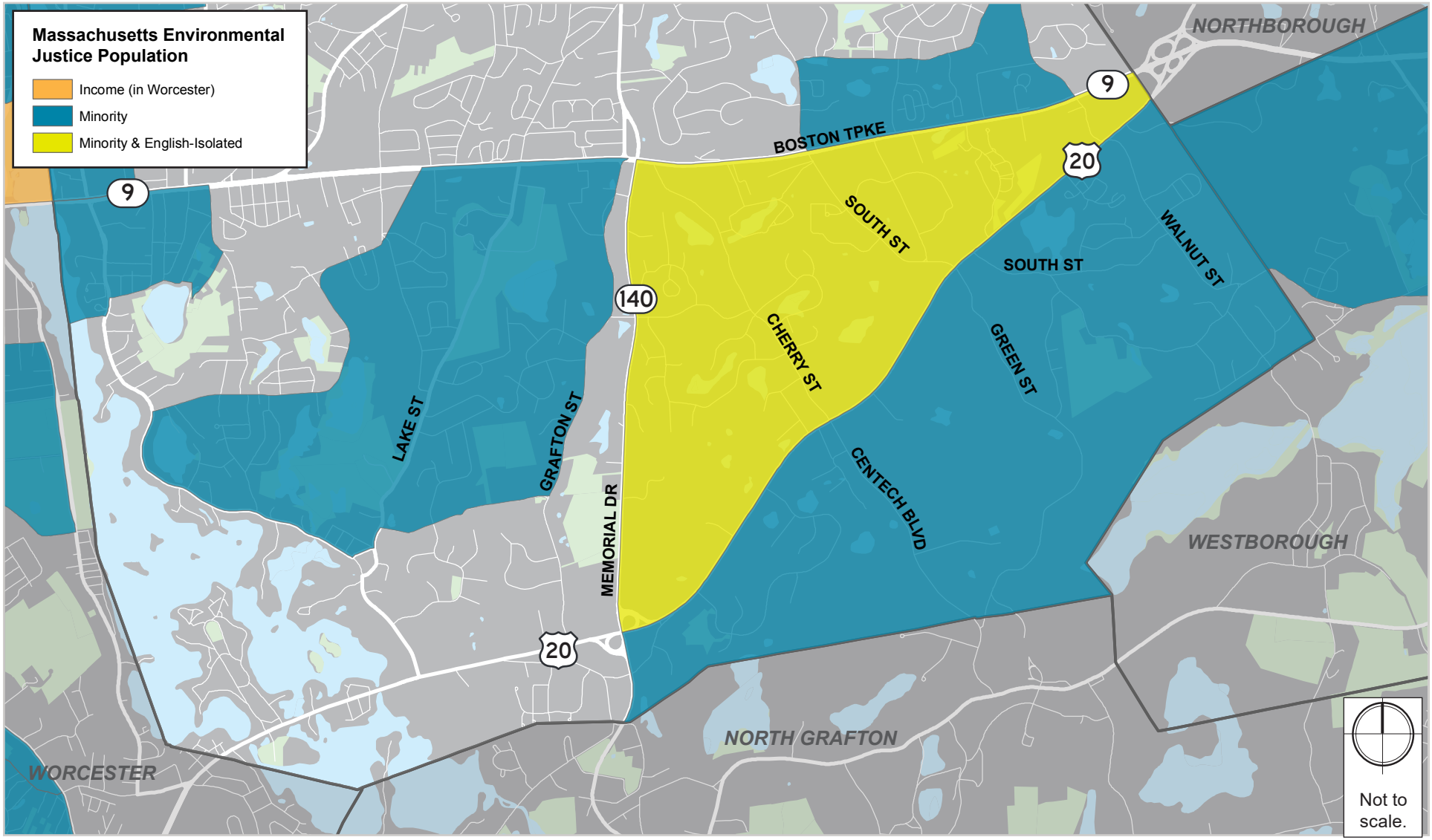
RACE

Shrewsbury is becoming a more diverse community. While the Town is still 71% white, demographic changes have shown an increase in population of other ethnic groups. In 2000 and 2010, the percentages of white population were 88%[12] and 77%[13] (respectively), while the Asian population increased from 2000 to 2010 (8% in 2000 and 15.3% in 2010). Population estimates put the Asian population at 18% of the total population in Shrewsbury.

Within Census Tract 7391, the distribution of population is similar to what you would see Town-wide, where most of the population is White-alone (60%), followed by Asian-alone (25%), Two or more races (7%), Hispanic or Latino[14] (4%), Black or African American-alone (3%), and then Some other race (<1%). **Figure 20** provides a breakdown of the race and ethnicity of residents in Census Tract 7391, Shrewsbury, Worcester County, and Massachusetts. The race distribution pattern in Shrewsbury does not follow Worcester County or Massachusetts' distribution. Although most of the population is White-alone in across all four geographic contexts, the share of Hispanic or Latino is higher in Worcester County and Massachusetts than Shrewsbury. Also, the share of Black or African American and Asian also have similar percentages in Worcester County and the Commonwealth.

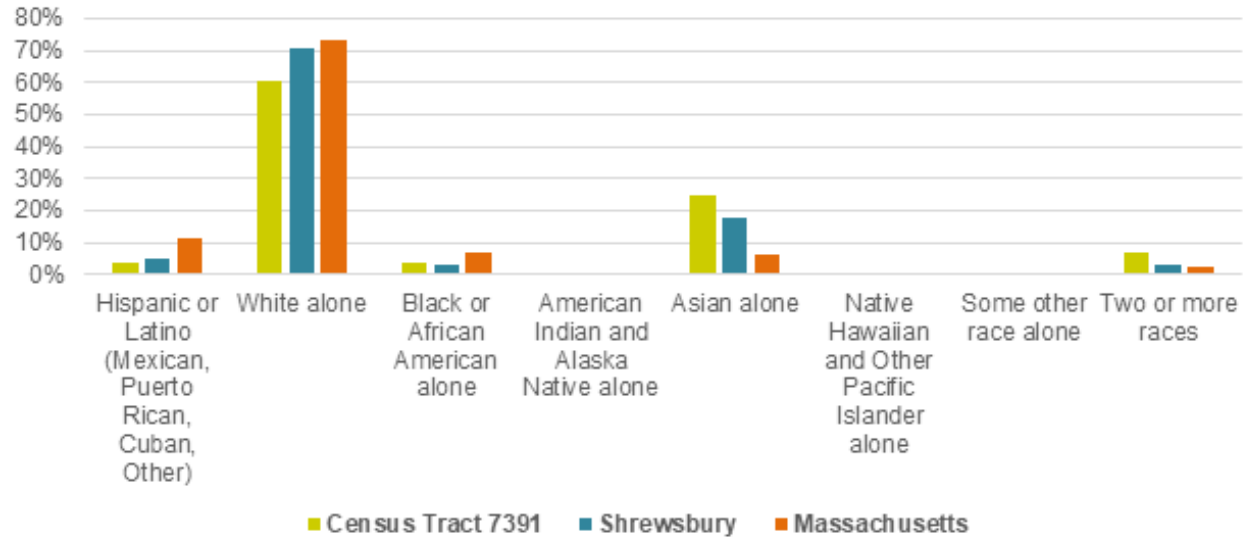
[10] This set of EJ data was compiled using Census 2010 block groups from the 2010 census redistricting tables and from the American Community Survey (ACS) 2006-2010 5-year estimates table.
[11] U.S. Census Bureau, 2013-2017 American Community Survey 5-Year Estimate
[12] 2000 U.S. Census
[13] 2010 U.S. Census
[14] Includes Mexican, Puerto Rican, Cuban, and Other
[15] https://www.telegram.com/news/20171210/indian-community-at-home-in-central-mass

Figure 19. Environmental Justice Populations near Route 20



Shrewsbury – Route 20 Corridor Improvements

Figure 20. Race Distribution[15]



Further examining the Town at the census tract level, it becomes apparent that the Asian population is the most dominant minority. Town-wide, Asians account for approximately 18% of the total population. Within the Asian population, the majority group of the Asian population within Census tract 7391 is Asian-Indian (17% of Census Tract 7391 Asian population), followed by Chinese (4% of Census Tract 7391 Asian population), and Other Asian (2% of Census Tract 7391 Asian population). Asian groups such as Filipino, Japanese, Korean, and Vietnamese, were either nonexistent or consisted of less than 1% of the census tract's total Asian population. Many Asian groups, particularly Asian-Indian Americans, are drawn to Shrewsbury because of its high-quality education and community services, as well as its proximity to job opportunities in science, engineering, and technology[16].

[15] U.S. Census Bureau, 2013-2017 American Community Survey 5-Year Estimates
[16] https://www.telegram.com/news/20171210/indian-community-at-home-in-central-mass

Land Use and Development Pattern

The most widespread development along the Route 20 corridor is Industrial, Manufacturing, and Warehouse Development making up approximately 25% of the land uses. Interspersed among these uses are residential and general business uses, representing 25% and 11% of existing development in the corridor respectively. The remaining properties consist of a variety of uses including shopping centers, research and development offices, schools, motels, and community centers. Although the Town of Shrewsbury has adopted the two, mixed use overlay districts along the corridor, the majority of existing building types conform to the original underlying zoning which permits only single-use building types. In these areas of Route 20, the land uses are compartmentalized; as a result, streets and signs have been designed to accommodate the motorists, creating a cluttered environment lacking a distinct sense of place. The Edgemere neighborhood along Route 20 between the Worcester City line and the Flint Pond Bridge has a distinct land use pattern from the rest of the corridor that is characterized as a more densely developed neighborhood in which there are closely spaced buildings that collectively shape the street corridors and create a more compact, pedestrian-friendly environment.

Adopted in October 2005, the Town amended its zoning bylaws to create the Route 20 Overlay District and Edgemere Village Overlay District as special zoning districts over Route 20's existing zoning. The existing underlying zoning for Route 20 include: Limited Commercial – Business, Limited Industrial, Rural B, Commercial Business, and Limited Business throughout the corridor from the Worcester City Line to the Northborough Town Line. The Route 20 and Edgemere Village special zoning districts apply to the Commercial Business and Limited Industrial Districts along Route 20 and as an overlay, they provide for flexible development options that do not exist in those underlying districts. The special provisions within the overlay districts allow for an increase in minimum lot area, minimum open space percentage lot area, and a decrease in maximum lot coverage, height, and front yard setback. For more detailed information on land use in the study corridor, please refer to the ***Land Development and Transportation Memo*** in **Appendix H**.

Environmental Constraints

Shrewsbury has two major defining landscape features in the Town: Lake Quinsigamond in the west and the Shrewsbury Ridge to the east. On Route 20 to the south, Lake Quinsigamond is visible in various points. The Town has some hazardous waste sites. As of 2012, the state Department of Environmental Protection (DEP) reported a total of 21 hazardous waste (21E) sites, nine of which are located along Route 20. Also, because gas stations, active and former, make up most of the sites, the most common problems from these environmental constraints are soil and/or ground water releases of petroleum products from leaky underground storage tanks. Additionally, an active ash landfill or monofill is located on the south side of Route 20 between Cherry and Green Streets. This site takes the byproducts of the regional waste combustion facility in Millbury along with other facilities in New England. The site is partially lined and run by Wheelabrator. The Town

has had very little experience with flooding. One water resource management area owned by the State is in the northeast corner of Town but serves mostly to insure against downstream pollution in the Concord River basin and the Town of Northborough. Otherwise, relatively strict subdivision control laws have served to limit the amount of erosion and sedimentation of water resources. The wetland and shallow marsh system that surrounds Route 20 have habitat value and can be efficient at removing pollutants. Since these systems are frequently inundated, adequate safety measures such as guardrails, safety zones, fences, and safety benches should be provided. The environmental constraints are shown in **Figure 21**.

IMPLICATIONS OF ENVIRONMENTAL CONSTRAINTS TO TRANSPORTATION

Environmental constraints can really limit the amount of infrastructure improvements along Route 20. For instance, road widening projects have the potential to disturb existing land uses if located where additional Right of Way will need to be acquired.

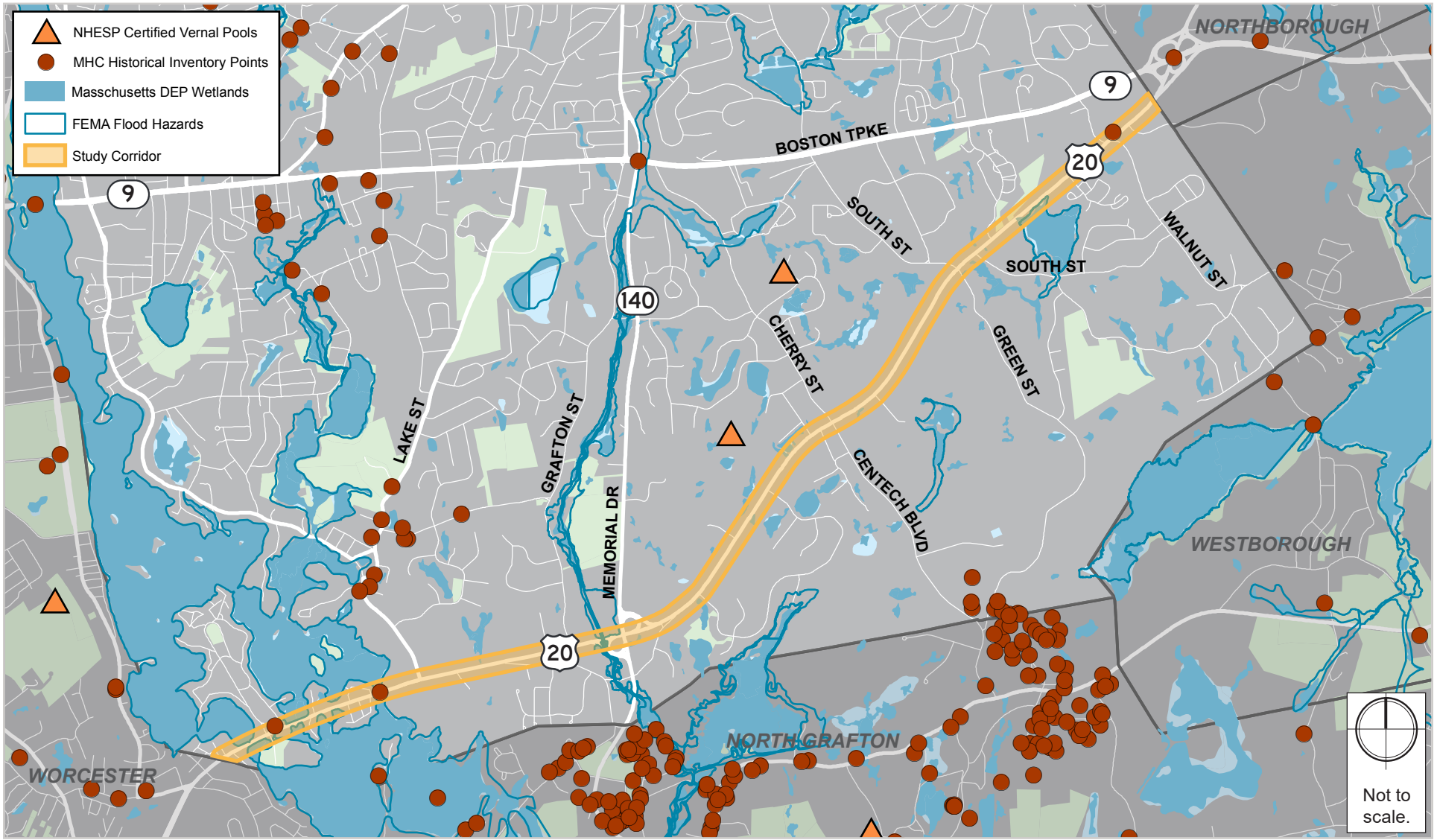
Lake Quinsigamond is visible along various points of Route 20.

Transportation Environment

GOODS MOVEMENT (FREIGHT)

Within the Commonwealth, 87% of freight shipments are exclusively moved on trucks, with the remaining shipments moving by rail, ocean shipping, and air freight. However, much of that remaining 13% of goods requires a truck for pickup or delivery. Many goods shipped into Massachusetts and through New England originate at warehouses and ports in the New York City area before travelling through Connecticut to Massachusetts and the Greater Boston Area by way of I-84 and I-90 (Massachusetts Turnpike). Additional goods come from the Midwest through New York via I-90. The paths of these highways mean that nearly all incoming and outgoing goods shipped by truck must pass through the vicinity of Route 20 in Shrewsbury. The Route 20 corridor is home to 19 trucking-related facilities, ranging from local and regional distribution centers, to corporate offices, truck parking facilities and repair shops, and truck sales centers. The concentration of trucking facilities has attracted multiple bulk and supply centers to also locate within the corridor, including Shrewsbury Lumber, Kamco Supply, and United Rentals, with seven total bulk facilities situated along the corridor. For more information on freight movement in Shrewsbury and in the region, please refer to the ***Freight Memo*** in **Appendix I**.

Figure 21. Environmental Constraints adjacent to Route 20



Shrewsbury – Route 20 Corridor Improvements

PUBLIC TRANSPORTATION

Worcester Regional Transit Authority (WRTA) and MBTA both serve the area near Route 20. MBTA's Worcester-Framingham Commuter Rail Line operates south of Route 20. MBTA commuter rail stops near Route 20 are the Grafton Stop and Westborough Stop. The MBTA Framingham-Worcester Line ranked second of the 14 commuter rail lines for ridership. The Westborough and Grafton stops represented 13.5% for inbound boardings in 2018, collectively[17].

WRTA Westborough Shuttle connects with the MBTA Commuter Rail at the Westborough Station and has routes to downtown Westborough and the office parks of I-495 and Route 9. According to unofficial estimates from the Central Massachusetts Regional Planning Commission, the Westborough Shuttle saw approximately 3,812 passenger trips in 2018[18]. The Westborough Shuttle has three routes. The Commuter Route has limited stops between the Westborough Commuter Rail Station and the Computer Drive/ Research Drive office parks. The Downtown Commuter route has limited stops between the Bay State Commons the Westborough Commuter Rail Station. The Local Route stops at all route destinations.

WRTA Route B connects with the MBTA at the Grafton Stop and connects to the Walmart Shopping Center in Northbridge. WRTA runs one vehicle per route and only provides service on weekdays. Route B saw approximately 4,060 passenger trips in 2018 (data not official.[18] Route B has one route that serves nine destinations. Adjacent Public Transportation Services in Shrewsbury are shown in **Table 5**. The public transportation services are shown in **Figure 22**. Both WRTA Community Shuttles only make stops at the MBTA commuter rail stations during morning and evening peak times. The Charlie Card is the primary payment method for both transit authorities. Commuters can use one card for both services.

Table 5. Adjacent Public Transportation Services in Shrewsbury

Service	Description	Hours of Service	Frequency
Trains			
MBTA Commuter Rail	Framingham-Worcester Line	Weekdays: 4:45 a.m. to 1:46 a.m. Weekend: 6:40 a.m. to 12:30 a.m.	1 Hr (Weekdays) 2 Hrs (Weekends)
WRTA Buses			
B	Walmart-Rockdale-Stop and Shop-Grafton MBTA Station	5:55 a.m. to 6:52 a.m. (Weekdays only)	1 Hr
Shuttle	Westborough Shuttle	6:24 a.m. to 6:30 p.m. (Weekdays only)	30

[17] http://cmrpc.org/sites/default/files/Documents/Trans/Study_and_Plan/2016%20RTP/Final%20PDF/8.%20RTP%20Chapter%20IV%20-%20Transportation%20Modes.pdf
[18] Worcester Regional Transit Authority

Figure 22. Existing Public Transportation

Shrewsbury – Route 20 Corridor Improvements

BICYCLE AND PEDESTRIAN CONNECTIONS

BICYCLE CONNECTIONS

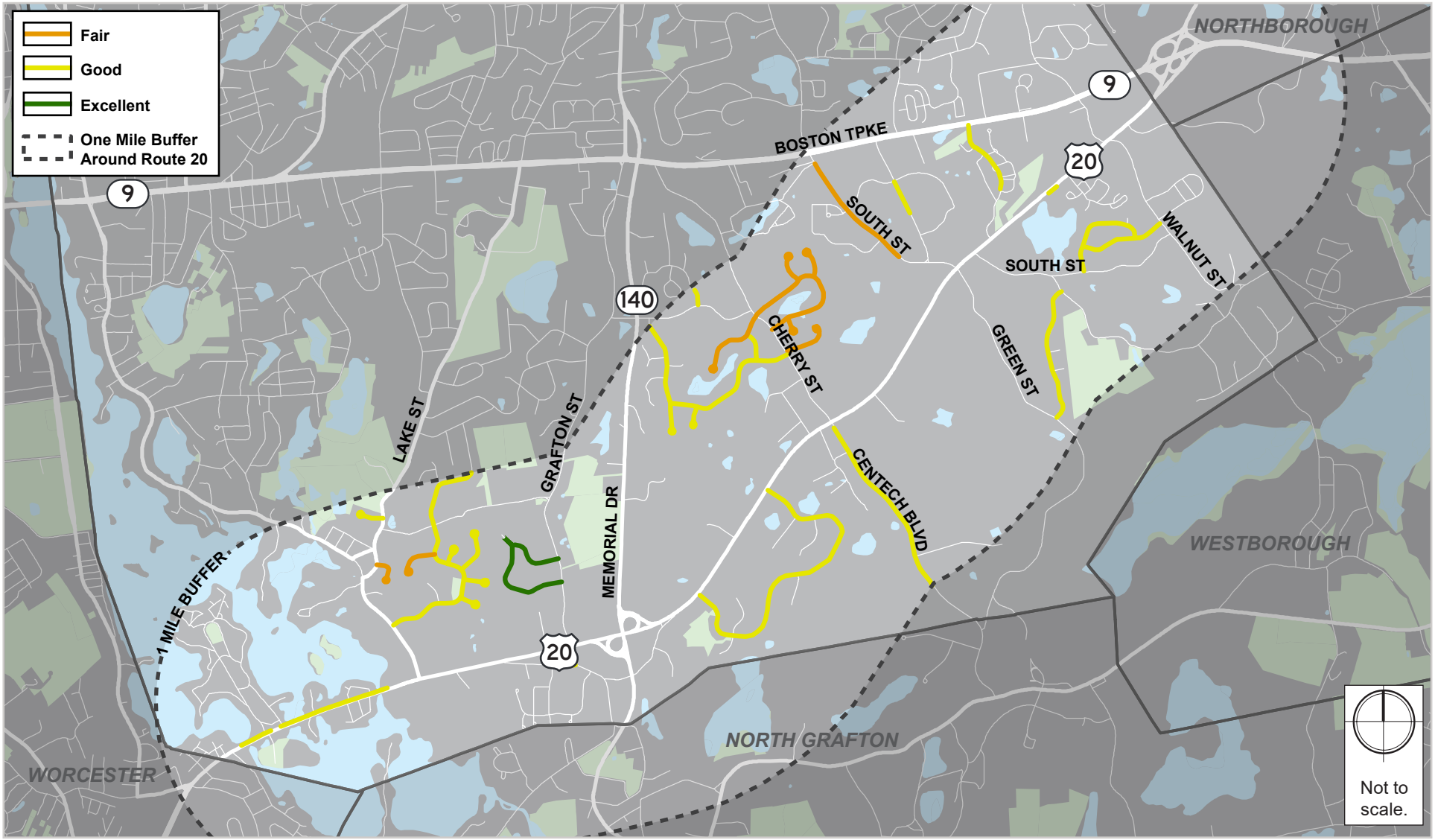
Currently, there is approximately five miles of existing bicycle infrastructure in the Town of Shrewsbury consisting of bike lanes on Main Street from I-290 to the Town Center and on Centech Boulevard from Route 20 to the Grafton Town Line. In 2018 the CMMPO outlined various corridors for potential bicycle infrastructure that would result in 21.07 miles of additional potential bicycle infrastructure, and 5.88 miles of multi-use path potential.

PEDESTRIAN CONNECTIONS

There is currently at least 100 miles of sidewalk in the Town of Shrewsbury. Sidewalks that are within a one-mile distance from Route 20 showed to be in decent shape, particularly along Route 140, South Street, Centech Boulevard, and Memorial Drive. The majority of Route 20 has no sidewalks on either side, with an exception to a portion within the Edgemere District and a portion that is adjacent to the Dunkin Donuts (**Figure 23**). Most roads that are within a one-mile distance from Route 20 do not have an existing sidewalk network. Major roads that do have sidewalks include: Walnut Street (north of Route 20) and Centech Boulevard (south of Route 20). The remainder of the sidewalk network is within residential neighborhoods.

The sidewalks and crosswalks at the Edgemere Boulevard intersection are typical of existing conditions along Route 20.

Figure 23. Sidewalk Condition within a One-mile Distance from Route 20



Shrewsbury – Route 20 Corridor Improvements

Existing Roadway Descriptions

Existing study area roadway geometry, speeds, and pedestrian accommodations are discussed in the following sections. Many of the side streets have a posted speed limit of 30 miles per hours (mph), unless otherwise noted in each roadway description. For the ones that don't have a posted speed limit, it is assumed that the prima fascie speed limit is also 30 mph. Finally, most of the corridor and side streets don't provide any sidewalk, wheelchair ramps, crosswalks or bicycle accommodations. The ones that do provide them are mentioned in the descriptions below.

STUDY AREA ROADWAYS

Route 20, also known as Hartford Turnpike within the study area, is classified as an urban principal arterial under MassDOT jurisdiction, running east-west through the towns of Shrewsbury and Northborough. As shown in **Figure 24**, the cross-section varies throughout its 5.1-mile length; starting at the City of Worcester Line, Route 20 provides two lanes in each direction up to its intersection with Lakeside Drive, where it narrows down to one lane in each direction. This continues up to the intersection with Lake Street, where the initial cross-section resumes. East of Lake Street and up to the study area limits, the number of lanes in each direction alternates between one and two lanes. **Figure 24** also mentions the sidewalk locations along the Route 20. The roadway width varies from 38 feet to 75 feet throughout the corridor, and shoulders vary from one foot to 12 feet wide. Eastbound and westbound lanes are separated by a double yellow centerline for most of the roadway length within the study area, which widens to scored concrete medians or painted medians that develop into turn lanes. The posted speed limit within the study area varies from 40 mph to 50 mph. Sidewalks are provided continuously on the north side and intermittently on the south side of Route 20, starting at the City of Worcester Line and ending approximately 280 feet east of Blackstone Street. There is also a 210-foot sidewalk in front of the Dunkin Donuts.

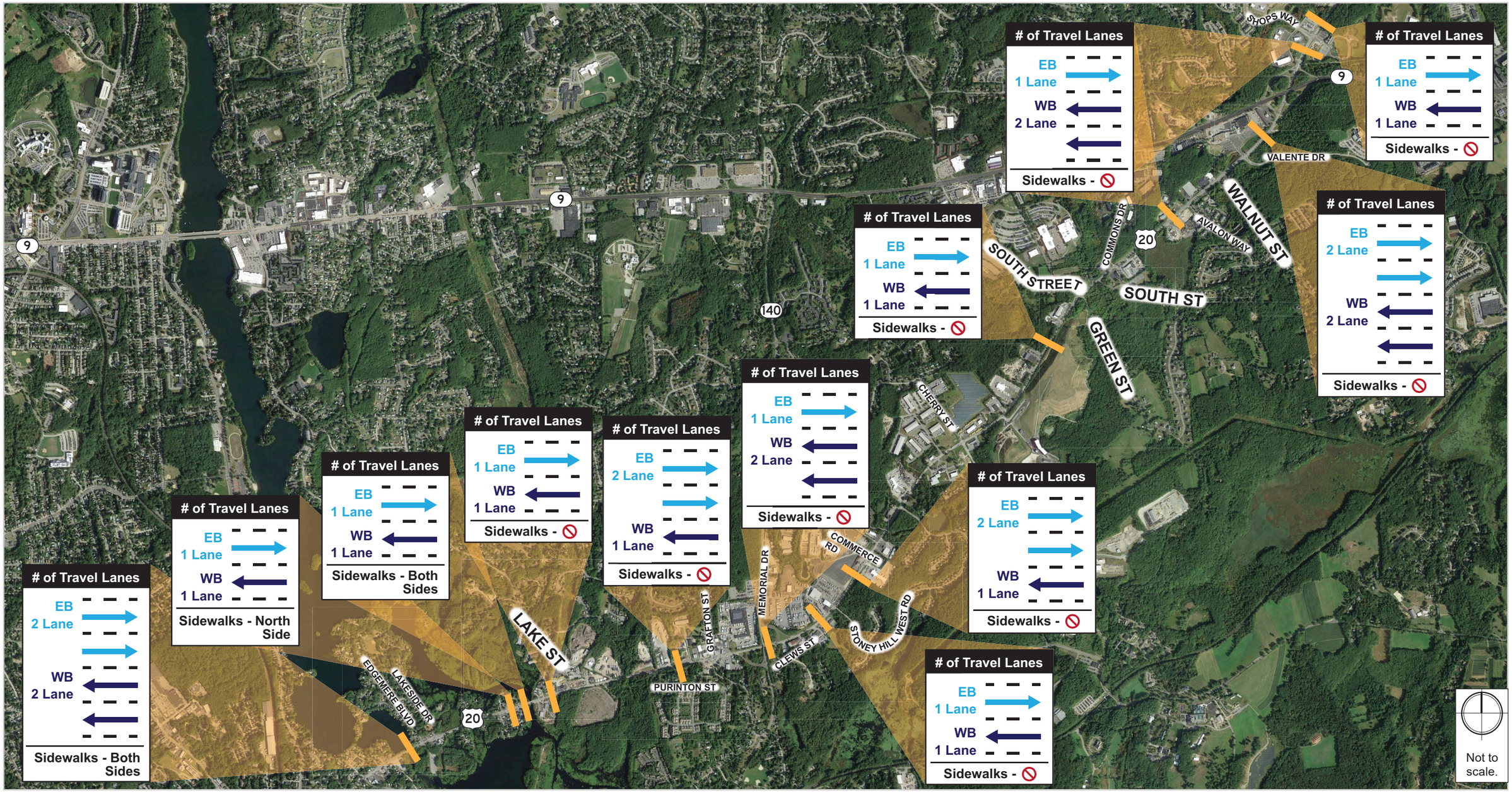
Edgemere Boulevard is a local roadway under local jurisdiction, running north-south between Robertson Drive in the north and Route 20 in the south. Within the study area, Edgemere Boulevard is approximately 26 feet wide and provides one lane in each direction, separated by a double yellow center line. Approximately 650 feet north of the intersection with Route 20, the double yellow center line on Edgemere Boulevard ends but two-way travel is still allowed.

Lake Street is classified as an urban minor arterial under local jurisdiction, running north-south between Route 140 in the north and Route 20 in the south. Within the study area, Lake Street is approximately 38 feet wide and provides one lane of traffic in each direction, separated by a double yellow center line. Six-foot wide shoulders are also provided.

Purinton Street is a local roadway under local jurisdiction, running east-west between Grafton Street in the east and Route 20 in the west. Within the study area, Purinton Street varies between 20 feet and 26 feet in width and provides no pavement markings; however, it allows two-way travel for its whole length.

Grafton Street is a local roadway under local jurisdiction, running north-south between Route 9 in the north and Route 140 in the south. Within the study area, Grafton Street provides one lane of traffic in each direction, separated by a double yellow center line. The roadway varies between 28 and 32 feet in width. A 300-foot long, five-foot wide sidewalk is provided along the western side of Grafton Street, starting 375 feet south of the intersection with Route 20.

Figure 24. Existing Route 20 Corridor Conditions



Shrewsbury – Route 20 Corridor Improvements

Route 140 (Memorial Drive) is classified as an urban principal arterial running north-south from Winchendon to New Bedford. The portion of Route 140 between the on- and off-ramps from and to Route 20, as well as the bridge, are under the jurisdiction of MassDOT. The rest of Route 140 within the Town of Shrewsbury lines is under the jurisdiction of the Town. Route 140 is designated as Taunton-New Bedford Expressway. Within the study area, Route 140 is 45 feet wide, provides one travel lane in each direction separated by a double yellow center line, and has shoulders that vary from two feet to 12 feet wide. The posted speed limit within the study area is 50 mph.

Clews Street is a local roadway under local jurisdiction, running north-south between Route 20 in the north and Route 140 in the south. Within the study area, Clews Street varies from 18 feet wide to 22 feet wide and allows two-way travel for its whole length. A double yellow center line is only present for 125 feet leading into the intersection with Route 140.

Stoney Hill Road is a local roadway under local jurisdiction, running east-west and intersecting with Route 20 at two different locations that are approximately half a mile apart. Within the study area, Stoney Hill Road is approximately 30 feet wide and provides no pavement markings but allows two-way travel for its whole length. A five-foot sidewalk and grass buffer are provided on both sides of Stoney Hill Road.

Commerce Road is a private roadway under the jurisdiction of the Town of Shrewsbury's planning board, running north-south between Route 20 in the south and the end of the roadway 650 feet to the north. Within the study area, Commerce Road is approximately 30 feet wide and provides no pavement markings but allows two-way travel for its whole length. A five-foot sidewalk and grass buffer are provided on the east side of Commerce Road.

Centech Boulevard is classified as an urban collector under local jurisdiction, running north-south between Route 20 in the north and Centennial Drive in the south. Within the study area, Centech Boulevard provides one lane in each direction. The roadway is approximately 32 feet wide. A five-foot sidewalk with a two-foot grass strip is provided on the west side of Centech Boulevard.

Cherry Street is a local roadway under local jurisdiction, running north-south between Route 9 in the north and Route 20 in the south. Within the study area, Cherry Street is approximately 19 feet wide and provides no pavement markings but allows two-way travel for its whole length.

South Street is classified as an urban collector under local jurisdiction, running north-south between Main Street in the north and Gleason Street, in Westborough, in the south. South Street on the south side of the intersection with Route 20 is offset by approximately 500 feet to the east compared to the north side of the intersection. The part of South Street within the study area that is north of Route 20 is approximately 27 feet wide, with one lane in each direction separated by a double yellow center line. South Street, south of Route 20, is approximately 20 feet wide, with no pavement markings, but allows two-way travel.

South Street eastbound at Route 20.

Green Street is a local roadway under local jurisdiction, running north-south between Route 20 in the north to Centech Boulevard in the south. Within the study area, Green Street is approximately 24 feet wide, and provides two travel lanes separated by a double yellow centerline.

Commons Drive is a private driveway that runs north-south between Route 9 in the north to Route 20 in the south. Within the study area, Commons Drive is approximately 20 feet wide and provides two lanes in each direction separated by a single yellow centerline.

Walnut Street is a local roadway under local jurisdiction, running north-south between Route 9 in the north to South Street in the south. Walnut Street is like South Street in that at its intersection with Route 20. Walnut Street South is offset by approximately 155 feet to the east of Walnut Street North. Both sides of Walnut Street measure approximately 30 feet wide and provide two lanes in each direction. The travel lanes on Walnut Street South are separated by a double yellow centerline; on Walnut Street North, there is faded pavement marking paint, which indicates that the travel lanes on this side were separated in a similar manner.

Route 9 is an urban principal arterial under MassDOT jurisdiction running east-west between Route 7 in Pittsfield to the west and Massachusetts Avenue in Boston to the east. Within the proximity of the study area, Route 9 runs from I-290 in Worcester to I-495 in Westborough. Route 9 connects to Route 20 as a partial cloverleaf where on and off ramps provide a single travel lane approximately 21 feet wide with no sidewalks on either side and no parking allowed. The Route 20 westbound to Route 9 eastbound movement happens under a signalized left turn, as does the Route 20 eastbound to Route 9 westbound movement.

Existing Intersection Descriptions

This section provides intersection conditions and intersection geometry descriptions. For many of the intersections within the study area, the existing signal equipment, pavement, pavement markings, and signage is in fair condition, unless otherwise noted. Furthermore, the corridor intersections don't provide any wheelchair ramps and crosswalk markings, unless otherwise noted below.

STUDY AREA INTERSECTIONS

Route 20 at Edgemere Boulevard/Oak Island Driveway is a signalized intersection with four approaches. The Route 20 eastbound and westbound approaches consist of a 12-foot left-turn/through lane and a 12-foot through/right-turn lane. The Edgemere Boulevard southbound approach consists of a 13-foot general use lane that widens to 28 feet at the stop line. The Oak Island northbound approach consists of a 10-foot general use lane that widens to 20 feet at the

stop line. Pedestrian crosswalks are provided across the Route 20 eastbound approach and the Edgemere Boulevard southbound approach. The southern end of the crosswalk across Route 20 doesn't appear to be ADA compliant as it doesn't provide a wheelchair ramp or an APS pushbutton. The eastern end of the crosswalk across Edgemere Boulevard doesn't appear to be ADA compliant as it doesn't provide a pushbutton.

Route 20 at Lake Street is a signalized intersection with three approaches. The Route 20 eastbound approach consists of a 12-foot shared left-turn/through lane and a 12-foot exclusive through lane. The Route 20 westbound approach is approximately 24 feet wide and consists of a 12-foot shared through/right-turn lane and a 12-foot exclusive through lane. The Lake Street southbound approach is approximately 24 feet wide and consists of a 12-foot exclusive left-turn lane and a 12-foot exclusive right-turn lane that widens to 28 feet at the stop line.

Route 20 at Purinton Street is an unsignalized intersection with three approaches. The Route 20 eastbound approach consists of an 11-foot shared through/right-turn lane and an 11-foot exclusive through lane and flows freely. The Route 20 westbound approach consists of a 12-foot general use lane and flows freely. The Purinton Street northbound approach is stop controlled and consists of one 18-foot shared left-turn/right-turn lane.

Route 20 at Grafton Street is a signalized intersection with four approaches. The Route 20 eastbound approach consists of an 11-foot shared left-turn/through lane and an 11-foot shared through/right-turn lane. The Route 20 westbound approach consists of a 12-foot shared left-turn/through lane and a 10-foot shared through/right-turn lane. The Grafton Street southbound approach consists of a 13-foot general use lane that widens to 15 feet at the stop line. The Grafton Street northbound approach consists of a 14-foot general use lane that widens to 20 feet at the stop line.

Signalized intersection on Route 20 at Grafton Street.

Route 20 Eastbound at Route 140 On/Off-Ramps is an unsignalized intersection with two approaches. The Route 20 eastbound approach consists of an 11-foot exclusive through lane and an 11-foot exclusive right-turn lane. The Route 140 off-ramp approach consists of a 19-foot lane with a yield sign as well as an auxiliary lane that is approximately 165 feet long.

Route 20 Westbound at Route 140 On/Off-Ramps is an unsignalized intersection with two approaches. The Route 20 westbound approach consists of a 13-foot through lane and a 10-foot shoulder, which narrows down to a foot to provide an unmarked auxiliary lane for Route 140-bound vehicles. Route 140 off-ramp approach consists of a 19-foot lane with a yield sign as well as an auxiliary lane that turns into a second travel lane on Route 20 that continues for approximately 290 feet to the west of Grafton Street.

Route 20 at Clews Street is an unsignalized intersection with three approaches. The Route 20 eastbound approach consists of a 12-foot general

use lane and a 10-foot wide shoulder. The Route 20 westbound approach consists of an 11-foot general use lane and a nine-foot wide shoulder. The Clews Street approach consists of a 10-foot shared left-turn/right-turn lane and is stop controlled. Pavement is in fair condition, except for the Clews Street approach which pavement is in poor condition.

Route 20 at Stoney Hill Road (West)/Driveway is an unsignalized intersection with four approaches. The Route 20 eastbound approach consists of an 11-foot shared left-turn/through lane and an 11-foot shared through/right-turn lane, which widens to 24 feet at the intersection. The Route 20 westbound approach consists of a 12-foot general use lane and a 13-foot shoulder. This shoulder narrows down to one-foot wide, 200 feet east of Stoney Hill Road and may be used as a pull-out lane for vehicles entering the Tri State Truck Center on the north side of the intersection. The Tri State Truck Center Driveway southbound approach consists of a 35-foot general use lane. The Stoney Hill Road northbound approach consists of a 15-foot general use lane that widens to 30 feet at the intersection and is stop controlled.

Route 20 at Commerce Road is an unsignalized intersection with three approaches. The Route 20 eastbound approach consists of a 20-foot general use lane. The Route 20 westbound consists of a 12-foot general use lane and a 10-foot shoulder. The Commerce Road southbound approach consists of a shared 16-foot left-turn/right-turn lane that widens to 32 feet at the intersection and is stop controlled.

Route 20 at Stoney Hill Road (East) is an unsignalized intersection with three approaches. The Route 20 eastbound approach consists of a 12-foot general use lane and a 14-foot shoulder. The Route 20 westbound approach of a 12-foot general use lane and a 12-foot shoulder. The Stoney Hill Road northbound approach consists of a 16-foot general use lane that widens to 27 feet at the intersection, and is stop controlled, but no stop line is provided.

Route 20 at Cherry Street/Centech Boulevard is a signalized intersection with four approaches. The Route 20 eastbound approach consists of a 12-foot exclusive left-turn lane, a 12-foot exclusive through lane and a 12-foot shared through/right-turn lane. The Route 20 westbound approach consists of a 12-foot exclusive left-turn lane and a 12-foot shared through/right-turn lane. The Cherry Street southbound approach consists of a 12-foot exclusive right-turn lane and a 12-foot shared through/left-turn lane. The Centech Boulevard northbound consists of a 12-foot exclusive right lane and a 12-foot shared through/left lane. Existing signal equipment are in fair condition, except for a new four-section signal indication with a flashing yellow arrow – facing Route 20 westbound – that was installed recently.

The Route 20 intersection at Cherry Street/Centech Boulevard is a signalized intersection with four approaches.

Route 20 at South Street/Green Street is a signalized intersection with four approaches. The Route 20 eastbound approach consists of a 12-foot exclusive left-turn lane and a 12-foot shared through/

right-turn lane. The Route 20 westbound consists of a 12-foot shared left-turn/through lane and a 12-foot shared through/right-turn lane. Adjacent to the Route 20 westbound left-turn/through lane there exists an 11-foot scored concrete median. The South Street southbound approach consists of a 14-foot wide general use lane that widens to 16 feet at the stop line. The Green Street northbound approach consists of a 10-foot wide general use lane that widens to 14 feet at the stop line. Existing signal equipment are in fair condition, except for a new four-section signal indication with a flashing yellow arrow – facing Route 20 eastbound – that was installed recently.

Route 20 at South Street is an unsignalized intersection with three approaches. The Route 20 eastbound approach consists of a 12-foot general use lane and flows freely. The Route 20 westbound approach consists of a 12-foot wide shared left-turn/through lane, a 12-foot through lane, and a four-foot shoulder, and flows freely. The South Street northbound approach is stop controlled and consists of an 11-foot wide general use lane that widens to 16 feet at the stop line.

Route 20 at Commons Drive/Sunbelt Rentals Driveway is an unsignalized intersection with four approaches. The Route 20 northbound approach consists of an 11-foot general use lane and flows freely. The Route 20 southbound approach consists of two 11-foot general use lanes and flows freely. The Commons Drive eastbound approach consists of a 12-foot general use lane that widens to 16 feet at the intersection. Commons Drive currently doesn't provide a stop sign or stop line at the intersection; however, it was observed that Commons Drive vehicles yield to Route 20 vehicles. The Sunbelt Rentals Driveway westbound approach consists of a 28-foot general use lane that is stop controlled at the intersection.

Route 20 at Dunkin Donuts Driveway (866 Hartford Turnpike) is an unsignalized intersection with three approaches. The Route 20 eastbound and westbound approaches consist of two 12-foot wide general use lanes each, and flow freely. The Dunkin Donuts Driveway northbound approach consists of a 20-foot wide general use lane. Like Commons Drive, the driveway doesn't provide a stop sign or stop line, but driveway exiting vehicles yield to Route 20 traffic. A sidewalk lies on the southern edge of Route 20 west of the Dunkin Donuts Driveway and does not continue east.

Route 20 at Avalon Way is an unsignalized intersection with three approaches. Route 20 eastbound and westbound approaches consist of two 12-foot wide general use lanes each, and flow freely. The Avalon Way northbound approach consists of one 28-foot general use lane that is stop controlled.

Route 20 at Walnut Street is an unsignalized intersection with four approaches, where the Walnut approaches are offset from each other by 155 feet. The Route 20 eastbound approach consists of two 12-foot general use lanes and flows freely. An 8-foot painted median on this approach separates the eastbound direction from the westbound direction. The Route 20 westbound approach consists of a 12-foot wide exclusive left lane, two 12-foot wide general use lanes, and flows freely. The Walnut Street North southbound approach consists of an 11-foot wide general use lane that widens to 16 feet at the stop line and is stop controlled. The Walnut Street South northbound approach is approximately 24 feet wide, consists of a 12-foot exclusive left-turn lane and a 12-foot exclusive right-turn only lane, and is stop controlled.

Route 20 at Old Shrewsbury Village/Valente Drive is an unsignalized intersection with four

approaches. The Route 20 eastbound and westbound approaches consist of an 11-foot wide exclusive left lane, two 11-foot wide general use lanes, and a three-foot wide painted median separating the left-turn lane from the general use lanes. Both approaches also flow freely. The Valente Drive northbound approach consists of a 15-foot wide exclusive right-turn lane that is stop controlled. The Old Shrewsbury Village Driveway southbound approach consists of a 14-foot wide shared left-turn/through lane and a 14-foot wide exclusive right-turn only lane. The approaches are uncontrolled, but a yield is implied to Route 20 traffic.

Route 20 at Route 9 eastbound on/off ramps is a partially signalized intersection with four approaches. The Route 9 eastbound on-ramp from Route 20 westbound is signalized, along with the opposing Route 20 eastbound approach. The Route 20 eastbound approach consists of one 12-foot wide general use lane. The Route 20 westbound approach consists of two 12-foot wide general use lanes and a 12-foot wide exclusive left-turn lane. The eastbound and westbound directions are separated by a 7-foot wide raised concrete median. The adjacent Route 9 eastbound off ramp to Route 20 westbound is unsignalized. The Route 9 eastbound off ramp approach consists of one 21-foot wide exclusive right-turn lane and is stop controlled. The Route 20 westbound approach consists of two 12-foot wide general use lanes. The Route 9 eastbound off ramp to Route 20 eastbound is unsignalized. The Route 9 eastbound off ramp approach consists of a 21-foot wide exclusive right-turn lane and is stop controlled. The Route 20 eastbound approach consists of a 12-foot wide general use lane. The Route 20 westbound approach consists of two 12-foot general use lanes.

Route 20 at Route 9 westbound on/off ramps is a partially signalized intersection with four approaches. The Route 9 westbound on ramp from Route 20 eastbound and the Route 9 westbound off ramp onto Route 20 eastbound are signalized, along with the opposing eastbound and westbound Route 20 approaches. The Route 20 eastbound approach consists of a 12-foot wide exclusive left-turn lane and a 12-foot exclusive through lane. The Route 20 westbound approach consists of two 12-foot wide general use lanes. South of the signal, the Route 20 eastbound and westbound directions are separated by a five-foot wide painted median, whereas north of the signal, they are separated by a 16-foot wide raised concrete median. The Route 9 westbound off ramp approach consists of one 21-foot wide exclusive right-turn lane and is unsignalized. The Route 9 westbound off ramp approach consists of a 21-foot wide exclusive right-turn lane and is stop controlled. The Route 20 westbound approach is 24 feet wide and consists of two 12-foot wide general use lanes.

Aerial view of the Route 20 and Route 9 on/off ramps.

Route 20 at Shops Way/Baseball Complex Drive is a signalized intersection with four approaches, currently under adaptive signal control. The signal here is coordinated with another signal approximately 350 feet to the west of Route 20 within the Shops Way development. The Route 20 eastbound approach consists of two 12-foot wide exclusive left-turn lanes and one 12-foot wide shared through/right-turn

lane. The Route 20 westbound consists of a12-foot wide exclusive left-turn lane, a 12-foot wide through lane, and a 12-foot wide through/right-turn lane. The westbound approach lanes and eastbound departure lanes are separated by a 10-foot wide painted median. The Shops Way southbound approach consists of two 12-foot wide exclusive right lanes, a 10-foot wide scored concrete median, and a 11-foot wide shared left-turn/through lane. The northbound approach and southbound departure lanes are separated by a 12-foot wide raised grass median. The Baseball Complex Drive northbound approach consists of an 11-foot wide exclusive left-turn lane, an 11-foot wide shared left-turn/through lane, and an 11-foot wide right-turn lane. The northbound approach and southbound departure lanes are separated by a 14-foot wide raised grass median. A pedestrian crosswalk with wheelchair ramps, detectable warning panels and APS pushbuttons is provided across the Route 20 southwest-bound approach. Sidewalks are provided on both sides of the Shops Way, and the east side of the Baseball Complex Drive. Existing traffic signal phasing for the study area signalized intersections may be seen in **Appendix J.**

Traffic Volumes

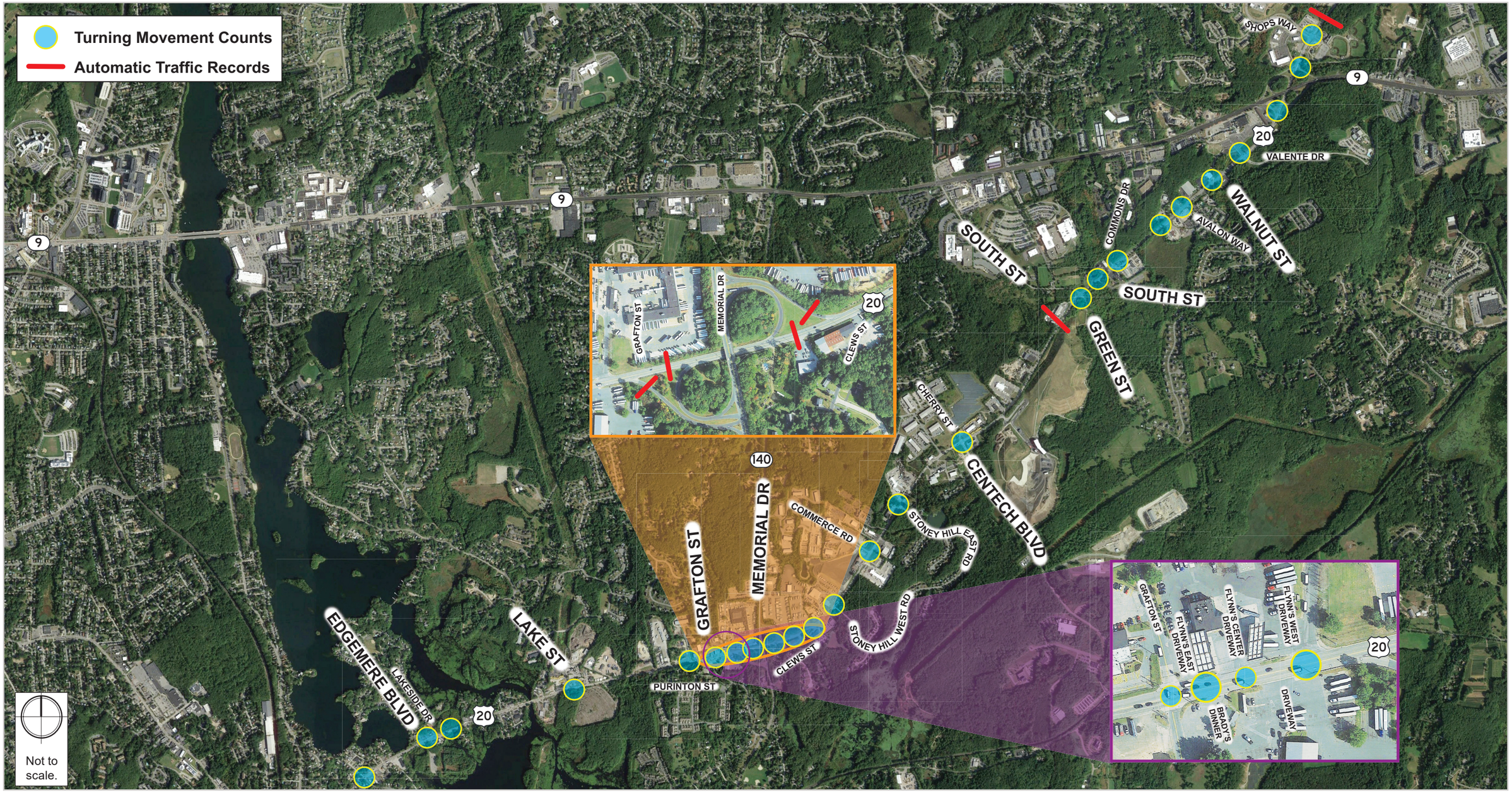
DAILY TRAFFIC ESTIMATES

MassDOT provided continuous 24-hour automatic traffic counts (ATR's) conducted during weekdays, while schools were in session, in September 2016 and March 2017 at the following locations:

- Route 20 west of South Street/Green Street (September 2016)
- Route 20 west of Walnut Street North (September 2016)
- Route 20 to east of Shops Way (September 2016)
- Route 20 eastbound On-Ramp Lane to Route 140 (March 2017)
- Route 20 eastbound Through Lane after On-Ramp to Route 140 (March 2017)
- Route 20 westbound Off-Ramp Lane from Route 140 (March 2017)
- Route 20 westbound Through Lane before Route 140 Off-Ramp (March 2017)

The traffic count locations are shown in **Figure 25. Table 6** summarizes the existing traffic data including the Average Daily Traffic (ADT), peak hour percentage (K), and 85th percentile speeds. **Figure 26** shows the daily traffic variations at these locations.

Figure 25. Traffic Count Locations

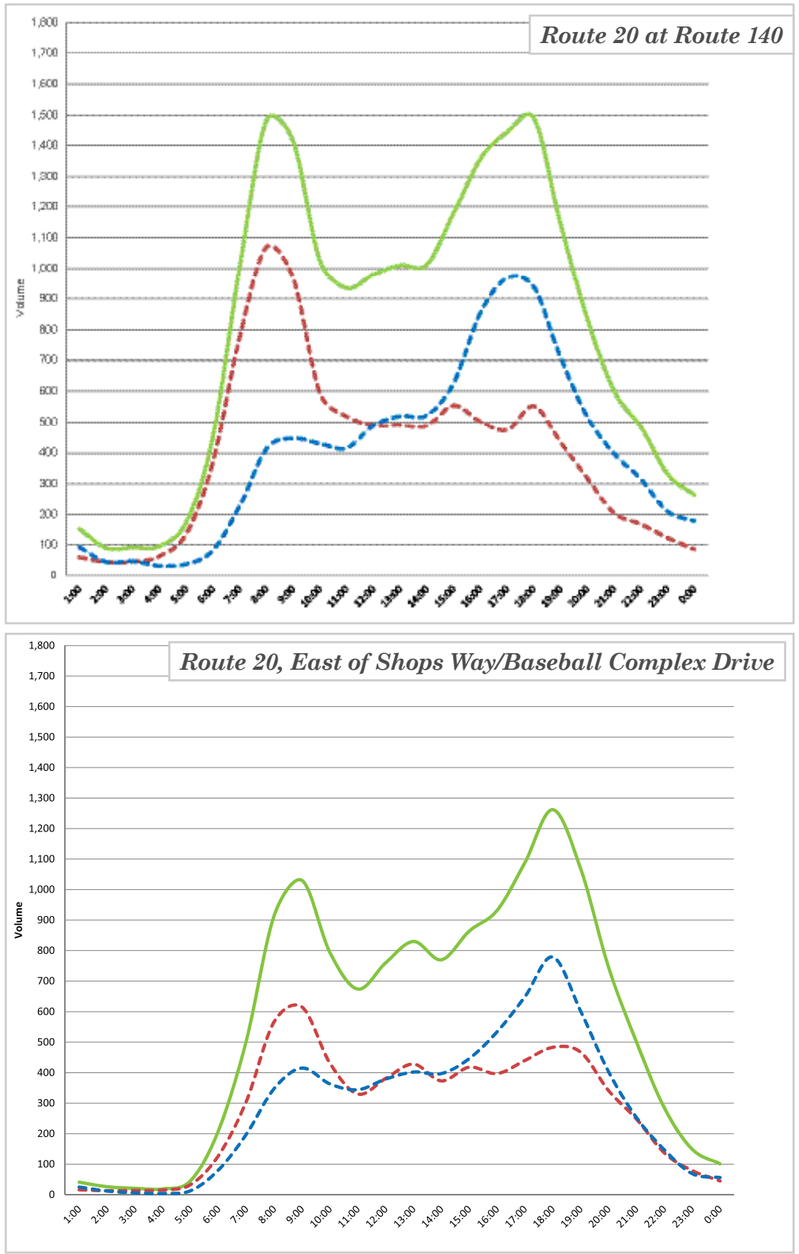


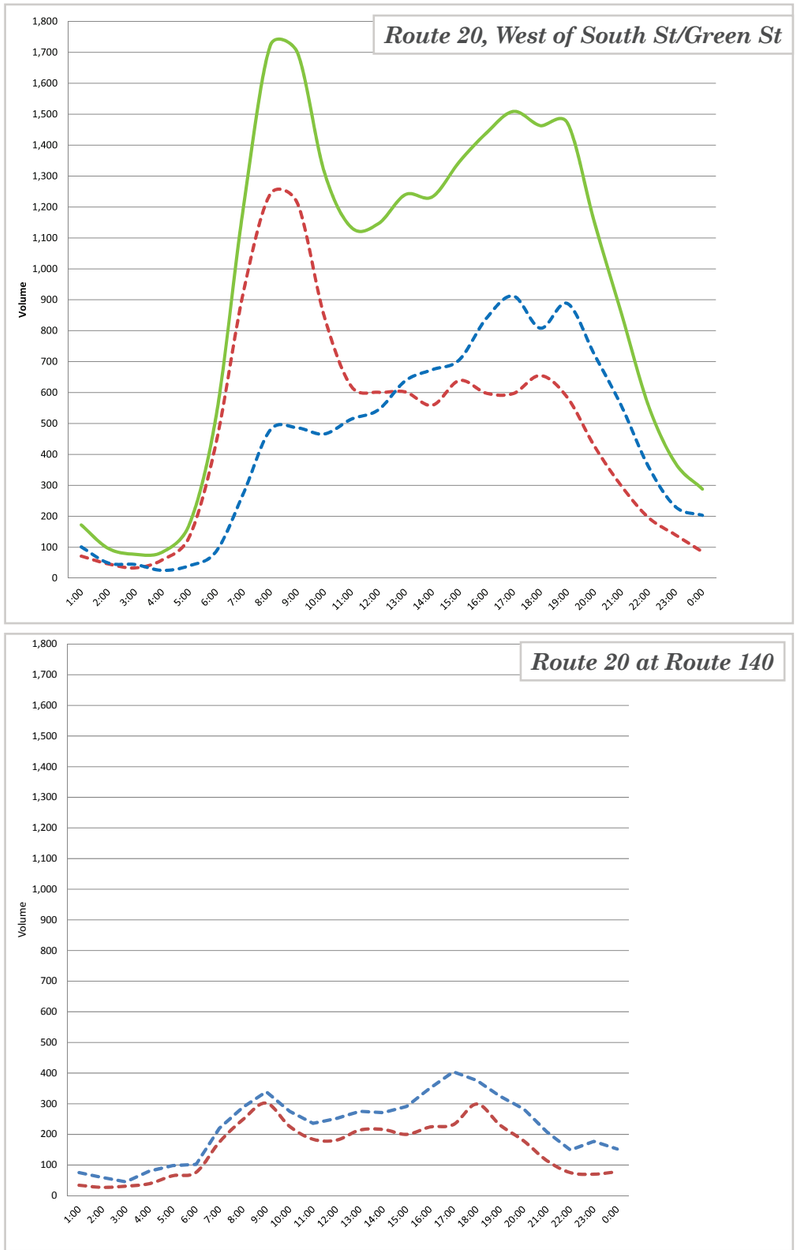
Shrewsbury – Route 20 Corridor Improvements

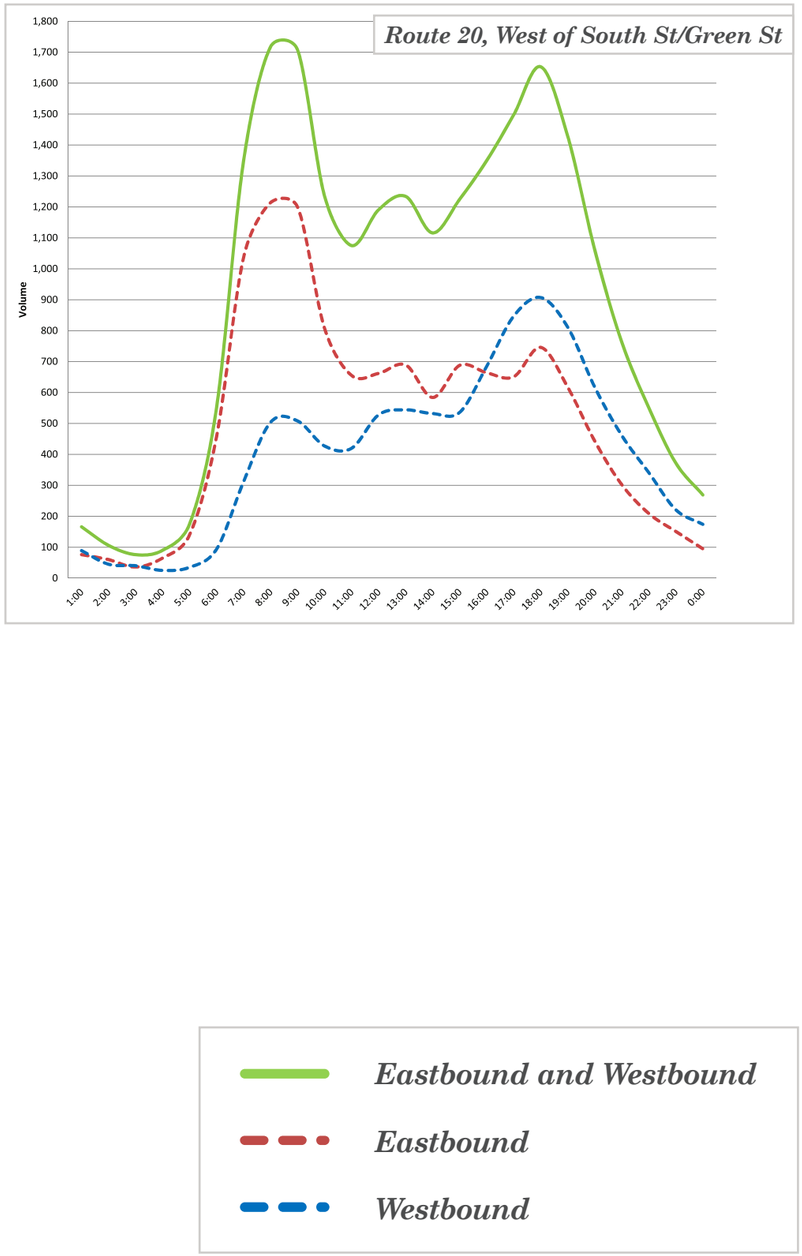
Table 6. Average Daily Traffic

Location	ADT	K%	85th Percentile Speed (mph)
Route 20 eastbound On-Ramp to Route 140			
Eastbound	3,400	8.1%	
TOTAL	**3,400**	**8.1%**	
Route 20 eastbound Lane to Route 140			
Eastbound	8,700	11.2%	
TOTAL	**8,700**	**11.2%**	
Route 20 westbound Off-Ramp Lane from Route 140			
Westbound	4,900	7.6%	
TOTAL	**4,900**	**7.6%**	
Route 20 westbound Lane before Route 140 Off-Ramp			
Eastbound	8,700	10.2%	
TOTAL	**8,700**	**10.2%**	
Route 20 west of South /Green Street			
Eastbound	10,600	10.7%	50
Westbound	9,700	8.6%	50
TOTAL	**20,300**	**8%**	**50**
Route 20 west of Walnut Street North			
Eastbound	10,700	9.9%	53
Westbound	8,500	9.3%	56
TOTAL	**19,200**	**8%**	**54**
Route 20 east of Shops Way/Baseball Complex Drive			
Eastbound	6,100	9.2%	53
Westbound	6,300	11.3%	50
TOTAL	**12,400**	**9%**	**52**

Figure 26. Daily Traffic Variations - Route 20 at Various Locations in Shrewsbury/Northborough







PEAK-HOUR INTERSECTION TURNING MOVEMENTS

MassDOT also provided turning movement counts (TMC's) for all 25 study area intersections, which are also shown in **Figure 27**. Two sets of counts, on different dates, were conducted for this study:

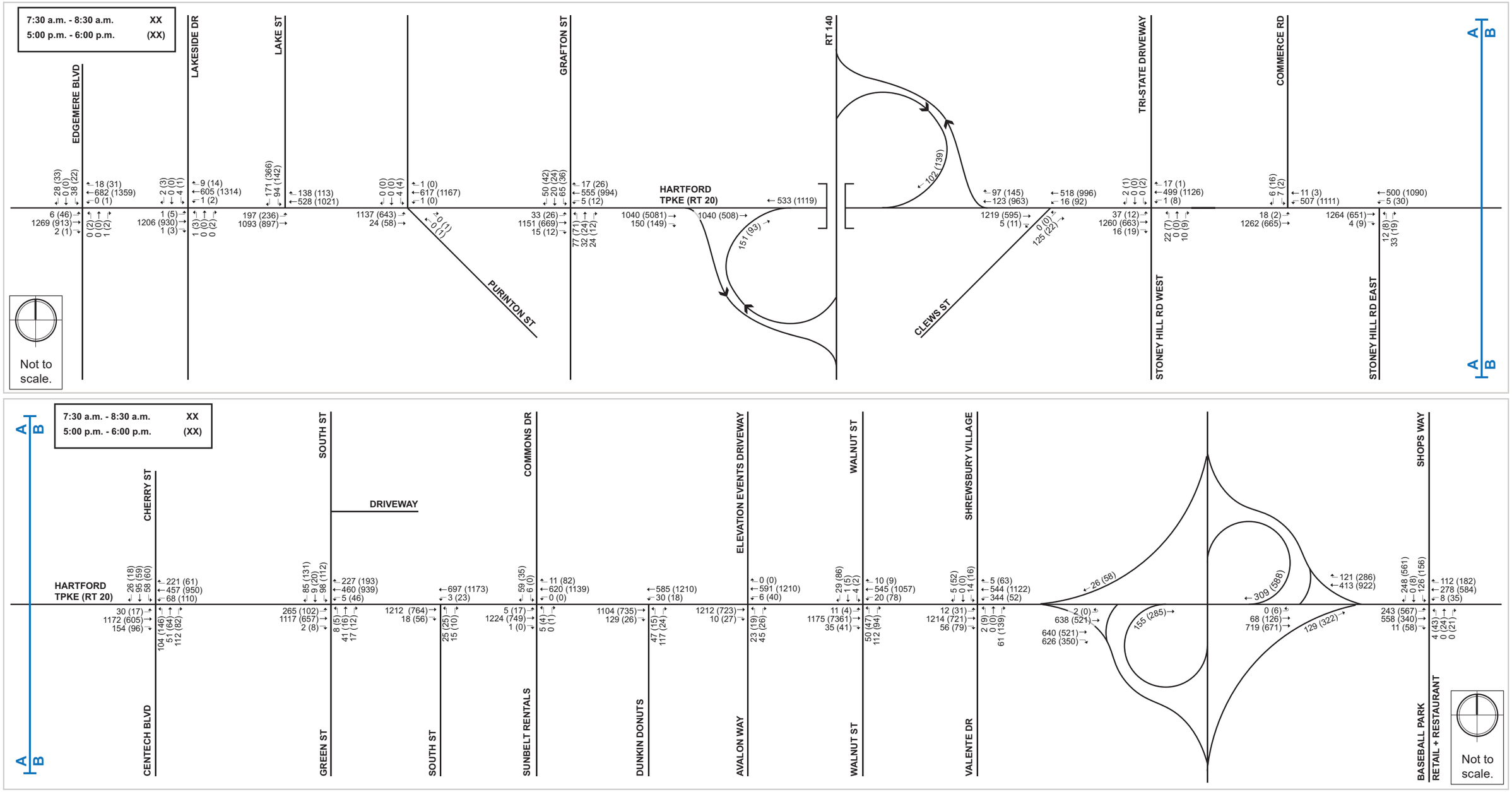
- The first was conducted on September 14, 2016 and included the Route 25 intersections listed below:
  - ~ Route 20 at Cherry Street/Centech Boulevard;
  - ~ Route 20 at South Street/Green Street;
  - ~ Route 20 at South Street;
  - ~ Route 20 at Commons Drive/Sunbelt Rentals Driveway;
  - ~ Route 20 at Dunkin Donuts Driveway;
  - ~ Route 20 at Avalon Way;
  - ~ Route 20 at Walnut Street North and South;
  - ~ Route 20 at Old Shrewsbury Village/ Valente Drive;
  - ~ Route 20 at Route 9 eastbound on and off ramps (three intersections);
  - ~ Route 20 at Route 9 westbound on and off ramps (two intersections); and
  - ~ Route 20 at Shops Way/Baseball Complex Drive
- The second set was conducted on March 13, 2019 and included the Route 20 intersections listed below:
  - ~ Route 20 at Edgemere Boulevard;
  - ~ Route 20 at Lake Street;
  - ~ Route 20 at Purinton Street;
  - ~ Route 20 at Grafton Street;
  - ~ Route 20 at Route 140 Off-Ramps (two intersections);
  - ~ Route 20 at Clews Street;
  - ~ Route 20 at Stoney Hill Road West;
  - ~ Route 20 at Commerce Road; and
  - ~ Route 20 at Stoney Hill Road East.

The 2016 counts were increased by 0.5% to reflect any growth that may have occurred between then and the 2019 counts. The TMC's showed that the a.m. peak hour occurred between 7:30 a.m. and 8:30 a.m. and the p.m. peak hour occurred between 5:00 p.m. and 6:00 p.m. Traffic count data is provided in **Appendix A**.

WESTBOROUGH STATION TRAFFIC USING WALNUT STREET

Concern was raised at the public meetings about vehicles that exit the Westborough MBTA Station using Walnut Street to connect to Route 20 and Route 9, instead of the more direct route on Otis Street located adjacent to the station and to the east. Traffic counts show that the volume of vehicles on Walnut Street approaching Route 20 from the south have grown by approximately 150 vehicles during both the a.m. and p.m. peak hours since 2003. Without directly surveying each driver on Walnut Street, it is difficult to tell how many of them are using that route as a cut-through from the Westborough MBTA Station. However, mapping programs such as Google and Bing do recommend using Walnut Street when traveling from the Westborough MBTA Train Station to destinations along Route 20 west of Walnut Street.

Figure 27. Existing (2016) Condition Traffic Volumes, Weekday a.m. and p.m. Peak Hour



Station exiting traffic was studied in July 2018 to determine the route most drivers choose during either peak hour. It showed that traffic from the Westborough MBTA Station is only responsible for some of the growth in traffic volumes on Walnut Street. The majority (70%) of vehicles exiting the station parking lot during the p.m. peak hour turn right towards Otis Street and Route 9. The remaining station exiting volume that turns left towards Walnut Street is only 39 vehicles. If all these vehicles travel on Walnut Street to Route 20, they would only account for approximately 22% of the Walnut Street traffic entering Route 20. The other new trips on Walnut Street are likely tied to the general growth in travel activity in the area. As the design process for improvements at Walnut Street move forward, MassDOT can work with the Town and area residents to continue monitoring conditions to better determine the source of added traffic on Walnut Street and see if there is any significant change in travel behavior or traffic volumes. Traffic counts collected in July 2018 can be found in **Appendix A.**

INTERSECTION OPERATIONS ANALYSIS

Traffic operations are determined through an analysis of intersection Level of Service (LOS) calculations. LOS at intersections was calculated using Synchro 9.0, which is based on the traffic operational analysis methodology of the Transportation Research Board's 2000 Highway Capacity Manual (HCM) (the 2000 HCM methodology was selected because the study area intersections operate using a non-NEMA phasing and cannot be analyzed using the 2010 HCM methodology) for signalized intersections, and 2010 HCM for unsignalized intersections. The LOS and delay (in seconds) are based on intersection geometry and traffic volume. **Table 7**, an excerpt from the HCM, provides LOS criteria for signalized and unsignalized intersections. LOS A defines the most favorable conditions, with minimum traffic delay. LOS F represents the worst condition, with significant traffic delay.

Table 7. Level of Service Criteria for Signalized and Unsignalized Intersections

Level of Service	Signalized Intersection Average Stopped Delay (seconds/vehicle)	Unsignalized Intersection Average Stopped Delay (seconds/vehicle)
A	0.0 – 10.0	0.0 – 10.0
B	10.1 – 20.0	10.1 – 15.0
C	20.1 – 35.0	15.1 – 25.0
D	35.1 – 55.0	25.1 – 35.0
E	55.1 – 80.0	35.1 – 50.0
F	>80.0	>50.0

Source: Highway Capacity Manual, 2000. Transportation Research Board.

In accordance with MassDOT guidelines, the peak 15 minutes of data collected during each peak hour were isolated in order to calculate the peak-hour factors for each approach. The percentage of heavy vehicles was noted for each approach as well. MassDOT District 3 provided existing signal timings for the signalized intersections which were confirmed in the field. The Synchro analysis for Existing (2017) Conditions was calibrated to match the existing traffic operations as closely as possible.

The Existing (2017) Conditions a.m. and p.m. peak hour Level of Service for each of the eight signalized and the 17 unsignalized intersections within the study area are shown graphically in **Figure 28**. **Table 8 and Table 9** show the existing conditions signalized intersection capacity analysis summary for the a.m. and p.m. peak hour, respectively.

Route 20 westbound on-ramp from Route 140.

Figure 28. Existing (2017) Conditions a.m. and p.m. Peak Hour Level of Service

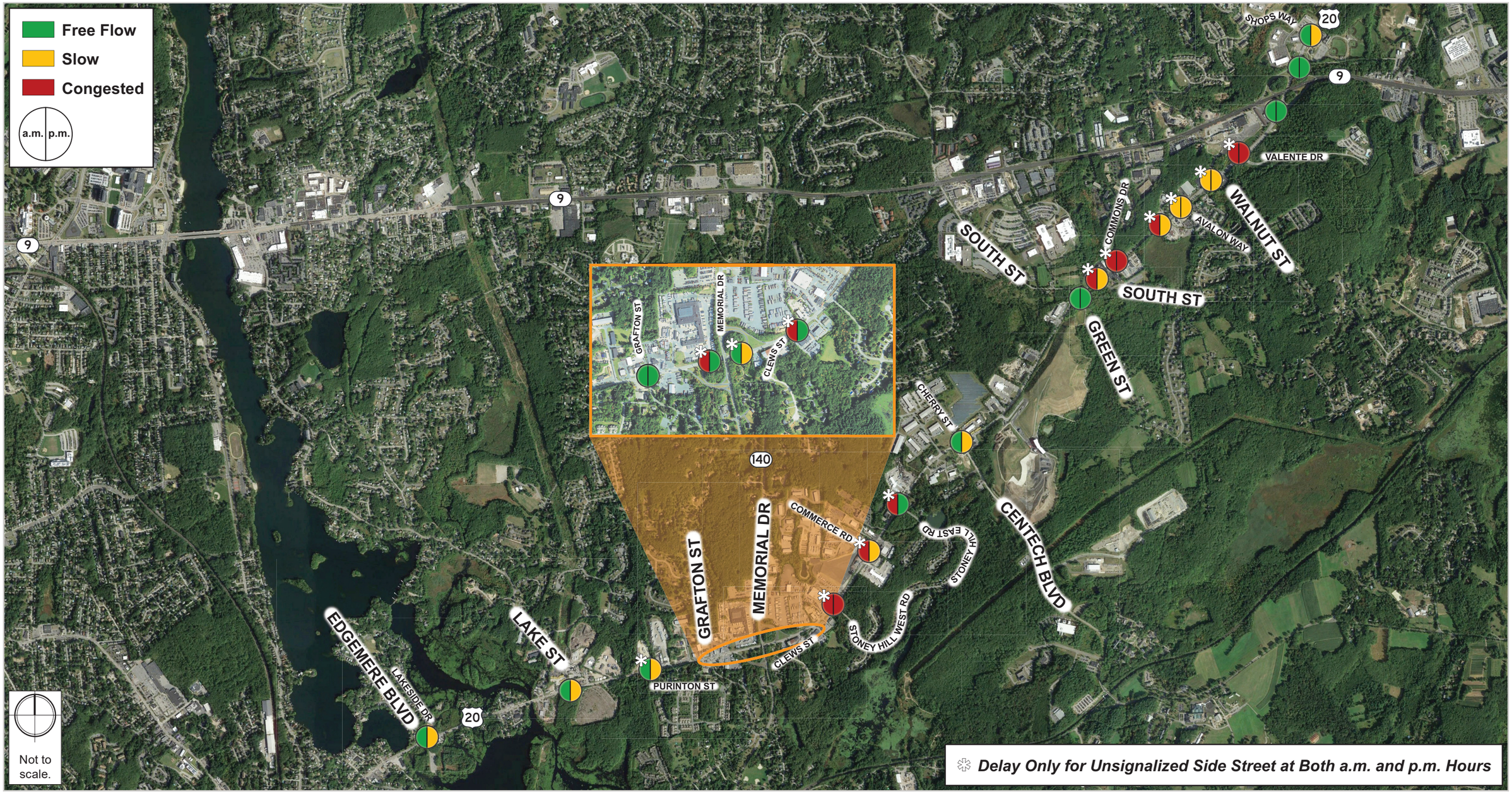


Table 8. Existing Conditions Signalized Intersection Capacity Analysis Summary, a.m. Peak Hour

Intersection/Movement	LOS	Delay (Seconds)	V/C Ratio	50th Percentile Queue Length (feet)	95th Percentile Queue Length (feet)
Route 20/Edgemere Boulevard/Oak Island Driveway	**C**	**33.2**	-	-	-
Route 20 EB left/thru|thru/right	D	48.5	1.05	221	#659
Route 20 WB left/thru|thru/right	A	5.9	0.58	54	223
Oak Island NB left/thru/right	C	29.6	0.00	0	0
Edgemere Boulevard SB left/thru/right	C	30.0	0.06	0	22
Route 20/Lake Street	C	**25.5**	-	-	-
Route 20 EB left/thru|thru	C	25.0	0.97	172	#471
Route 20 WB thru|thru/right	C	20.7	0.71	174	136
Lake Street SB left	E	63.2	0.75	78	#133
Lake Street SB right	C	24.8	0.12	0	38
Route 20/Grafton Street	**C**	**24.8**	-	-	-
Route 20 EB left/thru|thru/right	C	24.0	0.94	223	#405
Route 20 WB left/thru|thru/right	A	7.8	0.54	66	107
Grafton Street NB left/thru/right	E	60.9	0.86	58	#155
Grafton Street SB left/thru/right	E	60.7	0.86	56	#135
Route 20/Cherry Street/Centech Boulevard	**C**	**28.4**	-	-	-
Route 20 EB left	A	8.5	0.10	5	12
Route 20 EB thru|thru/right	C	22.1	0.87	287	395
Route 20 WB left	B	12.0	0.40	14	21
Route 20 WB thru/right	B	12.7	0.59	166	270
Centech Boulevard NB left/thru	F	100.6	1.04	107	114
Centech Boulevard NB right	B	18.5	0.23	0	10
Cherry Street SB left/thru	D	48.0	0.85	~125	103
Cherry Street SB right	B	19.3	0.03	30	58
Route 20/South Street/Green Street	**C**	**21.9**	-	-	-
Route 20 EB left	A	6.4	0.57	48	86
Route 20 EB thru/right	C	26.6	0.95	485	#908
Route 20 WB left/thru|thru/right	B	12.2	0.45	97	169
Green Street NB left/thru/right	C	28.4	0.26	36	55
South Street SB left/thru/right	D	46.0	0.79	101	142
Route 20/Route 9 EB on ramp	**A**	**2.6**	-	-	-
Route 20 EB thru	A	5.3	0.51	81	148
Route 20 WB left	A	1.0	0.26	0	1
Route 20 WB thru|thru	A	0.1	0.18	0	0
Route 20/Route 9 WB on/off ramp	**A**	**8.7**	-	-	-
Route 20 EB left	C	30.0	0.28	25	m49
Route 20 EB thru	A	7.5	0.58	144	286
Route 20 WB thru|thru/right	A	4.4	0.28	36	63
Route 9 WB off ramp NB right	C	22.4	0.09	0	0
Route 20/Shops Way/Baseball Complex Drive*	**C**	**28.3**	-	-	-
Route 20 EB left|left	D	49.3	0.67	117	140
Route 20 EB thru/right	B	19.7	0.59	185	295
Route 20 WB left	E	78.8	0.55	8	21
Route 20 WB thru|thru/right	B	18.8	0.30	62	121
Baseball Complex NB left	E	59.3	0.21	3	8
Baseball Complex NB left/thru	E	59.3	0.21	3	8
Baseball Complex NB right	A	0.0	0.00	0	0
Shops Way SB left/thru	D	49.4	0.66	103	44
Shops Way SB right|right	C	27.5	0.10	0	27

Table 9. Existing Conditions Unsignalized Intersection Capacity Analysis Summary, a.m. Peak Hour

Intersection/Movement	LOS	Delay (Seconds)	V/C Ratio	50th Percentile Queue Length (feet)	95th Percentile Queue Length (feet)
Route 20/Stoney Hill Road (East)	-	-	-	-	-
Route 20 EB thru/right	A	0.0	0.00	-	0
Route 20 WB left/thru	B	14.0	0.03	-	3
Stoney Hill Rd NB left/right	F	>50.0	0.81	-	105
Route 20/South Street	-	-	-	-	-
Route 20 EB thru/right	A	0.0	0.00	-	0
Route 20 WB left/thru|thru	B	13.7	0.01	-	0
South St NB left/right	F	>50.0	0.46	-	50
Route 20/Commons Drive/Sunbelt Rentals Driveway	-	-	-	-	-
Route 20 EB left/thru/right	A	8.9	0.01	-	0
Route 20 WB left/thru|thru/right	A	0	0.00	-	0
Sunbelt Rentals NB left/thru/right	F	>50.0	0.19	-	15
Commons Drive SB left/right	D	31.4	0.38	-	43
Route 20/Dunkin Donuts Driveway	-	-	-	-	-
Route 20 EB thru|thru/right	A	0.0	0.00	-	0
Route 20 WB left/thru|thru	B	12.5	0.07	-	5
Dunkin Donuts NB left/right	F	>50.0	1.11	-	258
Route 20/Avalon Way	-	-	-	-	-
Route 20 EB thru/thru|right	A	0.0	0.00	-	0
Route 20 WB left/thru|thru	B	14.2	0.03	-	3
Avalon NB left/right	E	38.2	0.44	-	53
Route 20/Walnut Street N	-	-	-	-	-
Route 20 EB left/thru|thru	A	8.8	0.01	-	0
Route 20 WB thru|thru|right	A	0.0	0.00	-	0
Walnut Street SB left/thru/right	C	15.4	0.12	-	10
Route 20/Walnut Street S	-	-	-	-	-
Route 20 EB thru|thru/right	A	0.0	0.00	-	0
Route 20 WB left	B	11.7	0.04	-	3
Route 20 WB thru/thru	A	0.0	0.00	-	0
Walnut Street NB left	F	>50.0	0.64	-	78
Walnut Street NB right	C	16.5	0.28	-	28
Route 20/Old Shrewsbury Village/ Valente Drive	-	-	-	-	-
Route 20 EB left	B	10.1	0.04	-	3
Route 20 EB thru|thru/right	A	0.0	0.00	-	0
Route 20 WB left	B	12.7	0.10	-	8
Route 20 WB thru|thru/right	A	0.0	0.00	-	0
Valente Drive NB left/thru/right	C	21.9	0.28	-	28
Old Shrewsbury Village SB left/thru	F	>50.0	0.53	-	45
Old Shrewsbury Village SB right	B	11.0	0.04	-	3
Route 20/Route 9 EB off ramp	-	-	-	-	-
Route 20 EB thru	A	0.0	0.00	-	0
Route 20 WB thru|thru	A	0.0	0.00	-	0
Route 9 EB off ramp SB right	B	10.5	0.04	-	3
Route 20 EB/Route 9 EB off ramp	-	-	-	-	-
Route 20 EB thru	A	0.0	0.00	-	0
Route 20 WB thru|thru	A	0.0	0.00	-	0
Route 9 EB off ramp NB right	C	17.0	0.37	-	32
Route 20 SB/Route 9 WB off ramp	-	-	-	-	-
Route 20 EB thru	A	0.0	0.00	-	0
Route 20 WB thru|thru	A	0.0	0.00	-	0
Route 9 WB off ramp SB right	B	13.5	0.43	-	55

Table 10. Existing Conditions Signalized Intersection Capacity Analysis Summary, p.m. Peak Hour

Intersection/Movement	LOS	Delay (Seconds)	V/C Ratio	50th Percentile Queue Length (feet)	95th Percentile Queue Length (feet)
Route 20/Edgemere Boulevard/Oak Island Driveway	**D**	**44.4**	-	-	-
Route 20 EB left/thru|thru/right	D	38.4	1.00	134	#495
Route 20 WB left/thru|thru/right	D	49.5	1.05	221	#691
Oak Island NB left/thru/right	C	29.8	0.01	0	0
Edgemere Boulevard SB left/thru/right	C	31.6	0.27	11	38
Route 20/Lake Street	**D**	**52.4**	-	-	-
Route 20 EB left/thru|thru	E	77.0	1.24dl	~184	#356
Route 20 WB thru|thru/right	B	17.9	0.87	306	430
Lake Street SB left	E	71.1	0.82	113	#219
Lake Street SB right	F	>80.0	0.98	~223	#417
Route 20/Grafton Street	**B**	**18.7**	-	-	-
Route 20 EB left/thru|thru/right	A	9.8	0.74	102	#218
Route 20 WB left/thru|thru/right	C	21.5	0.93	194	#389
Grafton Street NB left/thru/right	D	35.9	0.69	52	83
Grafton Street SB left/thru/right	C	27.4	0.49	35	62
Route 20/Cherry Street/Centech Boulevard	**D**	**40.5**	-	-	-
Route 20 EB left	B	15.8	0.18	4	6
Route 20 EB thru|thru/right	A	9.7	0.36	106	144
Route 20 WB left	A	4.9	0.27	19	28
Route 20 WB thru/right	C	25.1	0.91	554	#958
Centech Boulevard NB left/thru	F	>80.0	1.13	~235	#313
Centech Boulevard NB right	C	28.4	0.06	0	31
Cherry Street SB left/thru	F	>80.0	1.17	~152	#203
Cherry Street SB right	C	30.7	0.02	0	13

Intersection/Movement	LOS	Delay (Seconds)	V/C Ratio	50th Percentile Queue Length (feet)	95th Percentile Queue Length (feet)
Route 20/South Street/Green Street	**C**	**21.1**	-	-	-
Route 20 EB left	B	11.1	0.51	20	47
Route 20 EB thru/right	A	8.1	0.61	186	300
Route 20 WB left/thru|thru/right	C	24.0	0.90	323	#509
Green Street NB left/thru/right	C	24.3	0.10	11	35
South Street SB left/thru/right	D	43.0	0.82	118	#252
Route 20/Route 9 EB on ramp	**A**	**1.2**	-	-	-
Route 20 EB thru	A	3.4	0.36	65	135
Route 20 WB left	A	0.9	0.38	0	0
Route 20 WB thru|thru	A	0.3	0.36	0	0
Route 20/Route 9 WB on/off ramp	**B**	**16.5**	-	-	-
Route 20 EB left	D	46.5	0.62	103	141
Route 20 EB thru	A	5.7	0.52	90	337
Route 20 WB thru|thru/right	B	10.9	0.53	256	273
Route 9 off ramp WB right	D	44.2	0.66	84	167
Route 20/Shops Way/Baseball Complex Drive*	**D**	**37.0**	-	-	-
Route 20 EB left|left	D	36.8	0.76	172	206
Route 20 EB thru/right	B	15.5	0.47	183	158
Route 20 WB left	F	>80.0	0.88	39	49
Route 20 WB thru|thru/right	C	31.3	0.71	213	283
Baseball Complex NB left	E	56.7	0.61	30	47
Baseball Complex NB left/thru	D	54.4	0.59	30	65
Baseball Complex NB right	D	39.2	0.01	0	0
Shops Way SB left/thru	F	>80.0	1.04	~151	#117
Shops Way SB right|right	C	23.3	0.44	86	136

 # = 95th percentile volume exceeds capacity, queue may be longer
~=Volume exceeds capacity, queue is theoretically infinite
**=Under Adaptive Signal Control*

Table 11. Existing Conditions Unsignalized Intersection Capacity Analysis Summary, p.m. Peak Hour

Intersection/Movement	LOS	Delay (Seconds)	V/C Ratio	50th Percentile Queue Length (feet)	95th Percentile Queue Length (feet)
Route 20/Purinton Street	-	-	-	-	-
Route 20 EB thru|thru/right	A	0.0	0.00	-	0
Route 20 WB left/thru	A	0.0	0.00	-	0
Purinton St NB left/right	E	37.7	0.07	-	5
Route 20/Route 140 West Off-Ramp	-	-	-	-	-
Route 20 EB thru	A	0.0	0.00	-	0
Route 20 WB thru/thru	A	0.0	0.00	-	0
Route 140 West NB right	C	15.4	0.23	-	22
Route 20/Route 140 East Off-Ramp	-	-	-	-	-
Route 20 EB thru	A	0.0	0.00	-	0
Route 20 WB thru	A	0.0	0.00	-	0
Route 140 East SB right	E	35.1	0.58	-	83
Route 20/Clews Street	-	-	-	-	-
Route 20 EB thru/right	A	0.0	0.00	-	0
Route 20 WB left/thru	A	9.4	0.13	-	13
Clews St NEB left/right	B	14.5	0.20	-	20
Route 20/Stoney Hill Road (West)/Driveway	-	-	-	-	-
Route 20 EB left/thru|thru/right	B	12.9	0.03	-	3
Route 20 WB left/thru	A	9.2	0.02		3
Route 20 WB right	A	0.0	0.00	-	0
Stoney Hill Rd NB left/thru/right	F	>50.0	0.52	-	50
Driveway SB left/thru/right	F	>50.0	0.14	-	13
Route 20/Commerce Road	-	-	-	-	-
Route 20 EB thru/left	B	13.9	0.01	-	0
Route 20 WBthru/right	A	0.0	0.00	-	0
Commerce Rd SB left/right	E	35.7	0.19	-	18

Intersection/Movement	LOS	Delay (Seconds)	V/C Ratio	50th Percentile Queue Length (feet)	95th Percentile Queue Length (feet)
Route 20/Stoney Hill Road (East)	-	-	-	-	-
Route 20 EB thru/right	A	0.0	0.00	-	0
Route 20 WB thru/left	A	9.2	0.05	-	3
Stoney Hill NB left/right	D	29.9	0.29	-	30
Route 20/South Street	-	-	-	-	-
Route 20 EB thru/right	A	0.0	0.00	-	0
Route 20 WB left/thru|thru	A	9.9	0.04	-	3
South St NB left/right	E	48.2	0.37	-	40
Route 20/Commons Drive/Sunbelt Rentals Driveway	-	-	-	-	-
Route 20 EB left/thru/right	B	12.3	0.05	-	5
Route 20 WB left/thru|thru/right	A	0.0	0.00	-	0
Sunbelt Rentals NB left/thru/right	F	>50.0	0.21	-	20
Commons Drive SB left/right	C	15.0	0.10	-	8
Route 20/Dunkin Donuts Driveway	-	-	-	-	-
Route 20 EB thru|thru/right	A	0.0	0.00	-	0
Route 20 WB left/thru|thru	A	9.6	0.03	-	3
Dunkin Donuts NB left/right	D	27.8	0.33	-	36
Route 20/Avalon Way	-	-	-	-	-
Route 20 EB thru/thru|right	A	0.0	0.00	-	0
Route 20 WB left/thru|thru	A	9.8	0.07	-	5
Avalon NB left/right	E	43.4	0.40	-	13
Route 20/Walnut Street N	-	-	-	-	-
Route 20 EB left/thru|thru	B	11.5	0.01	-	0
Route 20 WB thru/thru|right	A	0.0	0.00	-	0
Walnut Street SB left/thru/right	C	21.0	0.32	-	35

Table 11. Existing Conditions Unsignalized Intersection Capacity Analysis Summary, p.m. Peak Hour (cont'd)

Intersection/Movement	LOS	Delay (Seconds)	V/C Ratio	50th Percentile Queue Length (feet)	95th Percentile Queue Length (feet)
Route 20/Walnut Street S	-	-	-	-	-
Route 20 EB thru|thru/right	A	0.0	0.00	-	0
Route 20 WB left	B	10.3	0.14	-	13
Route 20 WB thru/thru	A	0.0	0.00	-	0
Walnut Street NB left	F	>50.0	1.31	-	200
Walnut Street NB right	B	12.9	0.20	-	20
Route 20/Old Shrewsbury Village/ Valente Drive	-	-	-	-	-
Route 20 EB left	B	11.9	0.07	-	5
Route 20 EB thru|thru/right	A	0.0	0.00	-	0
Route 20 WB left	B	10.0	0.08	-	8
Route 20 WB thru|thru/right	A	0.0	0.00	-	0
Valente Drive NB left/thru/right	D	26.9	0.52	-	70
Old Shrewsbury Village SB left/thru	F	>50.0	0.69	-	55
Old Shrewsbury Village SB right	C	15.1	0.16	-	15
Route 20/Route 9 EB off ramp	-	-	-	-	-
Route 20 EB thru	A	0.0	0.00	-	0
Route 20 WB thru|thru	A	0.0	0.00	-	0
Route 9 EB off ramp SB right	C	15.7	0.19	-	18
Route 20/Route 9 EB off ramp	-	-	-	-	-
Route 20 EB thru	A	0.0	0.00	-	0
Route 20 WB thru|thru	A	0.0	0.00	-	0
Route 9 EB off ramp NB right	C	24.8	0.66	-	120
Route 20/Route 9 WB off ramp	-	-	-	-	-
Route 20 EB thru	A	0.0	0.00	-	0
Route 20 WB thru|thru	A	0.0	0.00	-	0
Route 9 WB off ramp SB right	F	>50.0	1.16	-	528

SIGNALIZED INTERSECTIONS

Under both peak hour conditions, all the study area signalized intersections operate at a LOS D or better. During the a.m. peak hour, a few of the side street approaches operate with more delay than other approaches, most likely since Route 20 receives most of the signal cycle time provided at those intersections. One such example is both Grafton Street approaches to Route 20, where Route 20 receives approximately 70% of the provided signal cycle time. These delays also mean long queues that use up the available capacity on these side streets and may block adjacent side streets.

The same situation exists during the p.m. peak hour as well with the only difference being that two Route 20 approaches also experience higher delays; the Route 20 eastbound approach at Lake Street and the Route 20 westbound left turn at Shops Way/Baseball Complex Drive. The inside lane of two on the Route 20 eastbound approach at Lake Street operates as a de-facto left-turn lane in the p.m. peak hour, as there are more left turns occurring then, thus blocking the through movements on this Route 20 eastbound lane. This condition may create a long queue on this lane, so much so that the outside lane is also affected, as through vehicles attempt to switch lanes to get around the left-turning vehicles, causing the outside lane to slow down. The Route 20 westbound left turn at Shops Way/Baseball Complex Drive experiences high delays because of how long vehicles have to wait to receive the green arrow; however, in general, the traffic using this lane is low, thus not exceeding the available capacity.

UNSIGNALIZED INTERSECTIONS

The Route 20 mainline at the corridor unsignalized intersections or driveways operates at LOS A, since it is uncontrolled, however, the stop or yield controlled side streets and driveways operate at LOS F, due to heavy traffic and high speeds on Route 20 that make it difficult to find an adequate gap to enter Route 20. The analysis shows that queues don't exceed the available capacity, but they do reach lengths of up to 530 feet at some locations.

Details of the Synchro analyses are provided in **Appendix B.**

Safety Analysis

HSH received crash data for the entire 5.1-mile length of the Route 20 corridor in Shrewsbury and Northborough from different sources; for the portion of Route 20 that starts at the City of Worcester Line and ends at just to the west of the Route 20/Centech Boulevard/Cherry Street intersection (Western Section), MassDOT provided crash records from 2014 to 2017. For the portion of Route 20 that starts at Centech Boulevard and ends just to the east of the Route 20/Shops Way/Baseball Complex Drive (Eastern Section), crash records were received by MassDOT and the police departments of both the Towns of Shrewsbury and Northborough.

For the Western Section, and during the 2014-2017 period, 224 vehicular crashes occurred at the studied intersections. For the eastern section, and during the 2014-2016 period, 78 vehicular crashes occurred at the study area intersections. Rear-end and angle collisions were the most commonly reported types of collision, which suggests that, at signalized intersections, clearance intervals may be insufficient and, at

unsignalized intersections, high speeds, insufficient gaps between vehicles, and impatience of drivers exiting side streets or driveways may contribute to these collisions.

Figure 29 and **Figure 30** show the number of crashes that each intersection experienced in the time periods mentioned above. **Table 12** and **Table 13** summarize the crash data at each intersection in the Western Section and Eastern Section respectively. Crash rates are determined based on the number of crashes per million entering vehicles (MEV) in an intersection. The crash rate calculation is based on the traffic volumes and number of crashes at the intersection and compares the relationship between the two.

HSH recieved crash data from a variety of sources including the Town of Shrewsbury and Northborough's police departments.

Figure 29. Vehicle Crashes, 2014-2016

Figure 30. Figure Vehicle Crashes, 2014-2016 Continued

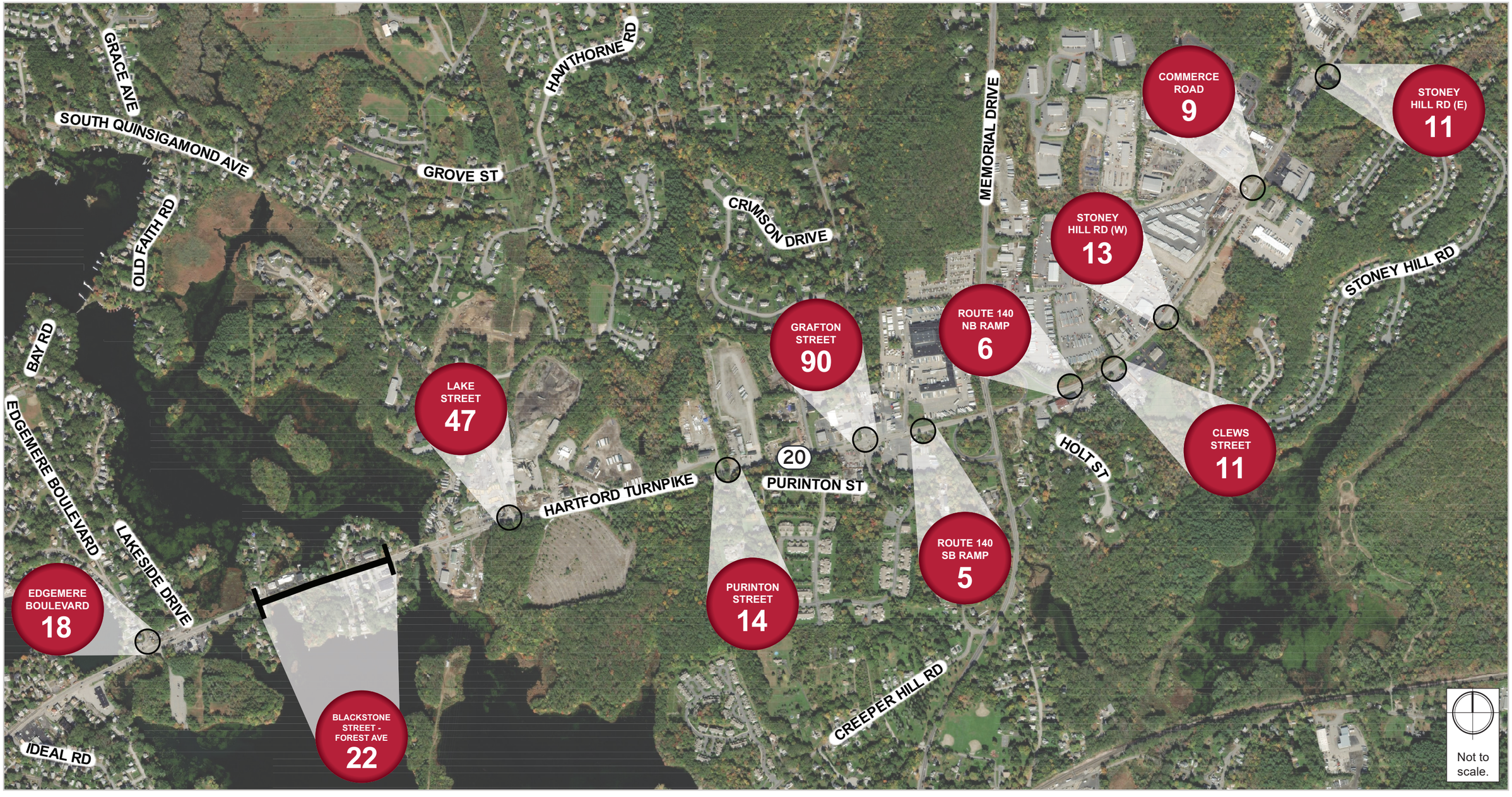


Table 12. Western Section Crash Data Summary (2014-2017)

Scenario	Route 20 & Edgemere Blvd (S)	Route 20 & Lake St (S)	Route 20 & Purinton St (U)	Route 20 & Grafton St (S)	Route 20 & Route 140 Off-Ramps SB (U)	Route 20 & Route 140 Off-Ramps NB (U)	Route 20 & Clews St (U)	Route 20 & Stoney Hill Rd (West) (U)	Route 20 & Commerce Rd (U)	Route 20 & Stoney Hill Road (East) (U)
Year										
2014	3	10	1	20	1	2	2	3	0	1
2015	3	16	6	27	1	2	3	4	2	4
2016	6	10	4	22	1	1	3	2	3	4
2017	6	11	3	21	2	1	3	4	4	2
Type										
Single Vehicle	0	2	2	9	0	2	0	0	1	4
Head on	1	1	0	3	0	0	0	0	0	0
Angle	3	16	1	52	2	1	3	1	3	3
Rear-end	7	24	10	17	1	3	6	10	5	4
Sideswipe	6	4	1	9	2	0	2	2	0	0
Severity										
Property Damage	16	41	9	66	5	5	9	12	5	8
Personal Injury	2	6	5	22	0	1	2	1	4	3
Fatality	0	0	0	1	0	0	0	0	0	0
Hit and Run	0	0	0	0	0	0	0	0	0	0
Unknown	0	0	0	1	0	0	0	0	0	0
Total	**18**	**47**	**14**	**90**	**5**	**6**	**11**	**13**	**9**	**11**
Crash Rate	**0.46**	**1.12**	**0.46**	**2.71**	**0.16**	**0.20**	**0.36**	**0.43**	**0.31**	**0.38**
District 3 Average	**0.90**	**0.90**	**0.65**	**0.90**	**0.65**	**0.65**	**0.65**	**0.65**	**0.65**	**0.65**
Satewide Average	**0.77**	**0.77**	**0.58**	**0.77**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**

U - Unsignalized Intersection, S - Signalized Intersection

Table 13. Eastern Section Crash Data Summary (2014-2016)

Scenario	Route 20 & Centech Blvd/ Cherry St. (S)	Route 20 & South St./ Green St. (S)	Route 20 & South St. (U)	Route 20 & Commons Dr./ Sunbelt Rentals Driveway (U)	Route 20 & Dunkin Donuts Driveway (U)	Route 20 & Avalon Way (U)	Route 20 & Walnut St (U)	Route 20 & Shrewsbury Village/ Valente Dr. (U)
Year								
2014	4	5	5	1	1	0	4	4
2015	5	5	4	1	2	1	7	6
2016	1	3	4	0	3	4	3	4
Type								
Single Vehicle	1	1	3	0	0	0	1	2
Head on	0	0	0	0	0	1	0	1
Angle	5	5	5	0	5	3	10	11
Rear-end	3	7	3	2	0	0	2	0
Sideswipe	1	0	2	0	1	1	2	0
Severity								
Property Damage	6	8	9	1	5	3	12	9
Personal Injury	4	5	4	1	1	2	3	5
Fatality	0	0	0	0	0	0	0	0
Hit and Run	0	0	0	0	0	0	0	0
Unknown	0	0	0	0	0	0	0	0
Total	**10**	**13**	**13**	**2**	**6**	**5**	**15**	**14**
Crash Rate	**0.37**	**0.47**	**0.52**	**0.08**	**0.24**	**0.20**	**0.57**	**0.50**
District 3 Average	**0.90**	**0.90**	**0.65**	**0.65**	**0.65**	**0.65**	**0.65**	**0.65**
Satewide Average	**0.77**	**0.77**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**

U - Unsignalized Intersection, S - Signalized Intersection

Safety Concerns

WESTERN SECTION

The severity of most crashes in the Western Section involved a mix of non-fatal injuries and property damage only, but the intersection at Grafton Street had one recorded fatal crash in the four-year study period. Throughout this portion of the corridor, angle and rear-end crashes were the most common type of crashes, making up 37% and 38% of total crashes, respectively. Following too closely, failure to yield the right of way, and inattention were the most common causes of crashes in the study area.

SIGNALIZED INTERSECTIONS

As shown in **Table 12**, two out of the three signalized intersections in the western section of the study area, Route 20 at Lake Street and Route 20 at Grafton Street, are high crash locations. At the Route 20 and Lake Street intersection, angle and rear end crashes comprised 34% and 51%, respectively, of the total crashes experienced at this location. At the Route 20 and Grafton Street intersection, angle and rear end crashes comprised 58% and 19%, respectively, of the total crashes at this location. It should be noted that Road Safety Audits (RSA's) have been conducted at both intersections and intersection improvement projects are under way to mitigate many of the safety concerns. For more information on the RSA's, please see the Field Visits and Road Safety Audits section.

UNSIGNALIZED INTERSECTIONS

The most common type of crash experienced at the unsignalized intersections in the western section of the study area was the rear-end crash. Rear-end crashes comprised 36% to 76% of total crashes experienced at all unsignalized locations, with Route 20 at Stoney Hill Road (West) seeing the highest number of rear ends. The most common reported cause for the rear-end crashes at this intersection was due to slowing traffic on Route 20, to turn left into Stoney Hill Road, or to allow a vehicle to exit Stoney Hill Road.

EASTERN SECTION

Table 13, for the Eastern Section, shows a similar mix of non-fatal injury and property-damage only crashes as the western section, but experienced no fatal crashes. Throughout this portion of the corridor, angle and rear-end crashes were the most common crashes at 41% each for both unsignalized and signalized intersections. Running the red light, following too closely, and failure to yield right of way were the most common causes for the crashes within the study area.

SIGNALIZED INTERSECTIONS

The two signalized intersections in this portion of the study area, Route 20 at Centech Boulevard/Cherry Street and Route 20 at Green Street/South Street, experienced a low number of crashes when compared to the signalized intersections in the western section. At the Route 20 and Centech Boulevard/Cherry Street intersection, angle crashes were the most common type of crash, comprising 50% of all crashes at this location. At the Route 20 and Green Street/South Street intersection, rear-end crashes were the most common type of crash, comprising 54% of all crashes at this location.

UNSIGNALIZED INTERSECTIONS

There were three intersections within the eastern section of the study area that experienced more crashes when compared to the rest of the intersections in both the western and eastern sections; Route 20 at South Street, Route 20 at Walnut Street, and Route 20 at Old Shrewsbury Village Driveway/Valente Drive. Angle crashes were predominant at all three intersections, comprising 38%, 67%, and 73% respectively. Detailed crash data, crash rate worksheets, and collision diagrams can be found in **Appendix C.**

Field Visits and Road Safety Audits

FIELD VISITS

HSH conducted a field visit with the Town of Shrewsbury Police and MassDOT District 3 personnel, in June 2017, visiting all study area intersections in the Eastern Section. While on site, the general observation was that, during the a.m. and p.m. peak hours, unsignalized side streets and driveways off Route 20 cannot find gaps on the Route 20 mainline traffic to enter Route 20 safely. It was also noted that, when attempting to exit Walnut Street South, there is poor visibility when looking for on-coming traffic from Route 20 westbound, most likely due to the vertical crest curve that exists at the Route 20/Old Shrewsbury Village/Valente Drive intersection.

Signalized intersection on Route 20 at South Street and Green Street.

HSH also conducted a field visit at all study area intersections in the Western Section, in June 2019. The same issue of side street traffic not finding safe gaps to enter Route 20 was present in this section. In addition, it was observed that drivers at signalized intersections would routinely speed up to go through the yellow, and sometimes, the red interval to avoid waiting at the intersection.

ROAD SAFETY AUDITS

A Road Safety Audit (RSA) conducted at the Route 20/ Grafton Street intersection in April 2015 found that the majority of crashes occurring at this intersection were caused by outdated signal equipment, phasing and timing; lack of left-turn lanes on Route 20; numerous driveways adjacent to the intersection; and a right-lane trap created by the Route 140 on-ramp to the east of the intersection. Furthermore, though no pedestrian-related crashes occurred, the RSA mentions that pedestrians were observed crossing Route 20 at this intersection to go from Flynn's Truck Stop and its parking lot to Brody's Diner and back. The Route 20/ Grafton Street intersection doesn't provide marked crosswalks or a pedestrian signal/phase, presenting a major safety concern, as Route 20 traffic is heavy during the peak hours and speeding is an issue.

Another RSA conducted at the Route 20/Lake Street intersection in July 2019, also found that the outdated signal equipment, timing, and phasing were the reasons for most crashes that occurred at this intersection. Blocked/limited sight distances due to utility poles on Route 20, the merge on Route 20 westbound west of the intersection, and the numerous curb cuts adjacent to the intersection were additional reasons cited as causes for the crashes at this intersection.