Chapter 2 Existing Conditions and Issues Evaluation

An understanding of study area conditions, both now and in the future, provides the basis for development and evaluation of alternatives to address future needs within the study area. The analysis conducted for this study shows that there are multiple traffic capacity and safety issues within the study area on the I-495 mainline and Route 9 and I-90 interchange ramps, as well as within the Route 9 corridor. The expected growth in population and employment in the area will generate additional traffic, exacerbating already congested conditions. Key findings regarding the study area include the following:

Economic Development

The area in Westborough and Southborough around the I-495/ Route 9 Interchange is a regional employment center with large office/industrial parks and significant areas of land with potential for future development and redevelopment. The ability of the transportation infrastructure to support this desired development is a key factor in achieving these economic development objectives.

Highway and Interchange Ramps

I-495 and Route 9 carry high peak period commuter traffic volumes, with the worst traffic conditions occurring in the peak travel direction. Today, I-495 northbound between Route 9 and I-90 as well as Route 9 westbound west of I-495 operate at deficient conditions in the morning peak. In the evening, the pattern is reversed, with I-495 southbound between Route 9 and I-90 as well as Route 9 eastbound west of I-495 operating at deficient levels. The interchange ramps with the worst traffic problems are the I-495 southbound off-ramp to Route 9 westbound and the I-495 northbound off-ramp to I-90. Traffic operations on the highway mainline and ramps will get worse by 2035 based on the projected growth in traffic.

Intersections

Each of the signalized intersections west of I-495 currently operates at acceptable conditions overall in both peak hours. However, there are individual movements that operate deficiently. During the morning peak hour, the Route 9 northbound left turn onto Computer Drive and southbound left turn on Connector Road onto Research Drive experience long queues of over 500 feet. The northbound Friberg Parkway approach to Research Drive operates at a deficient level with long queues in the evening peak hour. On Route 9 east of I-495, long vehicle queues are experienced on the Route 9 eastbound and westbound approaches to Crystal Pond Road for both the morning and evening peak hours. Future traffic volumes will generally increase vehicle delay and queuing at most study intersections.

Highway Geometry

None of the I-495/Route 9 and I-495/I-90 ramps, nor the four weaving areas on I-495 at the Route 9 interchange, meet current highway design speed standards. The acceleration lane distance for the I-90 on-ramp to I-495 northbound is also substandard. There are weaving, queuing, and signage issues at the I-90 toll plaza. On Route 9, there are sight distance issues for Route 9 eastbound approaching Crystal Pond Road and sub-standard driveway spacing for businesses on Route 9 westbound east of I-495.

Safety

The I-495 off-ramps to I-90 are a long-standing Top 60 Crash Location, with 208 crashes recorded between 2007-2009. About half were rear-end crashes. During that same time period, I-495/Route 9 had 106 crashes, with most on I-495 southbound to Route 9 westbound. Route 9 Eastbound at Crystal Pond road had 28 crashes, with 90 percent rear-end crashes.

Transit

There are few options besides travelling by automobile in the study area. The study area is located on the boundary of two Regional Transit Authority (RTA) service areas. Westborough is in the Worcester RTA and Southborough in the MetroWest RTA. Neither currently provides any fixed-route service in the study area, although the WRTA is planning on starting a shuttle service from the MBTA commuter rail station in Westborough to business parks on Route 9, and the MWRTA is planning on expanding their Route I Green Shuttle from its current terminus in Framingham to the Westborough Technology Park. The MBTA provides commuter rail service on the Worcester Line, with existing station stops in Westborough and Southborough, but there are a limited number of trains that could serve reverse commutes. The MetroWest/495 Transportation Management Association (TMA) promotes carpooling, vanpooling, taking public transit, biking, and walking to work for employees of their member companies in MetroWest.

Environmental Constraints

A review of the environmental conditions within the study area shows few environmental constraints in the vicinity of the I-495/Route 9 interchange and along Route 9 between Connector Road on the west and Crystal Pond Road on the east. There are some areas of wetlands on the north and south sides of Route 9 to the east of Crystal Pond Road. The I-495/I-90 interchange is located within the Cedar Swamp Area of Critical Environmental Concern (ACEC) that contains multiple environmental resource areas (protected species habitat, wetlands, water resources and water supply, and archeological sites) that pose constraints on potential improvement alternatives.

The following sections of this chapter describe the existing transportation, socioeconomic, land use, and environmental conditions within the study area in more detail. Future year conditions forecasted for the year 2035 are also presented. Deficiencies and issues are identified, including current and future traffic congestion, safety issues, land use and economic development, transit, and environmental issues.

2.1 Socioeconomic Conditions

Population and employment directly affect transportation demand. An understanding of existing conditions and growth trends for these factors provides the context for identifying future travel demand within the region served by I-495 and its interchanges with I-90 and Route 9.

2.1-1 Regional Context

A recent report sponsored by the 495/MetroWest Partnership examined the importance of the 495/MetroWest region to the Massachusetts economy, examined its strengths and competitiveness, and identified information technologies and advanced manufacturing as the key industries to be supported

cthrough economic development policies and investments.[1] This report examines 2002 to 2009 population, technology-based industry clusters, new business start-ups, productivity, and exports, and also profiles recent trends in regional employment, unemployment, and housing. The 495/MetroWest regional characteristics that follow provide appropriate context for subsequent descriptions of the socioeconomic conditions and projections, as well as existing and proposed development within the communities of Westborough and Southborough and the Study Area.

- The 495/MetroWest region has nearly 540,000 residents, slightly more than 8 percent of the total Massachusetts population, with high levels of educational attainment, median household incomes that exceed the statewide average, and below average unemployment.

- The 32 communities in the 495/MetroWest corridor have 18,000 businesses that collectively employ nearly 289,000 workers in diverse industries, with high concentrations of the workforce in professional services, information technologies, manufacturing, arts and entertainment.

- Payroll earnings, population growth, and unemployment rates exceed state and national averages; manufacturing, retail, health care, professional and technical services are the largest employment sectors; and the fastest job growth occupations have higher payroll earnings.

- Between 2008 and 2009, the region's population grew 1.7 percent, outpacing both the Commonwealth and the nation; and the fastest growth rates were generally to the west along the Interstate-495 beltway.

- The region has an estimated 465 businesses that each employs at least 100 workers, including EMC Corp. (5,000) in Hopkinton and Southborough and Global Investment Servicing (2,000) in Westborough. Twelve municipalities added net jobs in 2009, including Southborough. Westborough was one of five communities that experienced net job losses.

- The region's average payroll earnings were slightly more than $60,000, which was $4,000 higher than the state and $15,000 higher than the national averages; since 2000, the region had lower real wage growth than the Commonwealth or the nation.

- The largest employers established in the region cluster along major roadways with the largest concentration located in closest proximity to Boston along the Massachusetts Turnpike (I-90) and State Route 9. All 10 of the largest employer establishments in the region are located along or near the I-90 corridor.

- The region has concentrations of workers in some high-paying occupations (e.g. management of companies, professional services, information services) but is under-represented in other high-paying sectors (e.g. finance, insurance), and has many workers in low-paying retail jobs.

- Manufacturing remained the region's largest employing sector, representing 14 percent of the employment base in 2009, and the fastest job growth sectors had been arts, entertainment and recreation (33 percent), health care (21 percent), and professional services (20 percent).

- The region has a high concentration of employment in computer & electronics equipment, precision instruments, pharmaceuticals, medical instruments, and information services

[1] *Economic, Demographic and Housing Trends in 495/ MetroWest Region,* Henry Renski, Ph.D. and Kim McKee, UMass Amherst Center for Economic Development, Department of Landscape Architecture and Regional Planning (2010).

technologies; pharmaceuticals and information services technologies had the fastest employment growth of eight technology clusters.

- In 2009, the region accounted for almost 6 percent of all new business filings in the Commonwealth, an important indicator of entrepreneurial energy, and new businesses closely mirrored existing employment patterns led by Framingham, Natick and Marlborough.

2.1.2 Demographic Characteristics and Population Growth

Existing and near term (2016) population and household estimates are presented in Table 2.1-1. The population in Westborough is projected to reach 21,100 persons in 2035 (a 15 percent increase over the 18,272 persons in 2010), and the number of households is projected to grow from 7,030 in 2010 to 8,500 in 2035 (a 21 percent increase))[2] The 2035 population in Southborough is projected to reach 10,868 persons (an 11 percent increase over the 9,766 persons in 2010), and the number of households is projected to grow from 3,463 in 2010 to 3,953 in 2035 (a 14 percent increase)[3].

Table 2.1-1: Interstate 495/Route 9 Interchange Study Area Population & Households Summary

	One-Mile Study Area	Town of Southborough	Town of Westborough
Population			
2016 Projection	2,170	10,258	20,045
2011 Estimate	2,088	9,679	19,324
2000 Census	1,938	8,424	17,969
1990 Census	1,337	6,325	14,126
Projected Growth 2011 - 2016	3.93%	5.98%	3.73%
Estimated Growth 2000 - 2011	7.74%	14.90%	7.54%
Growth 1990 - 2000	44.95%	33.19%	27.21%
2011 Estimated Median Age	35.8	37.7	39.3
Households			
2016 Projection	691	3,295	6,937
2011 Estimate	678	3,168	6,836
2000 Census	644	2,820	6,525
1990 Census	462	2,172	5,390
Projected Growth 2011 - 2016	1.92%	4.01%	1.48%
Estimated Growth 2000 - 2011	5.28%	12.34%	4.77%
Growth 1990 - 2000	39.39%	29.83%	21.06%
Average Household Size	3.1	3.0	2.7

Source: Nielson *Claritas SiteReports* 2011 and FXM Associates

Annual median income of households in Westborough and Southborough is $112,280, and 32 percent of Westborough and Southborough households had household income of more than $150,000.

[2] Central Massachusetts Metropolitan Planning Organizations, *Regional Transportation Plan 2012.*
[3] Metropolitan Area Planning Council, MetroFuture 2035 Update, March 2011.

Approximately 97 percent of Westborough and Southborough residents age 25 and older had education levels of high school level or above, and 65 percent had a Bachelor Degree or higher.[4]

The labor force in Westborough and Southborough had approximately 21,850 residents aged 16 and older, with about 14,410 working in private sector jobs (73 percent), and 1,284 self-employed (11 percent). Occupations with relatively large numbers of employed residents included: Management (2,828), Sales Related (1,540), Office/Administration Support (1,528), Computer/Mathematical (1,106), Health Practitioner/ Technician (1,095) and Business/Financial Operations (1,043). By occupation classification, an estimated 11,840 residents in Westborough Southborough held White-Collar jobs (82 percent), 1,221 had Blue-collar jobs, and 1,351 had Service and Farm jobs, and the average travel time to work was 32 minutes.[5]

Additional demographic information may be found in Appendix B.

2.1.3 Environmental Justice Communities

Federal Executive Order (EO) 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, dated February 11, 1994, calls on federal agencies to identify and address disproportionately high and adverse human health or environmental effects of federal programs, policies, and activities on minority and low-income populations [termed here "Environmental Justice (EJ) Communities"]. In 1997, the U.S. Department of Transportation (USDOT) issued an order to establish procedures for use in complying with EO 12898 for its operating administrations, including the Federal Highway Administration (FHWA). The USDOT Order defines key terms and provides guidance for identifying and addressing disproportionately high and adverse impacts on minority or low-income populations. If such impacts would result from the proposed action, mitigation measures or alternatives must be developed to avoid or reduce the impacts, unless the agency finds that such measures are not practicable. The only Environmental Justice community that has been identified in proximity to the study area is located in Westborough, in the area of the Windsor Ridge Apartment complex near the intersection of Computer Drive and Connector Road, abutting the western edge of the study area.

2.1.4 Business Activity and Employment Growth

In 2011, the Study Area contained an estimated 307 business establishments that employed about 13,850 workers, and generated almost $1.8 Billion in estimated 2011 annual sales. Industry sectors with the largest number of employees included:

- Security & Commodity Broker Services (2,701),
- Home Furnishings & Furniture (1,710),
- Chemicals & Allied Products (1,501), and
- Business Services (1,508).

Westborough and Southborough overall had an estimated 1,783 business establishments, 1,305 in Westborough and 478 in Southborough, employing almost 31,200 workers and generating nearly $3.7 Billion in 2011 annual sales. Businesses in Westborough provided 26,155 jobs, and Southborough establishments had 5,137 jobs. Industry sectors with the largest number of employees in the two towns included:

- Security, Commodity Brokers Services (2,874),

[4] Nielsen *Claritas SiteReports*, 2011 and FXM Associates
[5] Nielsen *Claritas SiteReports*, 2011 and FXM Associates

- Business Services (2,439),
- Health Services (2,489), and
- Engineering, Architectural, Research/Management (1,880).

Employment projections for Westborough and Southborough for 2035 provided in the Central Massachusetts Metropolitan Planning Organization (CMMPO) and Boston Region MPO Regional Transportation Plans (RTP) are shown in Table 2.1-2. The projections are based upon the land use for 2035 that was adopted by the MPOs and their member communities. An alternate future development scenario was developed through the 495/MetroWest Development Compact Plan[6], whereby the area around the I-495/Route 9 interchange has been designated as a Regionally Significant Priority Development Area (PDA) (See Figures 2.2-2 and 2.2-3 for the PDA boundaries). This PDA scenario would focus development and employment in areas that currently have the infrastructure to support additional economic growth, thereby increasing the concentration of employment in this area.

Table 2.1-2: Employment Projections

	2010	2035 RTP Projections			2035 PDA Projections		
		Employment	Change 2010-2035	Percent Change	Employment	Change 2010-2035	Percent Change
Southborough	**6,963**	**7,688**	**725**	**9%**	**9,064**	**2,101**	**30%**
Westborough	**22,767**	**27,690**	**4,923**	**22%**	**28,311**	**5,544**	**24%**
Total	**29,730**	**35,378**	**5,648**	**19%**	**37,375**	**7,645**	**26%**

Source: CMRPC and the Central Transportation Planning Staff (CTPS), 2009

Table 2.1-3: Interstate 495/Route 9 Interchange Study Area – Industries Overview

		One-Mile Study Area		Interchange Project Area	
2 Digit SIC	**Industry Sectors**	**Number of Businesses**	**Number of Jobs**	**Number of Businesses**	**Number of Jobs**
	All Industries	307	13,849	1,783	31,292
20-39	Manufacturing	26	2,054	88	4,052
50-51	Wholesale Trade	24	267	82	956
52-59	Retail Trade	37	2,820	322	6,574
60-65	Finance, Insurance, Real Estate	55	3,160	212	4,412
70-89	Services	128	3,518	1,253	11,418
91-99	Public Administration	0	0	47	509

Source: Nielson *Claritas Site Reports* 2011 and FXM Associates

[6]. The 495/MetroWest Development Compact created a shared framework for state, regional, and local strategies and decisions regarding land use regulation and infrastructure investment over the next twenty years for Westborough, Southborough, Hopkinton, and 34 other constituent municipalities. A key component of the plan identifies regional priorities for development, land preservation, transportation and other public and private infrastructure investments. As defined in the plan, Priority Development Areas (PDA) are potentially capable of supporting additional development or redevelopment, and may require additional infrastructure investments. Generally, PDAs are characterized by good access, available infrastructure (primarily water and sewer), and an absence of environmental constraints. *495/MetroWest Development Compact Plan,* March 2012. Materials at I495 MetroWest Development Compact

2.2 Land Use and Development

2.2.1 Existing Land Use

As shown in Figure 2.2-1, commercial and industrial land uses are concentrated along Route 9 in Westborough and Southborough and along Flanders Road in Westborough. Approximately 3 percent of the Study Area is occupied by Commercial and 11 percent by Industrial land uses. Residential uses also comprise 11 percent of the study area, with another 7 percent dedicated to miscellaneous uses such as transportation and utility uses. A large portion (68 percent) of the study area is open land, including environmentally-sensitive areas such as Cedar Swamp. (See Section 2.3 for a discussion of environmental resources in the study area.)

Much of the commercial and industrial land uses in Westborough to the west of I-495 are found in office/industrial parks accessed from Route 9 via its interchange with Computer and Research Drives (See Figure 2.2-2). To the east of I-495, commercial and industrial uses include the EMC campus in Southborough accessed directly from Route 9 via Coslin Drive or Crystal Pond Road, and the former Verizon facility (now serving as distribution facility for Ken's Foods) with direct access to Route.9. There are also a number of smaller office and retail establishments along Route 9 in Southborough with direct curb-cut access to Route 9 (See Figure 2.2-3).

2.2.2 Proposed Development

Among the proposed major developments within the study area is the expansion of the existing EMC Campus in Southborough to include 2.2 million square feet (SF) of new and renovated research and development and office space on 445 acres of land in Southborough and Westborough. Additional access to the site would be provided from Flanders Road. A Final Environmental Impact Report on the project was completed in 2007, and the project is currently on-hold due to current economic conditions. Another 1.2 million SF of commercial office space is in the planning stage for a site on West Park Drive within the Westborough Office Park.

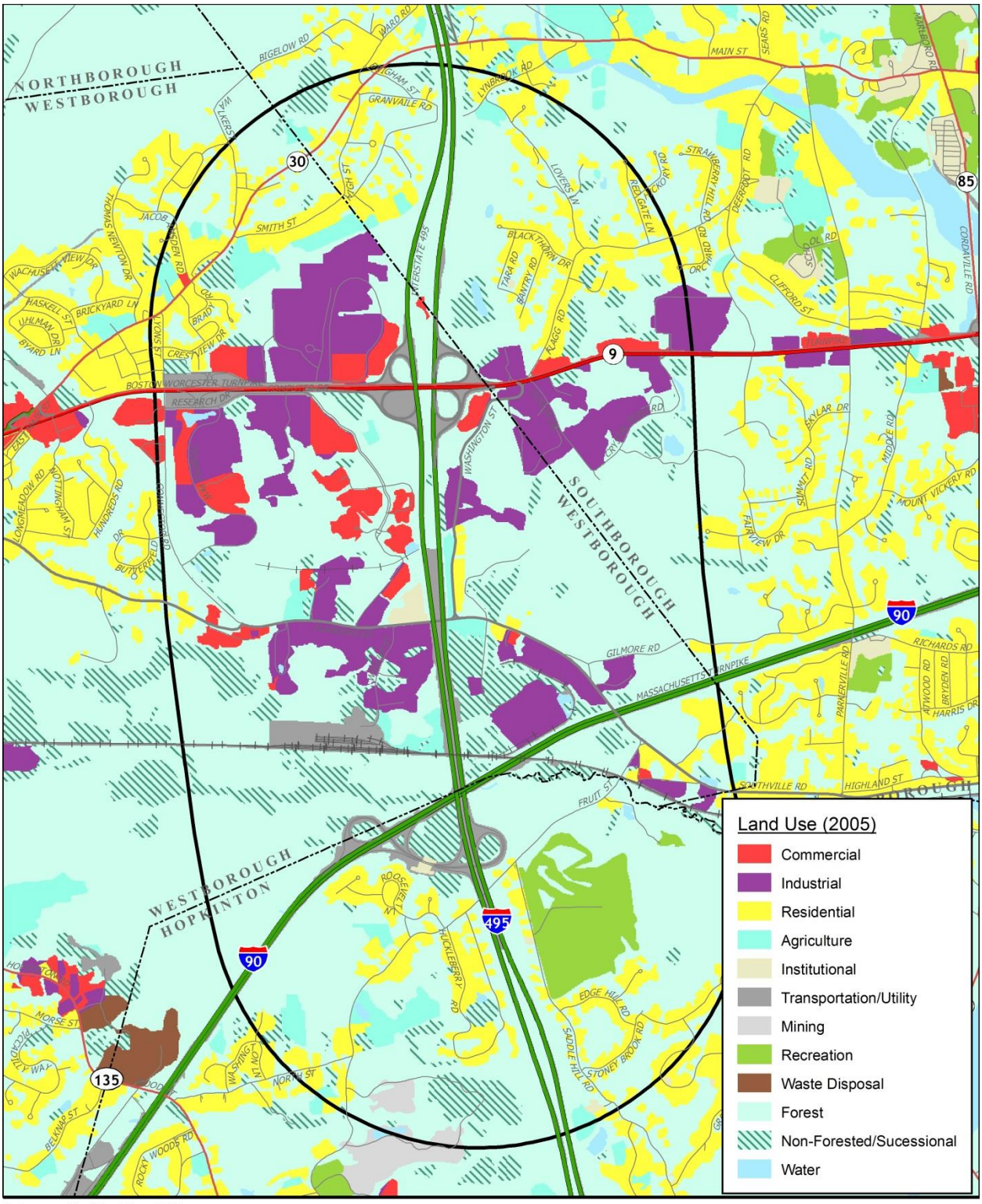
The area around the I-495/Route 9 interchange has been designated as a Regionally Significant Priority Development Area (PDA) by the recently completed 495/MetroWest Development Compact Plan (See Figures 2.2-2 and 2.2-3 for the PDA boundaries).

2.2.3 Commercial Real Estate Market Conditions and Trends

An analysis of existing and projected changes in the commercial real estate market was developed based on 4th Quarter 2011 data and projections through the 4th quarter of 2013[7].

[7] From Co Star *Property Information Systems*, a proprietary subscription data service that includes the most comprehensive listing available of properties and transactions. Analysis conducted by FXM Associates.

Figure 2.2-1: 2005 Land Use



Data provided by MassGIS

0 0.5 1
Miles

Figure 2.2-2: Land Use – West of I-495

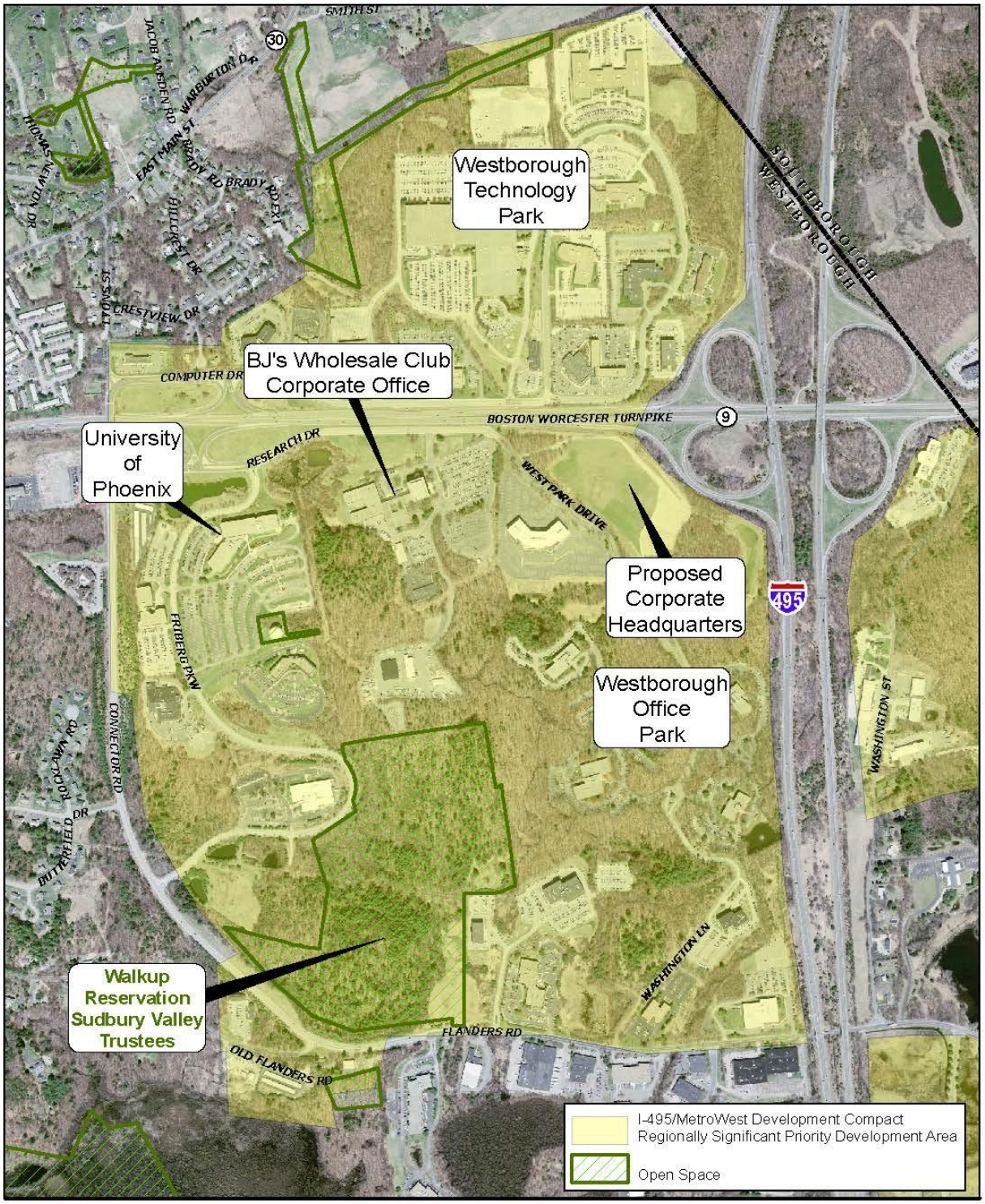
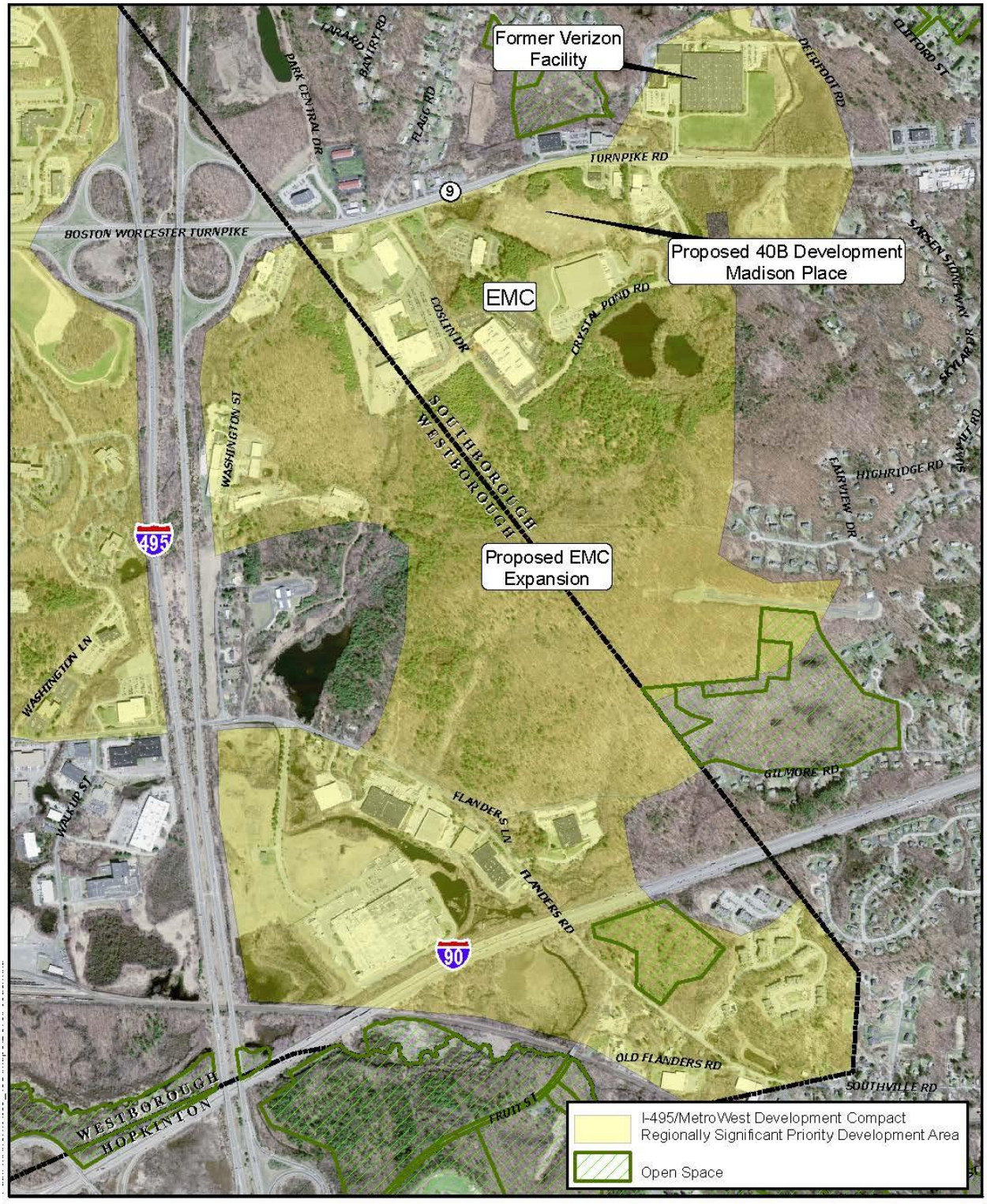


Figure 2.2-3: Land Use – East of I-495



Data provided by MassGIS and MassDOT.

0 1,000 2,000
Feet

The following text table and subsequent bullet points summarize the previous analyses.

Table 2.2-1: Conditions & Trends in Office, Industrial, and Flex Space – Westborough & Southborough, 2011-2016

Space Type	Office	Industrial	Flex	Totals
Total Inventory 2011 (SF)	5,722,800	4,406,600	1,495,300	11,624,700
Forecast Inventory 2013 (SF)	5,722,800	4,406,600	1,495,300	11,624,700
Projected 5 year Net Absorption	483,880	(266,880)	13,100	230,100
Vacancies 2011 (SF)	525,200	740,300	225,600	1,491,100
Percent Vacant	9%	17%	15%	

The following are the key findings from this analysis:

- Due to the economic climate created by the 2008 recession, available commercial and industrial space exceeds the projected short-term (2011-2016) demand.
- Vacancies in industrial space are expected to increase by 267,000 SF between 2011 and 2016.
- Vacancies in office and flex space are projected to decrease by 497,000 SF between 2011 and 2016.

Additional space demand based on RTP employment forecasts is approximately 300-400,000 SF between 2011 and 2016. This employment-driven space demand projection is also substantially less than the reported 2011 vacancies of 1,491,000 SF. However, long-term (2035) employment forecasts of a 19 percent increase in employment based on the RTP forecasts, and a 26 percent increase based on the PDA growth scenario suggest that over the long term, there will be a demand for additional commercial space in Westborough and Southborough.

2.3 Environmental Conditions

This section describes the existing environmental conditions for the I-495/Route 9 interchange and I-495/I-90 interchange study area. Review of the environmental conditions within the study area shows few environmental constraints in the vicinity of the I-495/Route 9 interchange and along Route 9 between Connector Road on the west and Crystal Pond Road on the east. There are some areas of wetlands on the north and south sides of Route 9 to the east of Crystal Pond Road. The I-495/I-90 interchange however, is located within the Cedar Swamp Area of Critical Environmental Concern (ACEC) that contains multiple resource areas (protected species habitat, wetlands, water resources and water supply, and archeological sites) that pose constraints on potential improvement alternatives. The potential for environmental impacts relative to these resource areas will be a consideration for any alternatives for improvements to this interchange.

2.3.1 Wetlands and Water Resources

Wetlands

MassDEP mapping[8] was used to identify wetland resource areas, as well as floodplain and riverfront protection areas (where appropriate) in the vicinity of the interchanges. Wetlands within the study area

[8] Massachusetts Department of Environmental Protection (DEP) Wetlands, MassGIS, January 2009.

are classified as scrub-shrub, shallow marsh meadow or fen, wooded swamp deciduous, wooded swamp mixed trees and deep marshes, depending on the type of dominant vegetation and flooding regime within the wetland. Wetland classifications are used to define habitat type and identify functional values associated with the wetlands for environmental impact assessments and permitting.

The area around the I-495/Route 9 interchange contains scattered wetlands classified as scrub-shrub, shallow marsh meadow or fen, wooded swamp deciduous, wooded swamp mixed trees and deep marshes. An area of wooded swamp wetland (4 acres) is located approximately 240 feet from I-495 northbound off-ramp to Route 9 east. Small areas of wetlands are located on either side of Route 9 between the I-495 northbound and southbound mainlines. The area of wetlands north of Route 9 is 1 acre and is approximately 150 feet from the ramps. The other area of wetlands south of Route 9 is 0.5 acre and is approximately 500 feet from the I-495 off-ramp to Route 9 east. Another area of wooded swamp deciduous wetlands abut Technology Drive and is located within 100 feet of Exit 23 B and the I-495 southbound off-ramp to Route 9 west. Other areas of wetlands are scattered along both sides of Route 9 on the east and on Research Drive (See Figure 2.3-1).

The area around the I-495/I-90 interchange contains large areas of wetlands associated with the Sudbury River and Cedar Swamp. An area of wetlands (18.15 acres) with a mix of scrub-shrub swamp, shallow marshes, and wooded swamp deciduous abut I-495 southbound off-ramp to I-90 eastbound. Other areas of wetlands that are located near the interchange abut the I-90 westbound and eastbound off-ramps to I-495. Similarly, a scrub-shrub swamp wetland of 3.6 acres abuts I-495 northbound off-ramp. A large body of wetlands abuts the I-90 westbound on-ramps on the north, I-90 mainline to the southwest and Framingham-Worcester Commuter Line to the northeast of the interchange. Smaller areas of wetlands are also found scattered on both sides of I-90 mainlines to the northeast (See Figure 2.3-1).

Waterbodies and Floodplains

There are no water bodies in the immediate vicinity of the I-495/Route 9 interchange. The closest open water body is located approximately 0.15 miles to the northeast of the Route 9 westbound on-ramp to I-95 north ramp. Crystal Lake is located to the east of Crystal Pond Road near the eastern boundary of the study area. Other water bodies in the study area are located near West Park Drive and Friberg Parkway to the southwest of the interchange, and at Research Drive on the west. The I-495/Route 9 interchange does not lie in a floodplain. The closest floodplain is the X500-floodplain that abuts Technology Drive and the Westborough/Southborough town line, approximately 0.15 miles northwest of the interchange.

The I-495/I-90 interchange lies in the Sudbury River Drainage Basin (part of the larger SuAsCO River Basin). The Sudbury River begins in Cedar Swamp near the Hopkinton border. The I-495 mainline crosses over the Sudbury River just north of I-90. The I-90 mainline also crosses the Sudbury River just east of I-495. The regulations of the Massachusetts Surface Water Quality Standards (314 CMR 4.00) classify the Sudbury River and associated wetlands as “Outstanding Resource Waters”, from its source in Cedar Swamp to the Fruit Street Bridge in Hopkinton. Massachusetts Surface Water Quality Standards (314 CMR 4.00), requires that the quality of these waters be protected and maintained. Any potential discharge of dredge or fill material and stormwater runoff associated with proposed changes to the I-495/I-90 Interchange would be regulated under 314 CMR 4,00 and mitigation measures would need to be employed to maintain water quality standards.

There are also numerous perennial and intermittent streams within the one mile study area of the interchange. Most drain into Cedar Swamp and all are relatively shallow and narrow. These streams are

designated as a habitat for fish, other aquatic life, and wildlife, and for primary and secondary contact recreation (Class B water quality).[9]

According to the MassGIS mapping, the I-495/I-90 interchange study area lies in "A" and "AE" flood zones.[10] The "A" and "AE" flood zones abut I-90 westbound on-ramp; I-495 mainlines immediately north of the interchange and I-90 mainlines to the southwest and northeast of the interchange (approximately 0.25 miles from the interchange).

2.3.2 Aquifers and Water Supply

Water supply resources were identified, including aquifers, Massachusetts Department of Environmental Protection (DEP) well-head protection areas for public groundwater supplies, municipal groundwater wells and surface water supplies.[11]

The I-495/Route 9 interchange does not lie within an aquifer. There are no other aquifers within one mile of the interchange. All reservoirs, including Sudbury reservoir are located outside the study area.

A medium yield aquifer of approximately 36.8 acres abuts the I-90 westbound on- and off-ramps to I-495 at Exit 11A, near the Westborough-Hopkinton town line. Another medium yield aquifer is located to the northeast of the I-495/I-90 interchange abutting I-495 northbound and I-90 westbound mainlines (but not the interchange). It is 65 acres in size and is located approximately 0.27 miles when measured from the I-495 northbound on-ramp. At approximately 0.37 miles to the northeast and within this medium yield aquifer lies a high yield aquifer of about 10 acres. A large medium yield aquifer (450 acres) also exists to the southwest of the interchange approximately 0.20 miles from I-90 eastbound off-ramp.

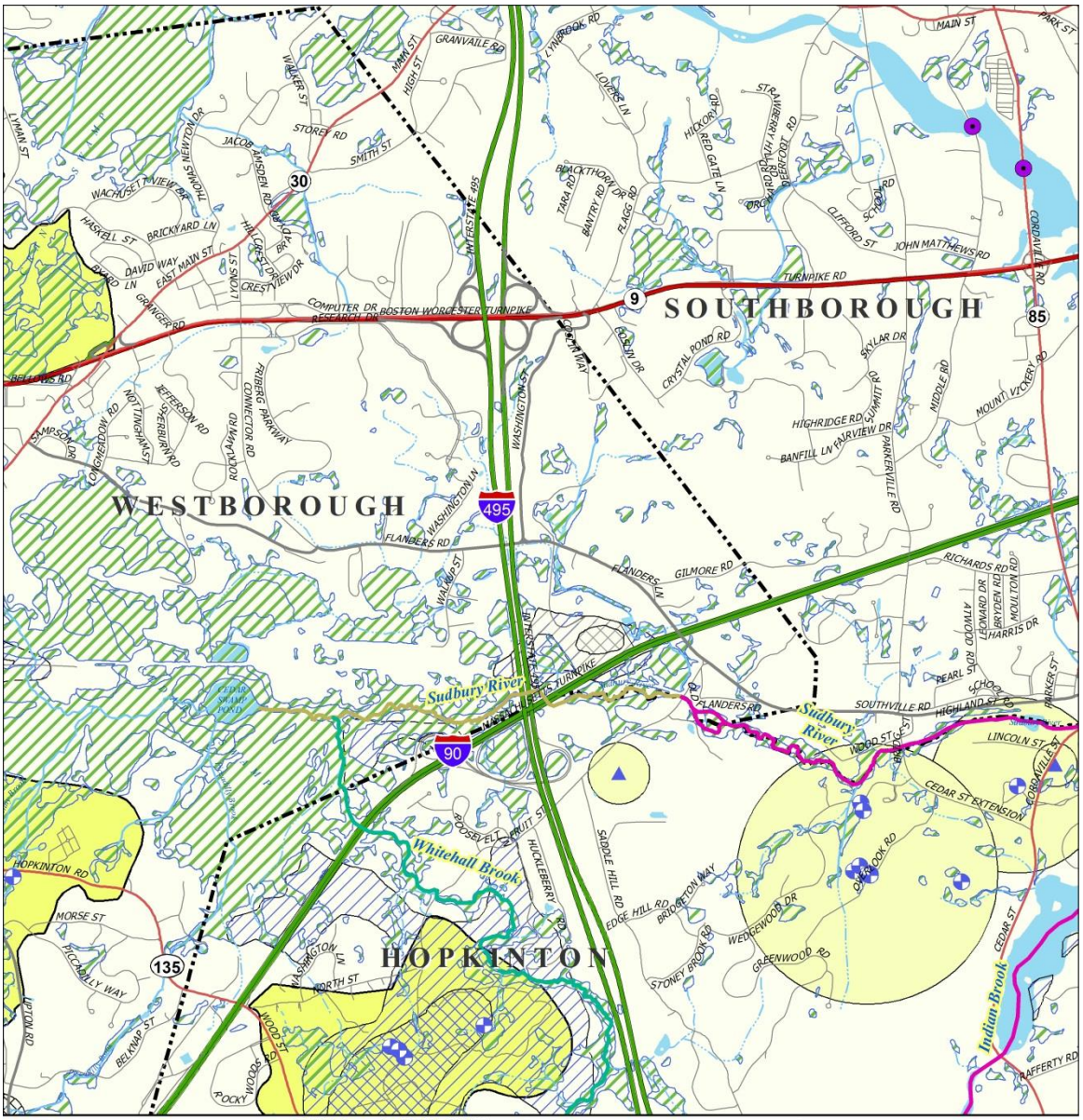
Cedar Swamp forms the headwaters for the Sudbury River. It is an important recharge area for two municipal drinking water wells. There is a DEP approved Zone II wellhead protection area (Zone II) to the southwest of the I-495/I-90 interchange approximately 0.60 miles from the I-90 eastbound off-ramp. Other approved wellhead protection areas lie outside the study area. There are several interim wellhead protection areas (IWPAs) to the southeast of the I-495/I-90 interchange. The closest IWPA lies approximately 330 feet (0.07 mile) from the I-495 northbound off-ramp to I-90. All the wellhead protection areas within the one mile study area are located in the Town of Hopkinton. Certain land uses may be either prohibited or restricted in both approved (Zone IIs) and interim (IWPA) wellhead protection areas. Zone II is the primary groundwater recharge area for the public wells, and includes areas that contribute water to the public wells under the most severe pumping conditions. As shown in Figure 2.3-1, there are several community groundwater wells in the wellhead protection areas, particularly to the southeast of the interchange.

[9] Town of Westborough, Massachusetts. 2003 Open Space and Recreation Plan. Chapters 4 and 5.

[10] "A" flood zones are 100 year flood zones that are prevalent in inland areas, especially within the extensive linear floodplains and bottomlands adjacent to rivers and streams. "AE' flood zones are areas that are inundated by 100-year flooding, for which Base Flood Elevations (BFEs) have been determined.

[11] Massachusetts Department of Environmental Protection (DEP), Water Supplies, MassGIS, July 2009; Surface Water Protection Areas, MassGIS, April 2009; DEP Approved Zone II, MassGIS, July 2011; Interim Wellhead Protection Area (IWPA), MassGIS, July 2011; Aquifers, MassGIS, July 2007; Non-Potential Drinking Water Source Areas (NPDWSA); July 2011.

Figure 2.3-1: Water Resources



2.3.3 Wildlife Habitats and Endangered Species

Wildlife habitats in the vicinity of the study area were indentified through Natural Heritage and Endangered Species Program (NHESP) priority and estimated habitats, potential and certified vernal pools mapping, Biomaps and other available through MassGIS.[12] Westborough has a series of habitat islands with an increased proportion of edge habitat. The remaining large habitat islands are mostly wetlands. Rivers and streams provide the best remaining linkages among these habitat islands.

According to the 2009 Open Space and Recreational Plan of Town of Southborough, the I-495/Route 9 interchange abuts an area of NHESP priority habitat for rare species.[13] This area of priority habitat is divided by Westborough – Southborough town line. Certain species of plants and animals are becoming rare in the priority habitat areas due to development pressures. Some of these species include the spotted turtle, wood turtle, and the triangle floater. There are no estimated habitats near the I-495/Route 9 interchange.

There are four NHESP certified vernal pools in the I-495/Route 9 Interchange area, although the potential exists for additional vernal pools in the area. Three certified vernal pools are located in the Technology Drive vicinity, approximately 0.20 miles to the northwest of I-495 southbound off-ramp. The fourth certified vernal pool is located at Friberg Parkway to the southeast of the interchange.

There is a large area of NHESP priority habitats for rare species and estimated habitats for rare wildlife in the study area of I-495/I-90 interchange. These habitat areas are found in the Cedar Swamp ACEC, extending on both sides of the Framingham-Worcester Commuter Train Line and abutting I-495 southbound mainline, I-90 westbound on- and off-ramps, and I-90 westbound mainline. The MA NHESP lists two records of rare vertebrates and two rare invertebrates in this area in Westborough.

The I-495/I-90 interchange area contains numerous potential vernal pools concentrated mostly in the Cedar Swamp west of I-495. There are six NHESP certified vernal pools in the study area; however, none of these vernal pools abuts the interchange. Three of the certified vernal pools are located approximately 0.45 miles to the northwest of the interchange between Flanders Road and Framingham-Worcester Commuter Line. The other three vernal pools are located north of Flanders Road more than 0.75 miles to the northeast of the interchange.

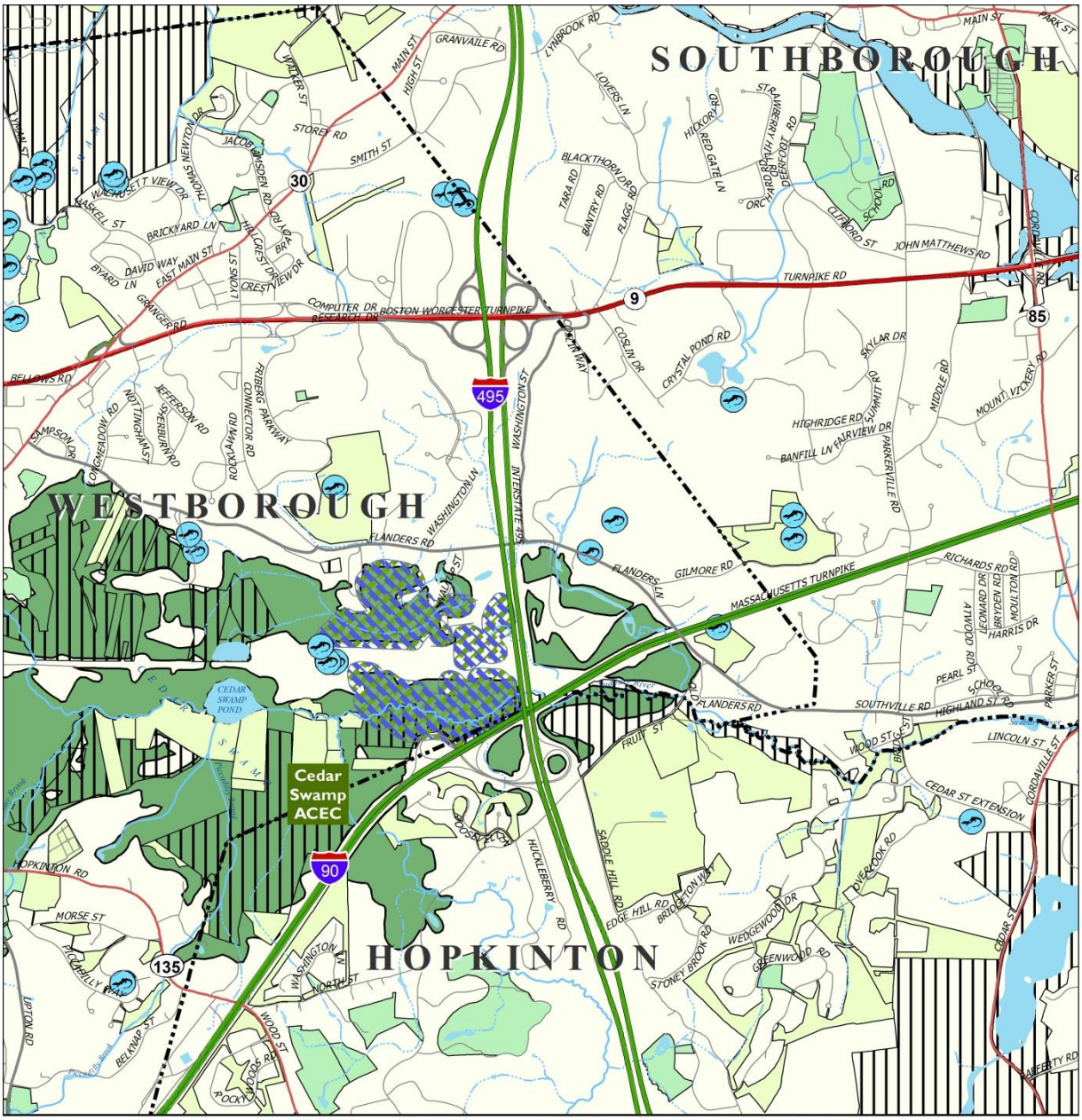
2.3.4 Open Space and Recreation

Area of Critical Environmental Concern

The Cedar Swamp ACEC is located on both sides of I-495 and I-90 and abuts all the ramps of the interchange.[14] Cedar Swamp forms the headwaters for the Sudbury River and is an important recharge area for two municipal drinking water wells. The Cedar Swamp wetland area includes many vernal pools and habitat for Spotted Turtles and Hessel's Hairstreak butterfly. (See Figure 2.3-2)

[12] Massachusetts Division of Fisheries & Wildlife, Natural Heritage and Engandered Species Program, MassGIS; Certified Vernal Pool, MassGIS, April 2012; Habitat, MassGIS, October 2008.
[13] Town of Southborough, Massachusetts. 2009 Open Space and Recreation Plan. Town of Southborough Conservation Plan
[14] Area of Critical Environmental Concern (ACEC) Program, Massachusetts Department of Conservation and Recreation, MassGIS, April 2009.

Figure 2.3-2: Open Space & Endangered Species



Map compiled by AECOM, June 2012
from data supplied by MassGIS.

0 1,500 3,000 6,000
Feet

Open Space and Parkland

Open space, parkland, trails and other recreational sites within the corridor study area were identified.[15] Municipal Open Space and Recreation plans were reviewed to identify these spaces. No open space or recreational areas abut the I-495/Route 9 interchange. The open space and recreational areas within one mile of the I-495/Route 9 interchange are provided below:

- A *Route 9 Conservation Area* owned by Southborough Open Land Foundation is located to the northeast approximately 0.5 miles from the interchange. It is approximately 12 acres in size and is protected and accessible to the public.

- *Crystal Pond*, located in Southborough to the east of the interchange, is considered as a scenic resource. It is approximately 0.35 miles from the interchange.

- *Walkup Robinson Memorial Reservation Park* is located in Westborough abutting Friberg Parkway west of I-495 (approximately 0.6 miles from I-495/Route 9 interchange). It is owned by Sudbury Valley Trustees and is approximately 63 acres. This is a popular walking spot in Westborough. The roadbed of the Boston and Worcester Trolley line runs through here linking this property with the Prentiss Forest Open Space to the west.

- *Data General Center*, a private open space owned by Data General Corporation, is located to the northwest approximately 0.50 miles from the I-495/Route 9 interchange. It is approximately 13 acres in size.

- The Sawink Farm Reservation, owned by Sudbury Valley Trustees, is located near the border of the study area to the northwest approximately one mile from the I-495/Route 9 interchange. Other open space and recreational areas adjacent to Sawink Farm Reservation include Bigelow Property (14 acres, owned by Southborough Open Land Foundation) and Uhlman Farms Center (17 acres, owned by Carrageen Development Corporation).

The I-495/I-90 interchange is abutted on the northwest and northeast along the Westborough-Hopkinton town line by open space associated with the Sudbury River. This open space is owned by Department of Conservation and Recreation (DCR) – Division of Water Supply Protection. To the west of the I-495/I-90 interchange lies the *Cedar Swamp ACEC*. It includes numerous parcels of land owned by DCR – Division of Water Supply Protection and various Land Trusts.

Other open space and recreational areas in proximity to the I-495/I-90 interchange are:

- The *Hopkinton Country Club* (formerly known as Saddle Hill Country Club), a privately owned recreational space, is located to the southeast of the I-495/I-90 interchange in the Town of Hopkinton. It is 130 acres and abuts Saddle Hill Road.
- Another private recreational area called *Southborough Rod and Gun Club* is located adjacent to the Hopkinton Country Club. The Southborough Rod and Gun Club abuts Fruit Street and is approximately 73 acres in size.
- *Roosevelt Farms*, a private farm, owned by Roosevelt Farm Association is located immediately to the southwest of the interchange approximately 200 feet from the I-90 eastbound off-ramp to I-495. It is approximately 33 acres and has limited public access. The Roosevelt Farms abut I-90 eastbound mainline and Fruit Street and has a low density residential development in the middle of the farm area.
- A private park called *EMC* is located in Southborough abutting the Westborough-Southborough town line to the northeast of the I-495/I-90 interchange. It is owned by EMC Corporation and is approximately 39 acres in size.

[15] Open Space, MassGIS, April 2011.

- *Hopkinton Meadow*, another privately owned, open, and recreational space is located to the southwest of the I-495/I-90 interchange bordering I-90 eastbound mainline and North Street. It is approximately 29 acres and is open for public access.

2.3.5 Historic and Archeological Resources

A cultural resource inventory was conducted for the study area using resources at the Massachusetts Historical Commission as well as local historical commissions to identify historic and archaeological resources within the study area.[16]

The I495/I-90 interchange lies within the Cedar Swamp Archaeological District in Westborough and Hopkinton. The Cedar Swamp Archaeological District was placed on the National Register of Historic Places in 1988. During the prehistoric period, the swamp was frequently used by native people because of its rich source of plants and animals. Archaeological research shows 42 separately identified archaeological sites in the Cedar Swamp Archaeological District. It is the second largest such site in the State of Massachusetts. No other historic districts and properties were identified within the 1-mile project Study Area.

2.3.6 Hazardous Materials Sites

Available MassGIS data was used to identify hazardous waste sites that may pose a constraint to the development of transportation alternatives, such as solid waste facilities and DEP Chapter 21E sites.[17] The environmental map shows a Chapter 21E site at 344 Turnpike Road in Southborough (between Coslin Drive and Crystal Pond Road). The name of the site is Cumberland Farms and is approximately 0.45 miles east of the I-495/Route 9 interchange. Chemicals found in the site includes diesel fuel. A 21E site should be handled according to Massachusetts Oil and Hazardous Material Release Prevention Act of Chapter 21E. There are no Chapter 21E sites in the vicinity of I-495/I-90 interchange.

There are also two closed landfills, to the southwest of the I-495/I-90 interchange, located at Route 135/Hopkinton Road on either side of the Westborough-Hopkinton town line. There is one inactive landfill to the northeast of the I-495/Route 9 interchange in Southborough. There no DEP Bureau of Waste Prevention (BWP) major hazardous waste treatment, storage and disposal facilities within the study area.

2.3.7 Air Quality

The 1990 Clean Air Act Amendments (CAAA) mandated that the US Environmental Protection Agency (EPA) designate geographic areas of the country that have measured pollutant concentrations exceeding the levels prescribed by the air quality standards as “non-attainment.” Massachusetts is classified as being in severe nonattainment for the eight-hour ozone standard, defined a 0.08 parts per million of ozone, averaged over eight hours and not to be exceeded more than once per year[18]. The state is divided into two nonattainment areas, and the project Study Area is within the Eastern Massachusetts Non-Attainment Area. As a result of this nonattainment status, the Commonwealth of Massachusetts is required to reduce emissions of volatile organic compounds (VOCs) and nitrogen oxides (NOx), the two

[16] Massachusetts Cultural Resource Information System (MACRIS), Massachusetts Historic Commission, 2012. http://mhc-macris.net/
[17] Massachusetts Department of Environmental Protection (DEP), Hazardous Sites, MassGIS, December 2011.
[18] Central Massachusetts Metropolitan Planning Organization, *Regional Transportation Plan 2012*, Chapter VIII-Air Quality Conformity. http://www.cmrpc.org/sites/default/files/Documents/Trans/Chapter%20VIII%20Air%20Quality.pdf

major precursors of the eight-hour ozone standard. Vehicle emissions contribute to VOC and NOX emissions, which are exacerbated by traffic congestion.

2.3.8 Noise

Based on the "Highway Traffic Noise: Analysis and Abatement Guidance" [FHWA-HEP-10-025, July 2010], the Federal Highway Administration (FHWA) defines roadway projects using three classifications:

- Type I projects include the construction of a major highway on new location or the physical alteration of an existing highway that substantially changes the horizontal or vertical alignment or increases the number of through traffic lanes.

- Type II projects are non-Type I projects where MassDOT has undertaken a voluntary effort to construct feasible and reasonable noise barriers along existing interstate highways under its jurisdiction, when funding priorities allow. Type II projects do not apply to state routes such as Route 9, or local roads.

- Type III projects (such as repaving or bridge rehabilitation, replacement or reconstruction) do not meet the classifications of a Type I or Type II project. Type III projects do not require a noise analysis.

Potential negative impact from traffic noise is assessed on the basis of predicted noise levels approaching or exceeding the Federal Highway Administration's (FHWA) *Noise Abatement Criteria* (NAC). The NAC for residences and similar sensitive exterior receivers is a one-hour equivalent sound level [Leq(h)] of 67 decibels (dBA) during the peak traffic hour.

The MassDOT Noise Abatement Policy has defined "approaching" as within one decibel of the FHWA NAC for residential or other similar sensitive land use areas. In addition, MassDOT defines a "substantial increase" as 10 dBA greater than existing noise levels. These noise levels are used by MassDOT to evaluate the need for noise mitigation measures due to highway improvements.

There are no existing or planned noise barriers (Type II projects) within the project Study Area. The closest sensitive receptors are residences located to the south of the toll plaza at the I-495/Route 9 interchange and west of the I-495 mainline on Washington Street, north of Flanders Road (See Figure 2.2-1 for the location of residential land uses in the study area).

2.4 Traffic

This section provides an overview of existing highway and traffic conditions, and includes a discussion of the following elements:

- Roadway, interchange and intersection physical characteristics,
- Roadway design and geometry,
- Traffic volumes (existing and future),
- Vehicle classification,
- Travel speeds,
- Crashes,
- Traffic capacity analysis (existing and future),
- Toll plaza operations, and
- Intelligent Transportation Systems (ITS).

Traffic capacity analysis is provided for existing (2011) conditions. Two future growth scenarios for 2035 were also evaluated – conditions as projected by the Regional Transportation Plan (RTP) and conditions as projected by the higher growth assumptions in the Priority Development Area (PDA) scenario as developed by the MetroWest Compact Plan (See section 2.4.9 for additional information).

I-495 carries approximately 100,000 vehicles per weekday, about 50,000 vehicles in each direction. Average weekday traffic on Route 9 is approximately 63,000 vehicles west of I-495 and 55,000 vehicles east of I-495. The study area highways carry high peak period commuter traffic volumes. The peak travel direction in the morning is northbound on I-495 to I-90 eastbound and Route 9 westbound. In the evening, the pattern is reversed, with the highest traffic on Route 9 eastbound to I-495 southbound, and from I-90 to I-495 southbound. By 2035, traffic on I-495 is projected to increase by 15-19 percent under the RTP scenario and 22-27 percent under the PDA scenario.

The traffic capacity analysis show that the worst traffic conditions occur in the peak travel direction. Today, I-495 northbound between Route 9 and I-90 and Route 9 westbound, west of I-495 operate at Level of Service [19](LOS) E in the morning peak. During the evening peak, I-495 southbound between Route 9 and I-90 and Route 9 eastbound, west of I-495 operate at LOS E. For the purposes of this study, LOS E and F are considered to represent deficient conditions. All other mainline segments operate at a LOS D or better, which is considered to be acceptable. (See Table 2.4-13 for the I-495 segment capacity analysis under existing conditions) The interchange ramps with the worst traffic problems are the I-495 southbound off-ramp to Route 9 westbound (LOS E) and the I-495 northbound off-ramp to I-90 (LOS F). (See Table 2.4-14 for the interchange ramp capacity analysis under existing conditions.)

Traffic operations are project to get worse by 2035 based on the projected growth in traffic. For the RTP scenario, the LOS for I-495 northbound goes to F for the segment south of I-90, and to E for the segment south of Route 9 in the morning peak. The Route 9 westbound west of I-495 is LOS E. In the evening peak, I-495 southbound is LOS E south of Route 9 and LOS F south of I-90. Route 9 eastbound west of I-495 is LOS E. Under the PDA scenario, I-495 northbound south of Route 9 and Route 9 westbound, west of I-495 deteriorates to LOS F in the morning peak, and I-495 southbound, south of Route 9 and Route 9 eastbound, west of I-495 deteriorates to LOS F in the evening peak. The interchange ramps serving these travel directions are similarly affected. (See Tables 2.4-17 and 2.4-18 for the 2035 freeway and interchange ramp capacity analyses.)

Today, each of the signalized intersections west of I-495 currently operate at acceptable conditions overall (LOS A-D) in both peak hours. However, there are individual movements that operate deficiently during the AM peak hour, the Route 9 northbound left turn onto Computer Drive and southbound left turn on Connector Road onto Research Drive experience longs queues of over 500 feet. The northbound Friberg Parkway approach to Research Drive operates at LOS F with long queues in the PM peak hour. On Route 9 east of I-495, the signalized intersection of Route 9/Crystal Pond Road operates at LOS F in the AM peak hour and LOS D during the PM peak hour. Long vehicle queues are experienced on the Route 9 eastbound and westbound approaches for both the AM and PM peak hours. (See Table 2.4-15 for the intersection capacity analysis under existing conditions.)

Future traffic volumes will generally increase vehicle delay and queuing at most study intersection movements. For the RTP scenario, the intersection of Route 9/Crystal Pond Road will deteriorate to LOS F overall in the PM peak hour and continue to operate at LOS F in the AM peak hour. Under the PDA

[19] Level of Service (LOS) is an index of the quality of traffic flow for roadway facilities such as highways, arterials and intersections. These levels of service are assigned letter grades of A to F, with A representing the best condition and F representing the worst condition. LOS A indicates that traffic is operating with little to no vehicle delay. LOS E indicates that the facility is operating at capacity, and LOS F indicates congestions and long delays. LOS B, C and D are indicative of intermediate conditions.

scenario the following intersections will deteriorate to LOS E or F: Connector Road/Research Drive (LOS E, AM; LOS F, PM), Research Drive/Friberg Pkwy (LOS E, AM) and Route 9/Deerfoot Road (LOS F, AM; LOS E, PM).(See Table 2-4-19 for the 2035 intersection capacity analysis.)

The analysis of roadway geometrics found that none of the I-495/Route 9 and I-495/I-90 ramps, or the four weaving areas at the I-495/Route 9 interchange meet current highway design speed standards[20]. The acceleration lane distance for I-90 and I-495 northbound is also substandard. There are weaving, queuing, and signage issues at the I-90 toll plaza. On Route 9, there are sight distance issues for Route 9 eastbound approaching Crystal Pond Road and sub-standard driveway spacing for businesses on Route 9 westbound east of I-495.

The I-495 off ramps to I-90 is a historic Top 60 Crash Location, with 208 recorded between 2007-2009. About half were rear-end crashes. During that same time period, I-495/Route 9 had 106 crashes, with most on I-495 southbound to Route 9 westbound. Route 9 Eastbound at Crystal Pond road had 28 crashes, with 90 percent rear-end crashes.

2.4.1 Description of Roadways and Intersections

Roadways and intersections in the study area are described below. Figure 2.4-1 shows the study area roadways.

Interstate 495

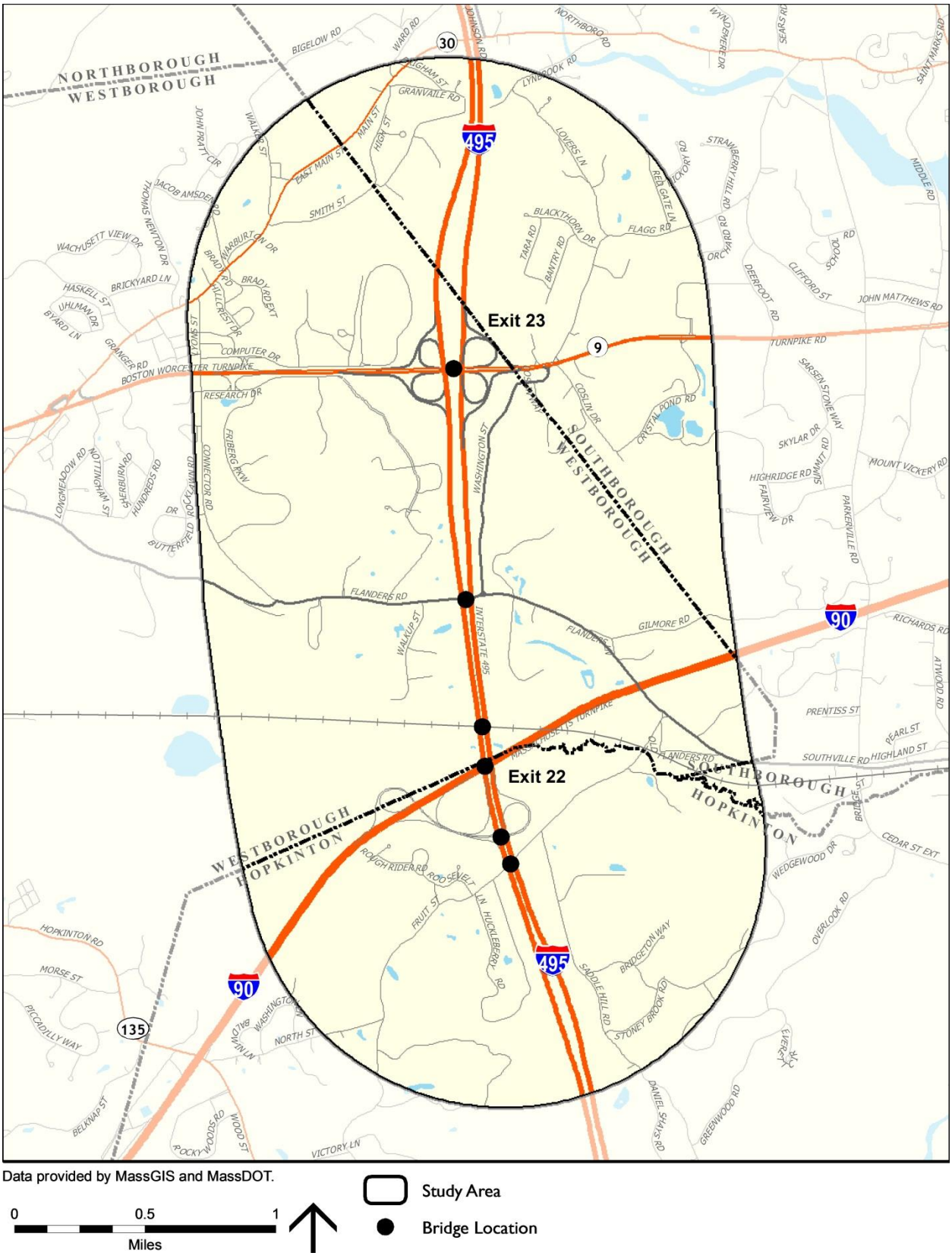
Interstate 495 (I-495) is a limited access divided highway that runs between I-195 in South Wareham to the south and I-95 in Amesbury to the north. In the study area there are two interchanges: #23 at Route 9 in Westborough and Interchange #22 at I-90 (MassPike) in Hopkinton and Westborough. Interchange #23 at Route 9 is a full clover-leaf configuration. Interchange #22 at I-90 is a trumpet configuration with a flyover provided for the I-495 northbound ramps over I-90. I-495 provides three travel lanes in each direction with an outside breakdown lane and inside shoulder. Additional lanes are provided at the on- and off-ramps at the Route 9 and I-90 interchanges. A landscaped median separates the northbound and southbound directions and ranges in width from 500 feet north of Route 9, 230 feet south of Route 9, 140 feet at Flanders Road, and 95 feet at and south of I-90. The posted speed limit in the study area is 65 mph. I-495 is under MassDOT jurisdiction.

There are six bridges/underpasses within the I-495 study corridor that include:

- Fruit Street Overpass,
- MassPike Ramps Overpass,
- MassPike Mainline Underpass,
- Commuter Rail Underpass,
- Flanders Road Underpass, and
- Route 9 Underpass.

[20] There are no weaving areas at the I-495/I-90 Interchange. Weaving areas occur at the I-90 toll plaza.

Figure 2.4-1: Study Area Roadways



There are two portable electronic changeable message signs on I-495 in the vicinity of the study area:

- Northbound I-495 at milepost 56.2 approximately 1.5 miles south of I-90, and
- Southbound I-495 at milepost 60.0, north of Route 9.

Neither sign was in operation when observed on July 7, 2011, but both have been observed to be operational at other times.

Interstate 90 (I-90) Massachusetts Turnpike (MassPike) is a limited access divided toll highway that runs between Boston to the east and the New York border to the west as I-90 continues to Buffalo, New York. I-90 in the study area generally provides three lanes in each direction in the vicinity of the I-495 interchange with additional lanes provided at the on- and off-ramps. Inside breakdown lanes and outside shoulders are provided in each direction. There is a concrete jersey barrier and outside guardrails. I-90 is under MassDOT jurisdiction.

There are a total of 12 lanes at the I-90/I-495 toll plaza with a variety of lane types including E-ZPass (electronic toll collection), cash lanes, combination cash/E-ZPass, and auto only lanes.

Route 9 (Boston Worcester Turnpike Road) is a primary limited access divided state highway that runs between Boston to the east and Pittsfield to the west. In the project study area Route 9 provides two travel lanes in each direction with additional lanes provided at the I-495 interchange and at intersections. West of I-495 in Westborough, Route 9 provides limited access in the study area with ramps provided to/from Research Drive (eastbound) and Computer Drive (westbound). There is a vertical curve on Route 9 with the crest located approximately near the Double Tree Hilton Hotel in the Westborough Technology Park on the north side. From this point the road slopes down in an easterly direction to I-495. The site distance is very good in this section with a long clear site line. If there is significant westbound queuing from the Lyman Street signal on Route 9 to the west of the study area in the PM peak period, the vehicles

may queue upstream to the crest on Route 9. This would be a safety issue where westbound vehicles further east may not see the queue until they approach the crest of the hill and may create rear-end collisions. The Lyman Street signal is located outside the study area of this project.

East of I-495 in Southborough, access is provided at a signalized intersection (Crystal Pond Road) and several unsignalized right-in/right-out only intersections and driveways. A landscaped median approximately 37 feet wide is provided along Route 9 in the vicinity of the I-495 interchange. Land use along Route 9 in the study area is primarily office and commercial. The posted speed limit in the study area is 55 mph. Route 9 is under MassDOT jurisdiction.

There is a permanent over-head electronic message advance warning sign on Route 9 eastbound approximately 1,250 feet west of the Crystal Pond Road (and 850 feet east of the Wendy's restaurant driveway on the north side). The sign is diagonally shaped and is mounted on a mast arm with yellow background. The word "Red" flashes when the downstream signal is Red for Route 9 eastbound.

The sign is located in a dip in the road where the sight distance is restricted due to the downstream vertical curve. The sign warns eastbound motorists on Route 9 that: 1) a signal is ahead, and 2) under a red signal phase for Route 9 eastbound at the Crystal Pond Road motorists may need to stop and/or slow down due to possible vehicle queues ahead which cannot be seen due to the vertical curve.

Route 9 has a bituminous sidewalk on the north (westbound) side between Flagg Road and the Wendy's restaurant (#359) in Southborough. It is in poor to fair condition. There are no bicycle facilities on Route 9.

Computer Drive is a four lane roadway that runs parallel to Route 9 on the north side in Westborough. It is under MassDOT jurisdiction, and essentially serves as an access roadway to the adjacent business parks, It terminates at Technology Drive to the east which is a private loop roadway. It links with Route 9 westbound and Connector Road on the west. Computer Drive is posted for 45 mph, but there is 15 mph sign for westbound Computer Drive approaching the near-90 degree turn at Connector Road. There is a sidewalk on the north side of Computer Drive for its entire length. It connects with sidewalks on both sides of Technology Drive to the east. There are no pedestrian signals or crosswalks at the intersection of Computer Drive/Rt. 9 westbound ramps. There are no bicycle facilities on Computer Drive. Technology Drive has sidewalk on both sides.

Research Drive is a four lane roadway parallel to, and south of, Route 9 that mirrors Computer Drive as a local access to the adjacent business parks. It links with Route 9 eastbound and Connector Road on the west. Research Drive ends to the east where it becomes West Park Drive which terminates further south adjacent to I-495. There is no posted speed limit on Research Drive. There is a sidewalk on the south side. The adjacent land use is office and commercial. Research Drive is under MassDOT jurisdiction and West Park Drive is a private roadway.

Research Drive has a sidewalk on the south side for its entire length. There are no pedestrian signals or crosswalks at the intersection of Research Drive/Route 9 eastbound ramps. There is a crosswalk on Research Drive on the east side of the intersection with Connector Road. While there are no pedestrian signals at this intersection, signal loops for bicycles are provided.

Connector Road is a collector roadway connecting Flanders Road on the south with Route 9 eastbound via Research Drive and westbound via Computer Drive. Connector Road is under MassDOT jurisdiction. Connector Road terminates as it connects into Computer Drive on the north. It has two lanes in each direction between Computer Drive and Research Drive and one lane in each direction south of Research Drive and north of Computer Drive. Connector Road passes over Route 9 on a bridge that has four travel lanes and a sidewalk on the eastern side. North of Research Drive, Connector Road is posted for 30 mph and south of Research Drive it is posted for 50 mph. There is a sidewalk on the east side of Connector Road between Research Drive and just north of the bridge over Route 9. Where the sidewalk terminates on the east side there is a crosswalk over to the west side of Connector Road, where the sidewalk then continues north to Windsor Ridge Drive where it terminates. There is also a short sidewalk on the east side of the curve portion of Connector Road between Computer Drive and Windsor Ridge Drive. The adjacent land use is commercial. There are no bicycle facilities on Connector Road.

Washington Street is a local roadway south of Route 9 that connects with Route 9 eastbound on the north in Southborough and with Flanders Road on the south in Westborough. For most of its length it runs north-south in Westborough parallel to I-495. It has one lane in each direction with no sidewalk. There is old deteriorated cable guard rail on each side near Route 9. Washington Street is under local jurisdiction.

Crystal Pond Road is a local roadway south of Route 9 that connects Route 9 eastbound on the north with Coslin Drive on the south. There is no posted speed limit. Crystal Pond Road and Coslin Drive form a loop roadway south of Route 9. There is a bituminous sidewalk on the west side of Crystal Pond Road a portion of the roadway. It is in fair to good condition. There is a pedestrian signal and crosswalk across Route 9 on the east side. The pedestrian signal runs concurrently with the northbound Crystal Pond Road signal phase. There is also a crosswalk across Crystal Pond Road on the northbound approach. No pedestrian signals are provided for this crossing. There are no bicycle facilities on Crystal Pond Road. The adjacent land use is commercial. Crystal Pond Road is under local jurisdiction.

Coslin Drive is a private two lane roadway that intersects with Route 9 eastbound on the north and Crystal Pond Road on the south. It is posted for 25 mph, and serves as an access roadway to the EMC[2] campus. It has a narrow bituminous sidewalk on the east side. It is in poor to fair condition. There are no bicycle facilities on Coslin Drive.

Flagg Road is a narrow local roadway on the north side of Route 9 connecting Route 9 westbound on the south with Deerfoot Road (north) to the northeast. No curb or sidewalk is provided. The posted speed limit is 25 mph. The adjacent land use is residential. Flagg Road is under local jurisdiction.

Park Central Drive is a short dead end roadway on the north side of Route 9 providing access from Route 9 westbound to commercial businesses. There is a sidewalk on the east side. There are no bicycle facilities on Park Central Drive There is no posted speed limit. The state prima facie speed for unposted roadways of this type is 30 mph.

Interchanges

The I-495 study area includes the interchanges of I-495/Route 9 (#23) in Westborough and I-495/I-90 (#22) in Hopkinton. Geometric conditions are described below.

I-495/Route 9 is a full clover-leaf interchange with loop ramps provided in each quadrant. Figure 2.4-2 shows the number of lanes, weaves merges, and diverges. Route 9 generally provides two travel lanes in each direction, with three weaving lanes in between the I-495 NB and SB Ramps. I-495 generally provides three travel lanes in each direction, with four weaving lanes in between the Route 9 EB and WB ramps.

Figure 2.4-2: I-495/ Route 9 Interchange

I-495/I-90 is a double trumpet-type interchange with a toll booth connecting both halves of the interchange. The I-495 half of the interchange provides direct ramps for three movements and a loop ramp for the northbound I-495 off-ramp to I-90. The I-90 half of the interchange provides direct ramps for three movements and a loop ramp for the I-90 eastbound on-ramp from I-495. Figure 2.4-3 shows the lane geometrics at the interchange and the toll plaza. A bridge is provided over I-495 for the I-495 NB off-ramp and the I-495 NB on-ramp. A second bridge is provided over I-90 for the I-90 EB off-ramp and the I-90 EB on-ramp.The toll plaza is located in the middle of the interchange to collect tolls from all vehicles entering and exiting I-90.

Figure 2.4-3: I-495/ I-90 Interchange

Intersections

Geometric conditions, intersection control, and pedestrian and bicycle facilities are described below for intersections of public and private roadways and major private driveways along Route 9. Other private driveways are described at the end of this section.

Intersections on Route 9 West of I-495

Figure 2.4-4 shows the location and traffic control for the study intersections on Route 9 west of I-495.

Figure 2.4-4: Route 9 West

Research Drive eastbound approach to Route 9 eastbound ramps

Route 9 Westbound Ramps/Computer Drive (Westborough) is a signalized T-intersection with the Route 9 westbound on- and off-ramps forming the stem of the Tee. The Computer Drive eastbound approach has two through lanes and one channelized right-turn lane that is under Yield control. The Computer Drive westbound approach has one through lane and one shared left/through lane. The northbound Route 9 off-ramp approach has two left-turn lanes and one channelized right-turn lane under Yield control. The signal operates with three phases, and is actuated. There are no pedestrian signals or crosswalks. The signal is controlled by MassDOT.

Route 9 Eastbound Ramps/Research Drive (Westborough) is a signalized T-intersection with the Route 9 eastbound on-and off-ramps forming the stem of the Tee. The Research Drive eastbound approach has one through lane, one shared left/through lane, and one left-turn lane. The westbound Research Drive approach has two through lanes and one channelized right-turn lane under Yield control. There is a concrete median on Research Drive on the east side. The southbound Route 9 eastbound approach has two left-turn lanes and one channelized right-turn lane under Yield control. The signal operates with three phases, and is actuated. There are no pedestrian signals or crosswalks. The signal is controlled by MassDOT.

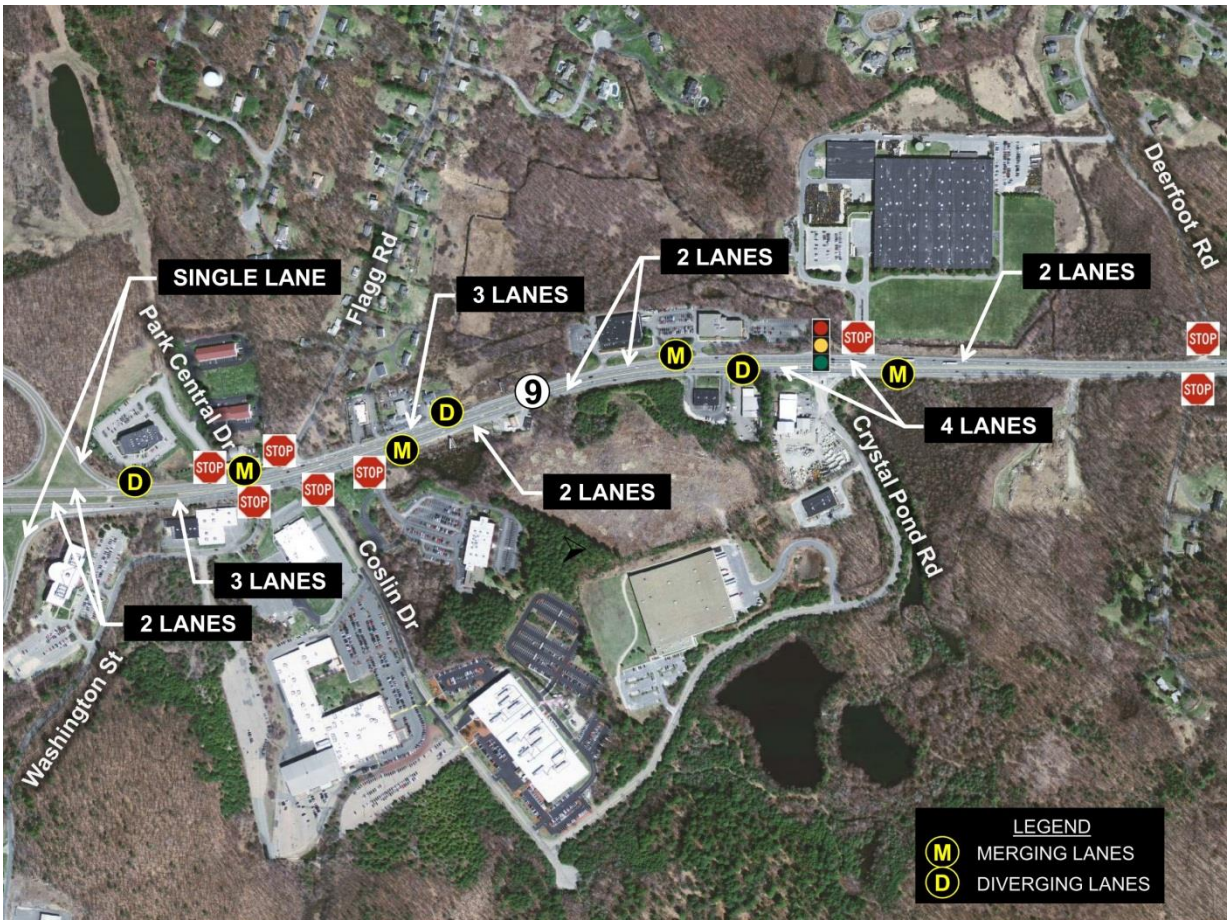
Connector Road/Research Drive (Westborough) is a signalized four-way intersection. The Connector Road northbound approach has one shared left/through and one shared through/right lane. The southbound Connector Road approach has two left-turn lanes and one shared through/right lane. The westbound Research Drive approach has one shared left/through lane and two channelized right turn lanes that are signalized. The eastbound approach is from a private driveway serving the former Piccadilly Pub Restaurant and Extended Stay America Hotel. The eastbound approach provides two undesignated shared lanes. There is a crosswalk with ADA accessible ramps across Research Drive on the east side of the intersection; however, there are no pedestrian signals. Signal loops are provided for bicycles. The signal operates with three phases, and is actuated. The signal is controlled by MassDOT.

Connector Road/Computer Drive/Lyons Street (Westborough) is an unsignalized T-intersection on a curve with Lyons Street forming the stem of the Tee. Although on a curve, Connector Road and Computer Drive are striped as a continuous movement. The left turns from Connector Road northbound onto Lyons Street are made from the left lane. The right turns from Computer Drive westbound are made from the right lane. The Lyons Street southbound approach is Stop controlled and has one shared left/right turn lane. Separate northbound receiving lanes are provided for the northbound Connector Road left turn and westbound Computer Drive right turn movements. The receiving lanes are separated by a raised concrete delta island.

Intersections on Route 9 East of I-495

Figure 2.4-5 shows the location and traffic control for the study intersections on Route 9 east of I-495.

Figure 2.4-5: Route 9 East



Route 9/Crystal Pond Road (Southborough) is a signalized T-intersection with Crystal Pond Road forming the stem of the Tee. The Route 9 eastbound approach has two through lanes, one left-turn lane and one right-turn lane. The left-turn lane is used only for u-turns to Route 9 westbound. On the westbound departure side there is a turn-out to accommodate trucks making a u-turn from the eastbound direction. The Route 9 westbound approach has three through lanes and one left-turn lane. The Crystal Pond Road northbound approach has two left-turn lanes and one channelized right-turn lane under Yield control. The signal is actuated and operates with three phases. There is a pedestrian signal and crosswalk across Route 9 on the east side. The pedestrian signal runs concurrently with the northbound Crystal Pond Road signal phase. There is a permanent over-head electronic message advance warning sign on Route 9 eastbound approximately 1,250 feet west of the Crystal Pond Road (and 850 feet east of the Wendy's restaurant driveway on the north side). There is a badly damaged guard rail on the southeast corner of the intersection. The signal is controlled by MassDOT.

Route 9 eastbound approach to Crystal Pond Road

Route 9 Eastbound/Washington Street and Route 9 Eastbound/Coslin Drive (Southborough) are two separate unsignalized T-intersections located approximately 250 feet apart. Both intersections provide only right in/right out movements from/to Route 9 eastbound. Washington Street and Coslin Drive form the minor intersection legs to the south. Route 9 eastbound provides three lanes with the outside lane functioning as both an acceleration lane from the I-495 northbound-to-eastbound off-ramp and a deceleration lane to the Washington Street and Coslin Drive roadways. The Washington Street and Coslin Drive northbound approaches provide one lane and are Stop controlled. A landscaped delta island separates the entering and exiting traffic at both intersections.

Route 9 eastbound at Coslin Drive showing lane drop in distance

Route 9 Westbound/Flagg Road (Southborough) is an unsignalized T-intersection with Flagg Road forming the minor leg of the intersection on the north. Only right turns are allowed in and out from Route 9 westbound. Route 9 westbound provides one right-turn lane and two through lanes. Single approach

and departure lanes are provided on Flagg Road separated by a landscaped delta island. Flagg Road is Stop controlled.

Route 9 Westbound/Park Central Drive (Southborough) is an unsignalized T-intersection with Park Central Drive forming the minor leg on the north. Only right turns are allowed in and out from Route 9 westbound. Route 9 westbound provides two travel lanes and a wide shoulder (approximately 12 feet). The shoulder functions as a deceleration lane to Park Central Drive, as an acceleration lane from Park Central Drive, and as a deceleration lane to the I-495 northbound on-ramp. However, the pavement markings are faded in this area (and can cause motorist confusion). This acceleration/deceleration lane also serves the Cumberland Farms driveway to the east. Single approach and departure lanes are provided on Park Central Drive separated by a landscaped delta island. Park Central Drive is Stop controlled.

Route 9 westbound at Gulf Station/Cumberland Farms Driveways and Park Central Drive

Route 9 Eastbound/#352 Boston Worcester Turnpike Road (Southborough) is an unsignalized T-intersection with the driveway forming the stem of the Tee. Only right turns are allowed in and out from Route 9 eastbound. Route 9 eastbound provides three travel lanes with the outside lane acting as a deceleration lane that ends at the intersection. The third lane begins to taper down to two lanes immediately east of this intersection. Single approach and departure lanes are provided on #352 driveway, and are separated by a landscaped delta island. The #352 driveway approach is Stop controlled. This driveway serves Southborough Executive Place.

Route 9 Westbound/#325 Worcester Turnpike Road (Southborough) is an unsignalized T-intersection with the driveway forming the stem of the Tee. Only right turns are allowed in and out of the driveway. The Route 9 westbound approach provides one left-turn lane (into Crystal Pond Road) and three through lanes. Single approach and departure lanes are provided on #325 driveway separated by a landscaped delta island and median. There is no control on the #325 driveway. This driveway serves warehouse space, but is currently unoccupied.

In addition to the driveways for properties #325 and #352**,** there are 10 parcels along Route 9 in the study area in Southborough (east of I-495) with exiting driveways. Table 2.4-1 summarizes the driveway

locations, direction, type and number of access points and land use. All driveways are right-in and/or right-out only under Stop control. Figure 2.4-6 shows the locations of driveways on Route 9 in the study area in Southborough.

There are no private driveways in the study area west of I-495.

Table 2.4-1: Driveway Locations on Boston Worcester Turnpike Road Route 9

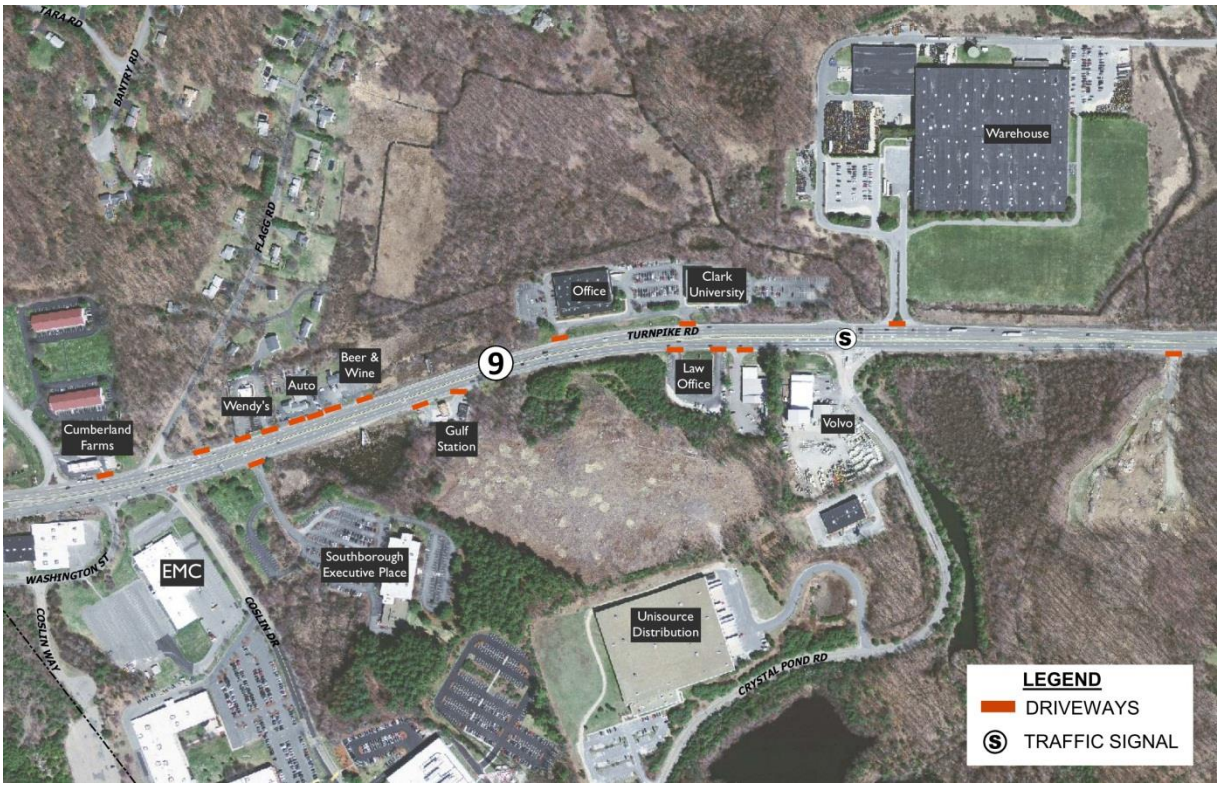
Driveway Location	Direction	Number/Type	Use
#278-296	EB	One driveway	Vacant
#302	EB	One driveway*	Fluid Power Products
#304	EB	One entrance driveway and one exit driveway	Law Office
#305-333	WB	Two driveways	Office use, Clark University, NEHT Specialty Pharmacy
#325	WB	One driveway*	Warehouse
#344	EB	One entrance and one exit driveway**	Gulf Gas Station/Cumberland Farms
#349	WB	One entrance and one exit driveway	Beer & Wine Store
#352	EB	One driveway*	Southborough Executive Place
#355	WB	One entrance and one exit driveway	Auto Body & Auto Sales
#359	WB	One entrance and one exit driveway	Wendy's
#361	WB	One driveway	Vacant
#365	WB	One driveway**	Cumberland Farms, Exxon Gas Station

Note:

* Has a small raised delta island or median separating entrance and egress.

** Additional access on Park Central Drive.

Figure 2.4-6: Route 9 Driveway Locations in Southborough



2.4.2 Roadway Geometric Evaluation

This section summarizes existing geometrics for interchanges, intersections, and driveway spacing, and compares the results with traffic engineering standards.

I-495/Route 9 Interchange

Table 2.4-2 summarizes the existing weaving distance at the four weave areas at the I-495/Route 9 interchange. The table shows that none of the four weaving areas meets current highway design standards.

Table 2.4-2: I-495/Rt. 9 Interchange Mainline Weaving Distance

Mainline Weaving Section	Existing Weaving Distance	Minimum Standard Weaving Distance1	Meets Standard
I-495 NB between Rt. 9 On-Ramp (B) and Off-Ramp (C)	690’	1,100’	No
I-495 SB between Rt. 9 On-Ramp (F) and Off-Ramp (G)	660’	1,100’	No
Rt. 9 EB between I-495 On-Ramp (G) and Off-Ramp (B)	875’	1,100’	No
Rt. 9 WB between I-495 On-Ramp (C) at Off-Ramp (F)	920’	1,100’	No

Source: MassDOT Highway Design Guide 2006. Section 7.6.3 Weaving Areas.

Table 2.4-3 summarizes the existing design speed at each of the eight ramps (four off- and four on-) at the I-495/Route 9 interchange. The table shows that none of the eight ramps meets current highway design speed standards.

Table 2.4-3: Summary of Design Speed at I-495/Rt. 9 Interchange Ramps

Location	Type	Lanes	Existing Design Speed	Minimum Standard1	Meets Standard
I-495 NB to Rt. 9 EB	Diagonal Off-Ramp	1	30 mph	50 mph	No
Rt. 9 EB to I-495 NB	Loop On-Ramp	1	30 mph	35 mph	No
I-495 NB to Rt. 9 WB	Loop Off-Ramp	1	30 mph	35 mph	No
Rt. 9 WB to I-495 NB	Diagonal On-Ramp	1	30 mph	50 mph	No
I-495 SB to Rt.9 WB	Diagonal Off-Ramp	1	30 mph	50 mph	No
Rt. 9 WB to I-495 SB	Loop On-Ramp	1	30 mph	35 mph	No
I-495 SB to Rt. 9 EB	Loop Off-Ramp	1	30 mph	35 mph	No
Rt. 9 EB to I-495 SB	Diagonal On-Ramp	1	30 mph	50 mph	No

Source: MassDOT Highway Design Guide 2006. Section 7.7.1.1 Design Speed.

I-495/I-90 Interchange

Table 2.4-4 summarizes ramp geometrics at the I-495/I-90 interchange. The acceleration distance for the I-90 on-ramp to I-495 northbound is below the standard distance. The turn radius for the I-495 southbound off-ramp to I-90 and the two lane diverge do not meet design standards.

Table 2.4-4: I-495/I-90 Interchange Ramp Geometrics

Location	Type	Lanes	Issue	Regional Minimum Standard
I-90 to I-495 NB	Loop/Diagonal On-Ramp	1	Accel. Distance =1,045’	1,420’[1]
I-495 SB to I-90	Direct Off-Ramp	2	Radius = 280’	1,000’[2]

Source:

1. MassDOT Highway Design Guide 2006. Exhibit 7-14.
2. MassDOT Highway Design Guide 2006. Section 7.7.1.3 Horizontal Alignment.

There are no weaving areas at the I-495/I-90 interchange. Weaving areas occur at the I-495 toll plaza but were only identified in qualitative terms for this study.

Table 2.4-5 summarizes the existing design speed at each of the four ramps (two off- and two on-) at the I-495/I-90 interchange. The table shows that two on-ramp design speeds are below standards. The design speed for the two off-ramps from I-495 to I-90 may be acceptable due to the location of the I-90 toll plaza downstream of the off-ramps.

Table 2.4-5: I-495/I-90 Interchange Ramps Design Speed Deficiencies

Location	Type	Lanes	Existing Design Speed	Minimum Standard	Meets Standard
I-495 NB to I-90	Loop Off-Ramp	1	30 mph	35 mph	Maybe
I-90 to I-495 NB	Loop/Diagonal On-Ramp	1	30 mph	50 mph	No
I-495 SB to I-90	Slip Off-Ramp	2	35 mph	50 mph	Maybe
I-90 to I-495 SB	Slip On-Ramp	1	30 mph	50 mph	No

Source: MassDOT Highway Design Guide 2006. Section 7.7.1.1 Design Speed.

Note: Engineering judgment must be considered because the I-90 toll plaza is located downstream of the off-ramps. Judgment must be used because the off-ramps connecting to the I-90 toll plazas are not free-flow. Motorists must slow down or stop to pick up a toll ticket or to pay the toll. Therefore, the typical ramp design speed is not necessarily applicable or desired in this case.

Route 9 Intersection and Driveway Spacing and Auxiliary Lanes

Intersection and driveway spacing impacts the operations and safety of the main line roadways as well as the minor intersecting roadways and driveways. Pedestrians and bicyclists are also impacted by the number and spacing of access points along a roadway.

The intersection/ driveway spacing and auxiliary lanes in Southborough along Route 9 east of I-495 were evaluated. On Route 9 west of I-495 in the study area, the only access breaks are at the Computer Drive (eastbound) and Research Drive (westbound) ramps. Therefore, an access spacing evaluation was not necessary for the segment of Route 9 west of I-495. Both the eastbound merge from Research Drive and the westbound merge from Commuter Drive with Route 9 meet standards. The two lane diverge on Route 9 WB also meets standards

Spacing Between I-495 Interchange and Route 9 Intersections

Guidelines published in the National Cooperative Highway Research Program (NCHRP) Synthesis 404, *State of the Practice in Highway Access Management*, Transportation Research Board, 2010, were used to evaluate spacing between I-495 ramps and Route 9 intersections east of I-495.The minimum spacing requirements for the following locations were evaluated:

- Route 9 eastbound between I-495 northbound off-ramp and Washington Street, and
- Route 9 westbound between Park Center Drive and I-495 northbound on-ramp.

The minimum spacing requirement for Route 9 eastbound between the I-495 northbound off-ramp and Washington Street is 990 feet. The existing spacing is approximately 570 feet. Coslin Drive (private) is also located within 990 feet from the northbound off-ramp.

The minimum spacing requirement for Route 9 westbound between Park Center Drive and the I-495 northbound on-ramp is 1,320 feet. The existing spacing is approximately 350 feet. Driveways for #361 and #359 (2) Turnpike Road are within 1,320 feet from the northbound on-ramp.

The results show that the intersection spacing between the I-495 northbound on- and off-ramps and Route 9 intersections is substandard. This situation is not desirable because vehicles either need to accelerate quickly in a short distance on Route 9 westbound to then take the northbound I-495 on-ramp,

or decelerate quickly in a short distance from the I-495 northbound off-ramp to the driveways on Route 9 eastbound. This close spacing creates safety and operational issues.

Driveway Spacing Between Route 9 Intersections and Driveways

The Southborough Zoning Code driveway spacing standards on Route 9[21] were used for this analysis. The standard for separation is 300 feet between driveways, and 150 feet between drives and side streets.

It is noted that the Southborough Zoning standards apply to "Any driveway likely to carry more than two hundred (200) trips per average business day…". The existing driveway and intersection spacing along Route 9 east of I-495 is summarized in Table 2.4-6, and compared to the spacing standard For this analysis all driveways are included, regardless of their trip generation characteristics.

Table 2.4-6 shows that most of the existing driveways meet the Southborough separation standards. The following driveways in the study area along Route 9 in Southborough do not meet the separation standard:

- #349 (west) beer & wine store and #355 (east) auto body and auto sales,
- #355 (west) and #359 (east) Wendy's restaurant, and
- #359 (west) and #361 currently vacant.

The *MassHighway Design Guide Intersection Space Guidelines*[22] were used to review intersection separation of public roadways along Route 9 east of I-495 in Southborough. For Route 9, the recommended intersection spacing is 500 feet.[23] The intersecting roadways of Flagg Road and Park center Drive on westbound Route 9 are approximately 400 feet apart with the Cumberland Farms/Gulf Gas Station driveways (#365 Turnpike Road) located in between. Therefore, the separation of these two roadways does not meet the standard. The remaining public roadway intersections in the study area (Washington Street and Crystal Pond Road) on Route 9 eastbound meet the separation standard.

[21] Southborough Zoning Code, Section 174-12. Parking and loading regulations, F. Egress, p.54.
[22] MassHighway Design Guide, Edition 2006, Exhibit 6-34, Intersection Space Guidelines, page 6-74.
[23] *For roadway design speed 50+ mph.*

Table 2.4-6: Southborough Driveway Spacing Summary - Route 9 Existing Conditions

Route 9 (Turnpike Road) Driveway Segment	Direction	Standard [1]	Spacing Distance	Meets Standard
Washington St. – Coslin Drive (Private)	EB	150'	195'	Yes
Coslin Drive (Private) - #352	EB	300'	315'	Yes
#352 - #344 West	EB	300'	630'	Yes
#344 East - #304 West	EB	300'	795'	Yes
#304 East - #302	EB	300'	105'	Yes[2]
#302 – Crystal Pond Road	EB	150'	405'	Yes
Crystal Pond Road - #278/296	EB	150'	1,150'	Yes
#325 - #305	WB	300'	750'	Yes
#305 - #333	WB	300'	465'	Yes
#333 - #349 East	WB	300'	750'	Yes
#349 West - #355 East	WB	300'	75'	No[3]
#355 West - #359 East	WB	300'	120'	No[4]
#359 West - #361	WB	300'	150'	Yes[5]
#361 – Flagg Road	WB	150'	195'	Yes
Flagg Road - #365	WB	150'	195'	Yes
#365 – Park Central Drive	WB	150'	180'	Yes

Notes:
1. Southborough Zoning Code, Section 174-12. Parking and Loading Regulations. F. Egress, P.54.
2. It is unlikely that either driveway carries more than 200 trips per average business day; therefore it would conform to standard.
3. #349 Beer & Wine store is assumed to exceed 200 trips per average business day.
4. #359 Wendy's store is assumed to exceed 200 trips per average business day.
5. #359 Wendy's store is assumed to exceed 200 trips per average business day. It is noted that #361 is currently vacant.

Route 9 Auxiliary Lanes

The Southborough Zoning Code requires acceleration and deceleration lanes for driveways on Route 9 likely to carry more than 200 trips per average business day[24]. Acceleration and deceleration lanes are important to allow vehicles to safely enter and exit the general flow of traffic on Route 9.

The presence of acceleration and deceleration lanes at driveways and roadways on Route 9 in Southborough in the study area is summarized in Table 2.4-7. For this analysis all driveways are included, regardless of their trip generation characteristics. The table shows that many of the driveways and roadways have acceleration and deceleration lanes. For the ones that do not, they either are assumed to generate fewer than 200 vehicle trips per business day, or have a wide shoulder that can help serve decelerating and accelerating vehicles at driveways and roadways.

[24] *Southborough Zoning Code, Section 174-12. Parking and loading regulations, F. Egress,* p.54.

Table 2.4-7: Route 9 Acceleration/Deceleration Lanes for Driveways/Roadways

	Deceleration Lane	Acceleration Lane
Eastbound		
Washington	Yes	Yes
Coslin Drive (Private)	Yes	Yes
#352	Yes	Yes
#344	No[1]	No[1]
#304	No[2]	No[1, 2]
#302	No[3]	No[3]
Crystal Pond Road	NA[4]	NA[4]
#278-296	No[1]	No[1]
Westbound		
#325	No[3]	No[3]
#305	Yes	Yes
#333	No[1]	No[1]
#349	Yes	Yes
#355	Yes	Yes
#359	Yes	Yes
#361	Yes	No[2]
Flagg Road	Yes	No[1]
#365	No[1]	No[1]
Park Central Drive	No[1]	No[1]

Notes:
1. Wide shoulder provided.
2. Assumed to generate fewer than 200 vehicle trips per day.
3. Roadway widens for approach to Crystal Pond Road.
4. Signalized Intersection

2.4.3 Traffic Volumes

MassDOT collected new traffic volumes and classification counts at study roadways and intersections in September 2011. Automatic Traffic Recorder (ATR) machines were used to collect data on the study roadways for a minimum of 48 consecutive hours between Monday, September 12 and Sunday, September 18, 2011. The traffic data was collected in 15-minute increments.

Roadway and Interchange Traffic Volumes

Daily and peak hour traffic volumes for I-495 and Route 9 and the interchanges of I-495/Route 9 and I-495/I-90 are summarized in Table 2.4-8 and Figures 2.4-7 through 2.4-9.

Figure 2.4-7: I-495 Study Interchanges Existing Conditions 2011 Weekday Average Daily

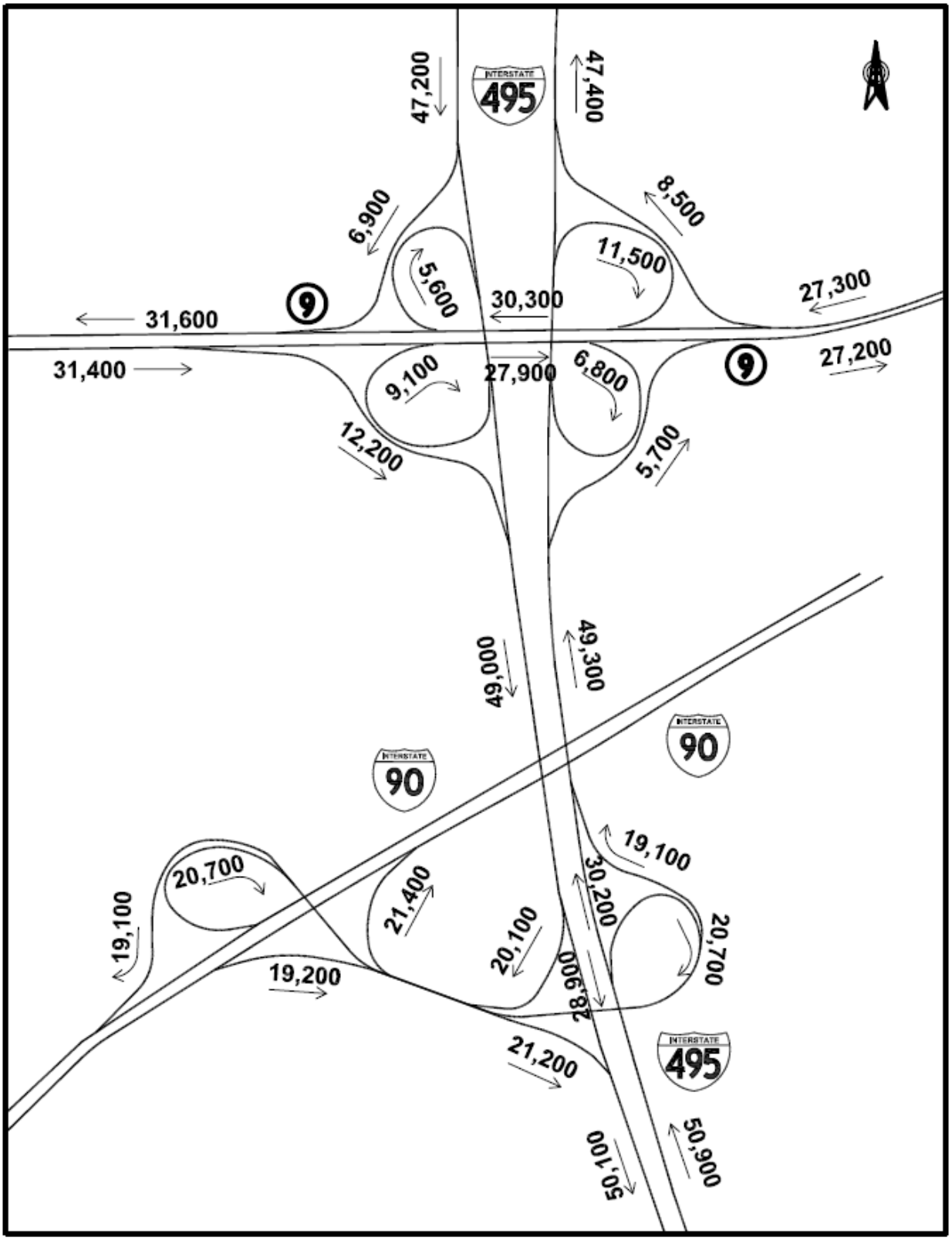


Figure 2.4-8: I-495 Study Interchanges Existing Conditions 2011 Weekday AM Peak Hour

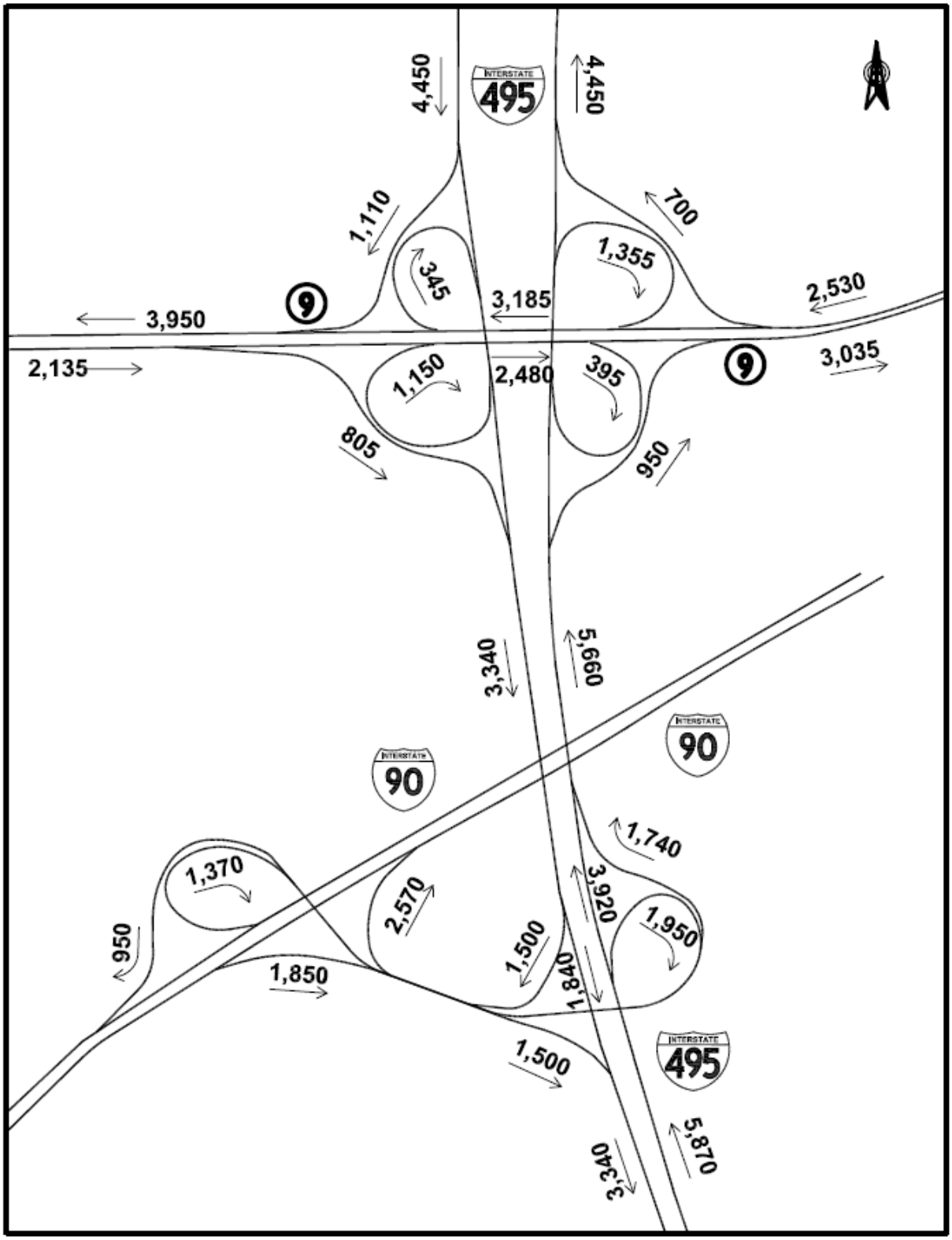


Figure 2.4-9: I-495 Study Interchanges Existing Conditions 2011 Weekday PM Peak Hour

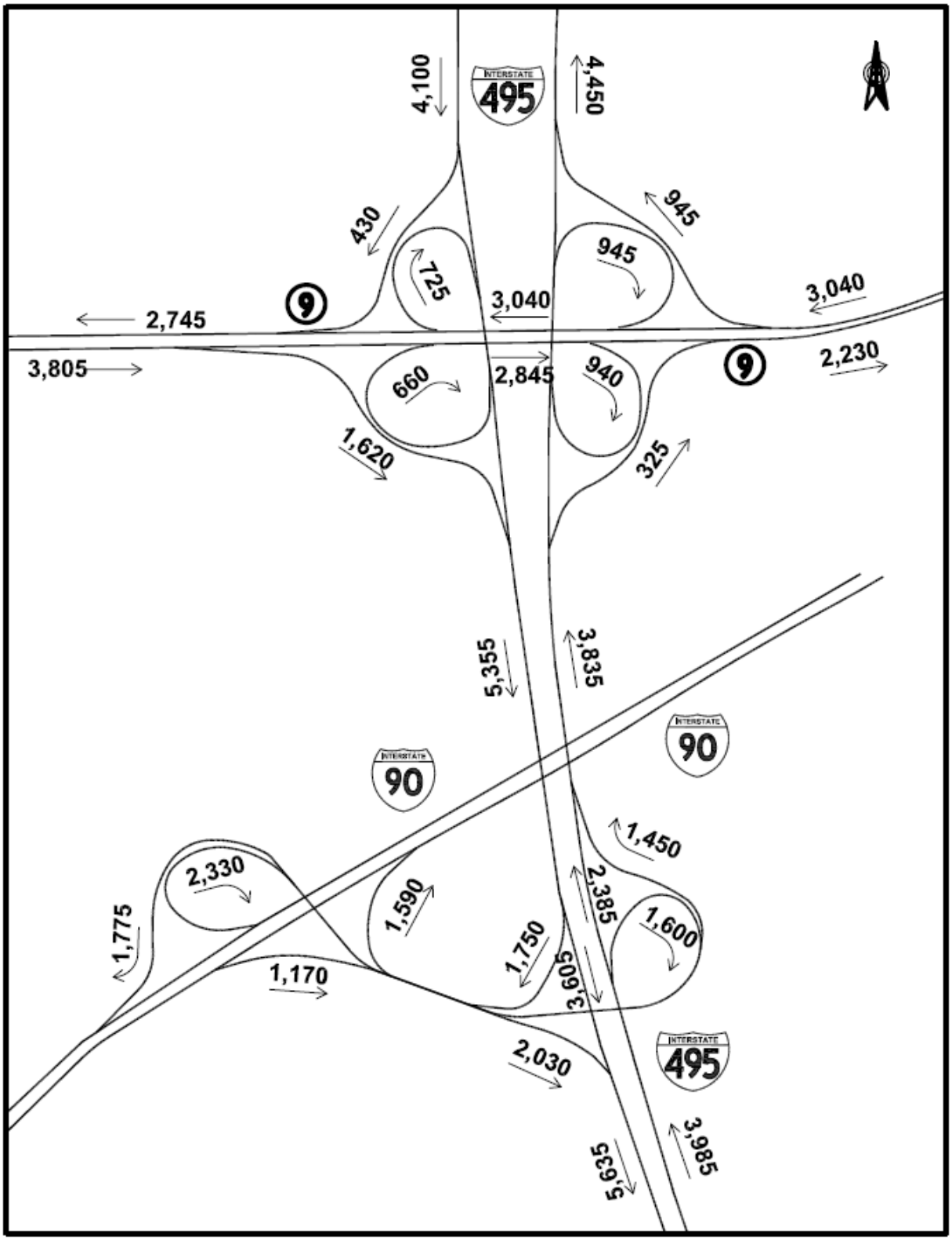


Table 2.4-8: Existing (2011) Traffic Volumes

ATR Location	Weekday Average[1]					Saturday[1]		
	ADT	AM		PM		ADT	Peak Hour Volume	K Factor[2]
		Peak Hour Volume	K Factor[2]	Peak Hour Volume	K Factor[2]			
I-495 Mainline								
NB Mainline n/o Rt. 9	47,400	4,450	9.4%	4,450	9.4%	NA	NA	NA
SB Mainline n/o Rt. 9	47,200	4,450	9.4%	4,100	8.7%	NA	NA	NA
NB Mainline s/o Rt. 9	49,300	5,660	11.5%	3,835	7.8%	NA	NA	NA
SB Mainline s/o Rt. 9	49,000	3,340	6.8%	5,355	10.9%	NA	NA	NA
NB Mainline s/o I-90	50,900	5,870	11.5%	3,985	7.8%	NA	NA	NA
SB Mainline s/o I-90	50,100	3,340	6.7%	5,635	11.2%	NA	NA	NA
Route 9 Mainline								
Rt. 9 EB e/o I-495	27,200	3,035	11.2%	2,230	8.2%	NA	NA	NA
Rt. 9 WB e/o I-495	27,300	2,530	9.3%	3,040	11.1%	22,600	1,252	5.5%
Rt. 9 EB w/o I-495	31,400	2,135	6.8%	3,805	12.1%	NA	NA	NA
Rt. 9 WB w/o I-495	31,600	3,950	12.5%	2,745	8.7%	NA	NA	NA
I-495/Route 9 Interchange								
I-495 NB Off-Ramp to Rt. 9 EB	5,700	950	16.7%	325	5.7%	4,800	615	12.8%
I-495 NB On-Ramp from Rt.9 EB	6,800	395	5.8%	940	13.8%	3,600	315	8.8%
I-495 NB Off-Ramp to Rt. 9 WB	11,500	1,355	11.8%	945	8.2%	9,100	815	9.0%
I-495 NB On-Ramp from Rt. 9 WB	8,500	700	8.2%	945	11.1%	4,900	355	7.2%
I-495 SB Off-Ramp to Rt. 9 WB	6,900	1,110	16.1%	430	6.2%	4,000	340	8.5%
I-495 SB On-Ramp from Rt. 9 WB	5,600	345	6.2%	725	13.0%	4,000	350	8.8%
I-495 SB Off-Ramp to Rt. 9 EB	9,100	1,150	12.6%	660	7.3%	5,900	455	7.7%
I-495 SB On-Ramp from Rt.9 EB	12,200	805	6.6%	1,620	13.3%	6,800	525	7.7%
I-495/I-90 Interchange								
I-495 NB Off-Ramp to I-90	20,700	1,950	9.4%	1,600	7.7%	16,400	1,295	7.9%
I-495 NB On-Ramp from I-90	19,100	1,740	9.1%	1,450	7.6%	14,300	1,100	7.7%
I-495 SB Off-Ramp to I-90	20,100	1,500	7.5%	1,750	8.7%	14,800	1,185	8.0%

ATR Location	Weekday Average[1]					Saturday[1]		
	ADT	AM		PM		ADT	Peak Hour Volume	K Factor[2]
		Peak Hour Volume	K Factor[2]	Peak Hour Volume	K Factor[2]			
I-495 SB On-Ramp from I-90	21,200	1,500	7.1%	2,030	9.6%	16,400	1,245	7.6%
I-90 EB On-Ramp from I-495	21,400	2,570	12.0%	1,590	7.4%	15,000	1,160	7.7%
I-90 EB Off-Ramp to I-495	19,200	1,850	9.6%	1,170	6.1%	17,600	1,410	8.0%
I-90 WB On-Ramp from I-495	19,100	950	5.0%	1,775	9.3%	15,300	1,350	8.8%
I-90 WB Off-Ramp to I-495	20,700	1,370	6.6%	2,330	11.3%	12,700	1,000	7.9%

Notes:

1. Traffic counts were conducted by MassDOT using ATR machines between Monday, September 12 and Sunday, September 18, 2011.
2. Percent of daily traffic that occurred during the peak hour.

I-495 and Route 9 Mainline

I-495 mainline carries approximately 100,000 vehicles per weekday with about 50,000 vehicles in each direction. During the AM peak hour, I-495 in the study area carries approximately 9,000 vehicles. North of Route 9 the distribution of traffic by direction is even (50 percent in each direction). South of Route 9 during the AM peak hour, the peak direction on I-495 is northbound (63 percent) with over 5,600 vehicles and approximately 3,300 vehicles in the southbound direction. The distribution and traffic patterns on I-495 change in the PM peak hour. North of Route 9, I-495 carries approximately 8,600 vehicles with over 4,400 vehicles (52 percent) in the peak northbound direction. South of Route 9, I-495 carries approximately 9,200 vehicles with almost 5,400 vehicles (58 percent) in the peak southbound direction (the reverse of the AM peak hour). South of I-90, the total PM peak hour traffic is over 9,600 vehicles with 59 percent (5,635) in the peak southbound direction. The percentage of daily traffic volume that occurs during the peak hour on I-495 in the study area is between 7 and 12 percent, which is typical for an interstate highway.

The average weekday traffic on Route 9 is approximately 55,000 vehicles east of I-495 and 63,000 vehicles west of I-495 with an even split between the eastbound and westbound directions. During the AM peak hour, Route 9 carries a total of over 5,500 vehicles east of I-495 with 55 percent eastbound (3,035). West of I-495, Route 9 carries over 6,000 vehicles with almost 4,000 (65 percent) in the westbound direction. During the PM peak hour, the peak directions on Route 9 are toward I-495, the reverse from the AM peak hour. East of I-495, the peak direction is westbound (58 percent) with over 3,000 vehicles and west of I-495 the peak direction is eastbound (58 percent) with over 3,800 vehicles.

I-495/Route 9 Interchange

The average weekday daily traffic on the I-495/Route 9 interchange ramps range between 5,600 and 12,200 vehicles. The I-495 ramps with the highest weekday volumes are:

- Southbound on-ramp from Route 9 eastbound (12,200),
- Northbound off-ramp to Route 9 westbound (11,500),
- Southbound off-ramp to Route 9 eastbound (9,100), and
- Northbound on-ramp from Route 9 westbound (8,500).

The remaining four ramps have daily weekday volumes between 5,600 and 6,900 vehicles

- .Northbound on-ramp from Route 9 eastbound
- Northbound off-ramp to Route 9 eastbound
- Southbound off-ramp to Route 9 westbound
- Southbound in-ramp from Route 9 westbound

During the AM peak hour, the following I-495 ramps experience high volumes:

- Northbound off-ramp to Route 9 westbound (1,355),
- Southbound off-ramp to Route 9 eastbound (1,150),
- Southbound off-ramp to Route 9 westbound (1,110), and
- Northbound off-ramp to Route 9 eastbound (950).

It is worth noting that each of these high volume ramps in the morning is an off-ramp to Route 9. This indicates the presence of employment in the area that is being accessed by Route 9 via I-495. The high

percentages of ramp traffic in the peak hour indicate that a high proportion of traffic is work related. During the PM peak hour, the following I-495 ramps experience high volumes:

- Southbound on-ramp from Route 9 eastbound (1,620),
- Northbound off-ramp to Route 9 westbound (945),
- Northbound on-ramp from Route 9 westbound (945), and
- Northbound on-ramp from Route 9 eastbound (940).

It is noted that three of these four high volume ramps in the afternoon peak hour are on-ramps to I-495 which is indicative of employees leaving work along Route 9 traveling home via I-495. It is noted that volume balancing was done between locations and between count methods, i.e. ATR counts versus turning movement counts. Where applicable, the peak hour counts were adjusted upward to represent a conservative condition. As a result, the afternoon peak hour volumes may be somewhat high in some cases.

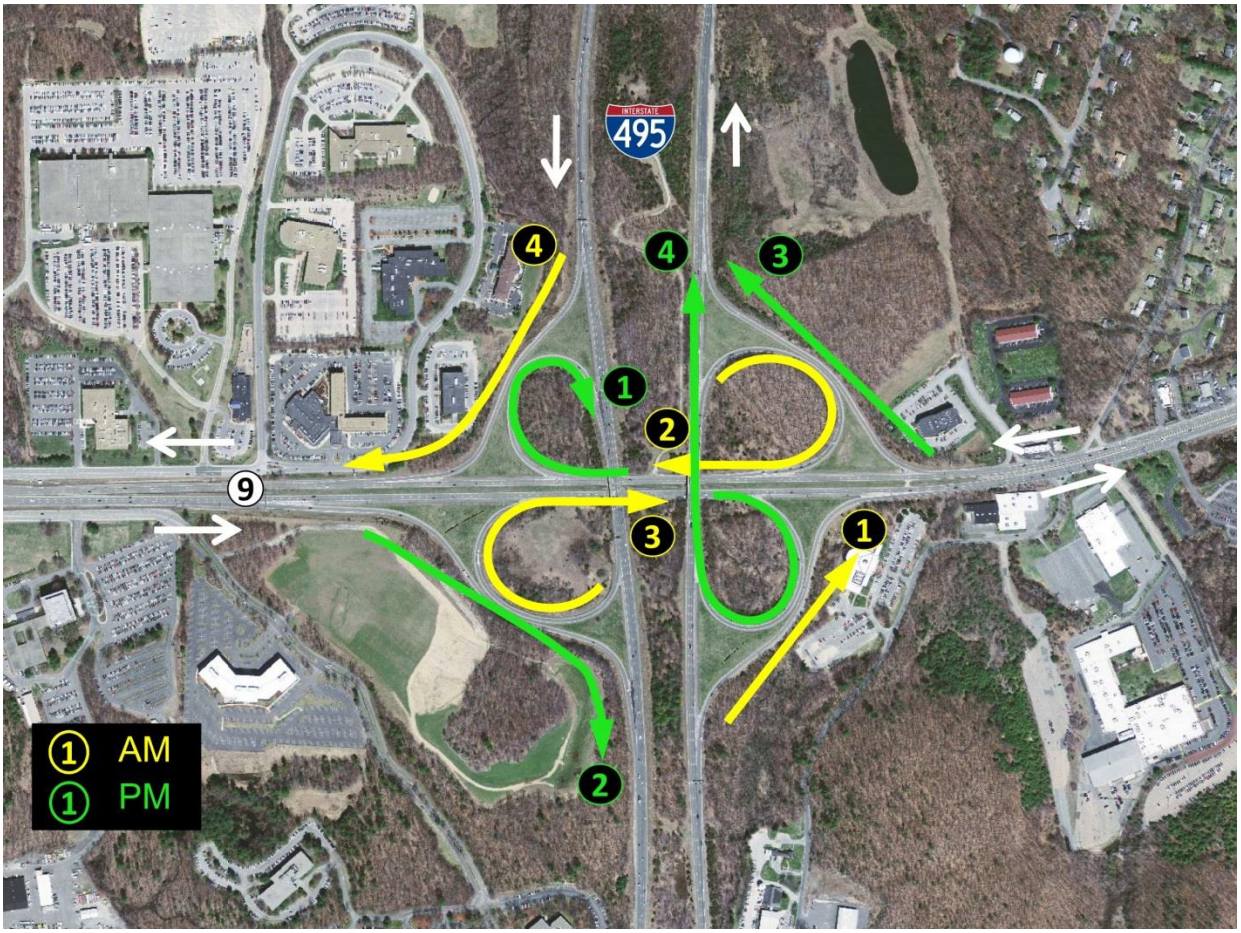
The traffic volumes at the I-495/Route 9 interchange demonstrate a commuter travel pattern in the AM and PM peak periods. The patterns depict commuters traveling from home to work from I-495 to Route 9 in the morning and reversing this pattern in the afternoon to return home. The key patterns are:

1. Northbound I-495 to eastbound Route 9 in AM and westbound Route 9 to southbound I-495 in PM,
2. Northbound I-495 to westbound Route 9 in AM and eastbound Route 9 to southbound I-495 in PM,
3. Southbound I-495 to eastbound Route 9 in AM and westbound Route 9 to northbound I-495 in PM, and
4. Southbound I-495 to westbound Route 9 in AM and eastbound Route 9 to northbound I-495 in PM.

These peak commuting travel patterns are summarized graphically in Figure 2.4-10.

Saturday daily and peak hour traffic volumes are lower than weekday volumes at all ramps at the I-495/Route 9 interchange.

Figure 2.4-10: High Volume Traffic Movements at the I-495/Route 9 Interchange



I-495/I-90 Interchange

Average weekday daily traffic on all ramps is approximately 20,000 vehicles. all ramps experience traffic volumes over 1,300 vehicles during the AM peak hour except for the I-90 westbound on-ramp which has a volume of 950 vehicles. The ramps with the highest volumes during the AM peak hour are:

- I-90 eastbound on-ramp (2,570),
- I-495 northbound off-ramp (1,950),
- I-90 eastbound off-ramp (1,850), and
- I-495 northbound on-ramp (1,740).

These ramp volumes show that the peak travel directions in the AM peak hour are eastbound for I-90 and northbound for I-495.

The ramps with the highest volumes during the PM peak hour are:

- I-90 westbound off-ramp (2,330),
- I-495 southbound on-ramp (2,030),
- I-90 westbound on-ramp (1,775), and
- I-495 southbound off-ramp (1,750).

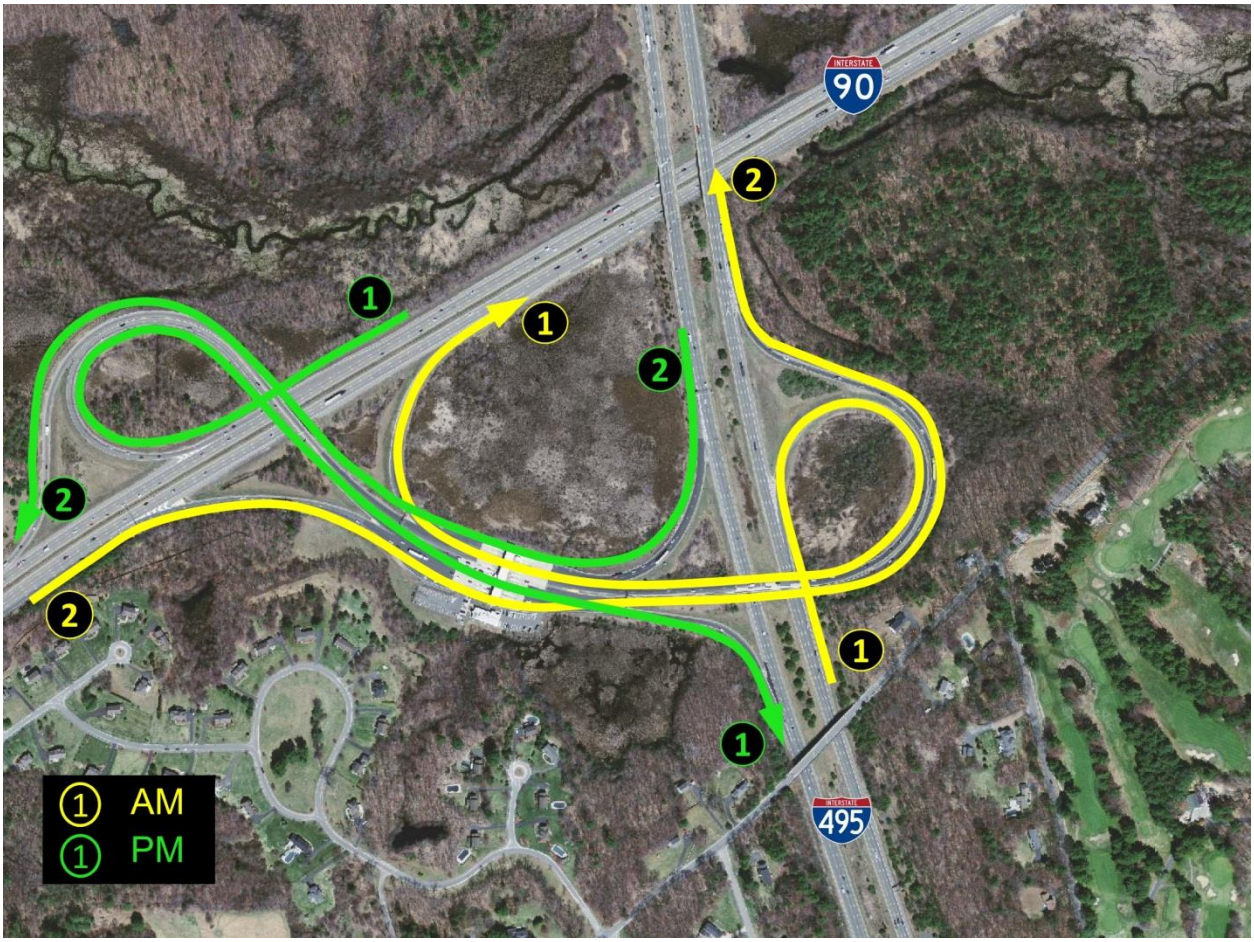
These ramp volumes show that the peak travel directions in the PM peak hour are westbound for I-90 and southbound for I-495, the reverse of the AM peak hour.

Like the I-495/Route 9 interchange, the traffic volumes at the I-495/I-90 interchange show a commuter travel pattern in the AM and PM peak periods. The patterns depict commuters traveling from home to work in the morning and reversing this pattern in the afternoon to return home. The key patterns are:

1. Northbound I-495 to eastbound I-90 in AM and westbound I-90 to southbound I-495 in PM, and
2. Eastbound I-90 to northbound I-495 in AM and southbound I-495 to westbound I-90 in PM.

These peak commuting travel patterns are summarized graphically in Figure 2.4-11.

Figure 2.4-11: High Volume Traffic Movements at the I-495/I-90 Interchange



Comparison to Historic Traffic Volumes

Comparisons between current 2011 traffic volumes and historic traffic volumes for mainline highways, interchange ramps, and intersections are discussed in this section. Traffic volume data previously collected in the study area by others was reviewed. This includes data from the following sources:

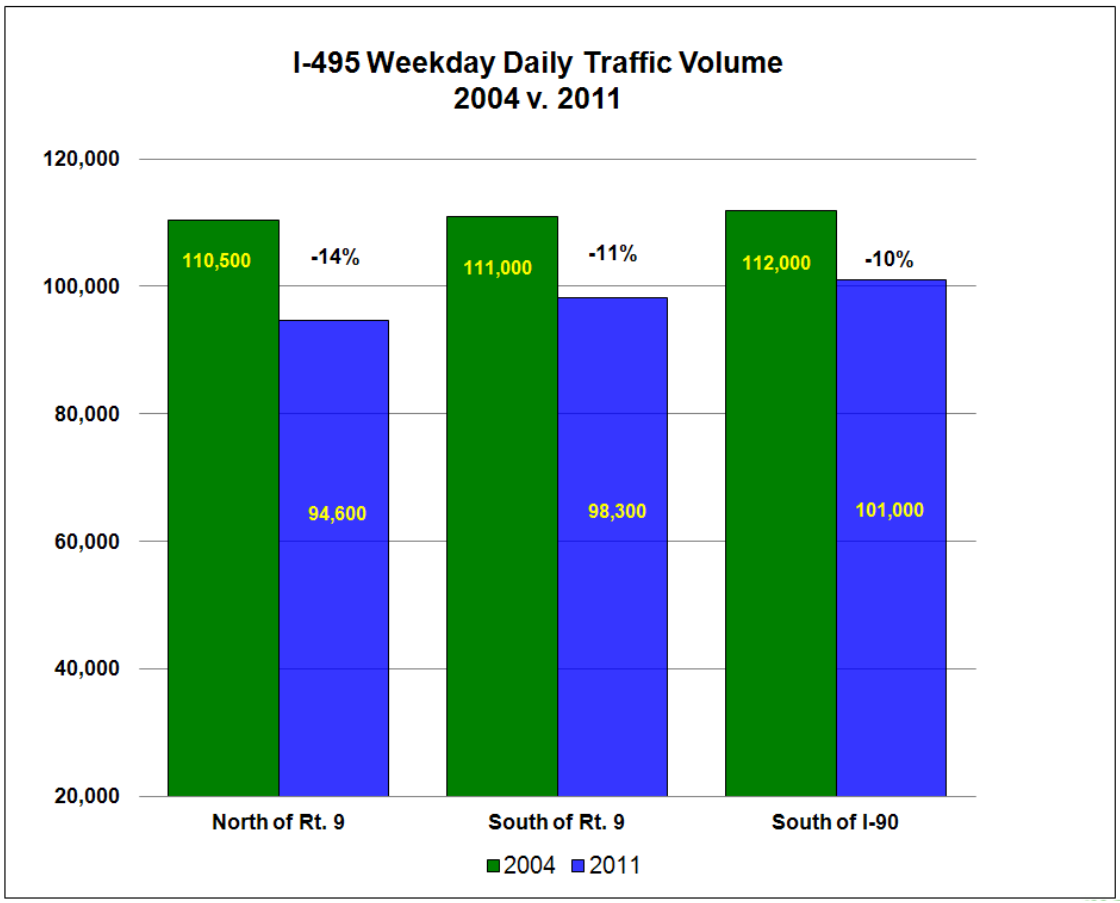
- MassDOT Highway mainline and ramps volumes, 2004;

- Central Massachusetts Regional Planning Commission (CMRPC) website;
- Route 9 East (Shrewsbury-Westborough) Corridor Profile, October 2005, CMRPC;
- I-495 Study – I-290 to I-90, Final Report, September 16, 2009, CMRPC;
- Mobility in the Boston Region, Existing Conditions and Next Steps, The 2004 Congestion Management System Report, Central Transportation Planning Staff (CTPS);
- Town of Westborough Master Plan, Final Report, May 2003; and
- The Case for A I-495 Corridor Study in Massachusetts, June 2009, 495/MetroWest Partnership.

Historic traffic volumes along I-495 in Westborough show that average daily traffic volumes (ADT) increased on this corridor by over 35 percent (3.9 percent/year) between 1991 and 2000[25]. Beginning in year 2000, the traffic growth along I-495 in the study area has varied, depending on the location. South of I-90 in Hopkinton, I-495 ADT increased by 19 percent between 2001 and 2004. For the section south of Route 9 in Westborough, I-495 ADT increased by 3 percent between 2001 and 2006.

Figure 2.4-12 compares 2011 I-495 daily traffic volumes to the historic year 2004 traffic volumes. The figure shows that daily traffic volumes on I-495 in the study area have decreased by approximately 10 percent since 2004.

Figure 2.4-12: 2004 v. 2011 I-495 Weekday Daily Traffic Volume



[25] *Town of Westborough Master Plan, Final Report, May 2003.*

Figure 2.4-13 shows 2011 peak hour volumes on I-495 compared with 2004 volumes. The results show that peak hour volumes on I-495 in the study area have decreased between 2 percent and 9 percent since 2004.

Figure 2.4-13: 2004 v. 2011 I-495 Peak Hour Traffic Volume

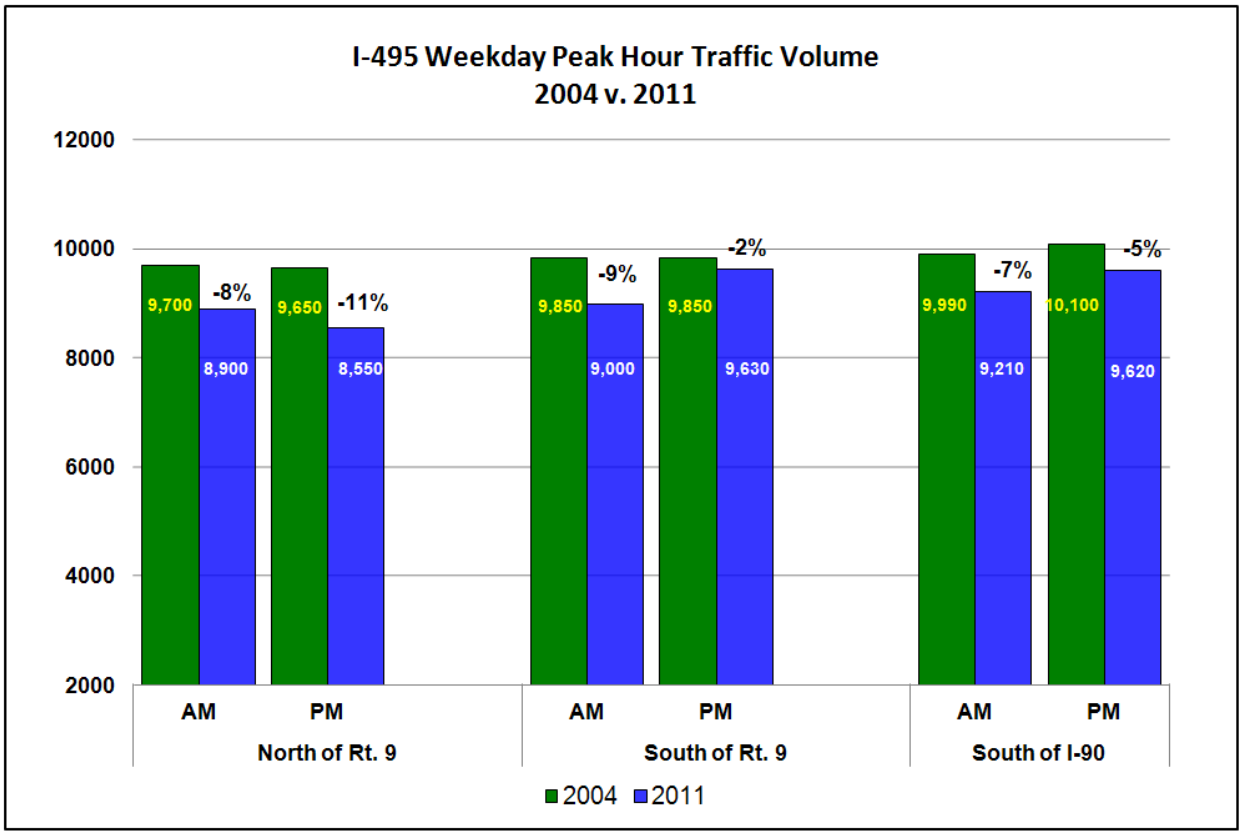


Figure 2.4-14 shows Route 9 PM peak hour traffic volumes for years 2011 and 2004. The charts indicate that traffic volumes on Route 9 have increased by 17 percent east of I-495 and 24 percent west of I-495 since 2004.

Figure 2.4-14: 2004 v. 2011 Rt. 9 PM Peak Hour Traffic Volume

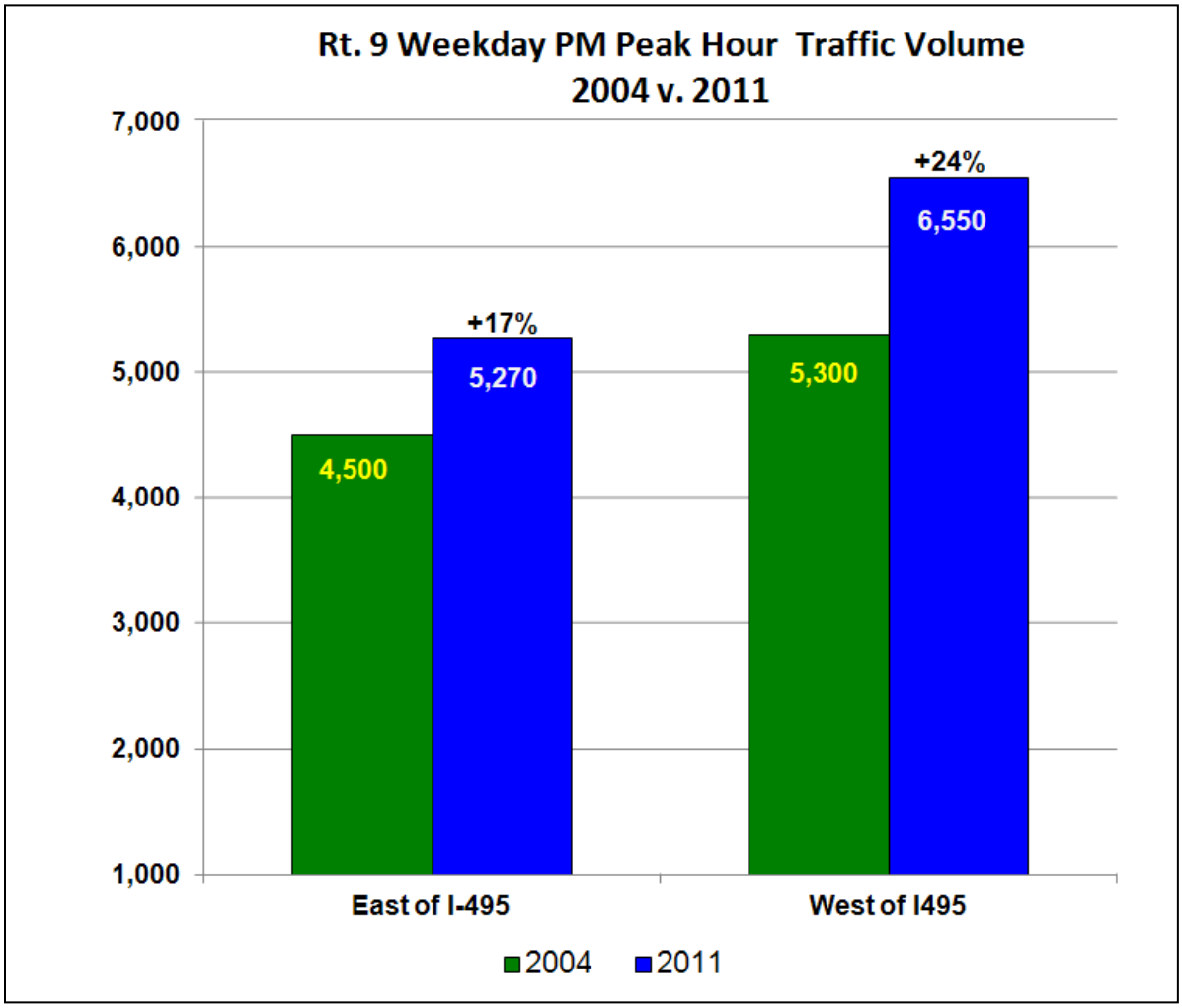
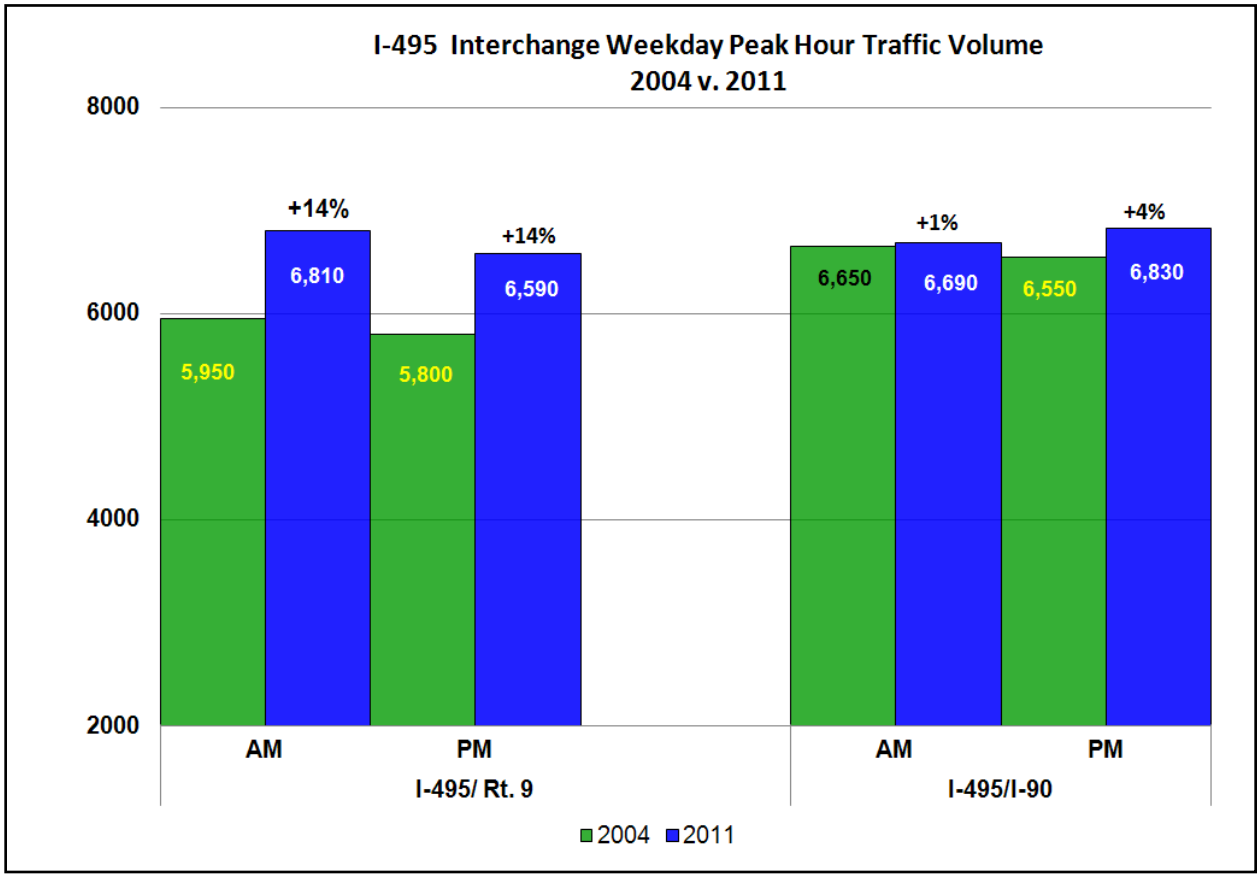


Figure 2.4-15 compares the peak hour total interchange volumes (all ramps) for I-495/Route 9 and I-495/I-90 for the years of 2004 and 2011. At the I-495/Route 9 interchange, total ramp volumes have increased by 14 percent in the AM and PM peak hours. At the I-495/I-90 interchange, total ramp volumes have increased slightly (1 to 4 percent) between 2004 and 2011.

Figure 2.4-15: 2004 v. 2011 I-495/Route 9 and I-495/I-90 Peak Hour Total Interchange Volumes



Saturday daily and peak hour traffic volumes are lower than weekday volumes at all ramps at the I-495/I-90 interchange, except at the I-90 westbound on-ramp where the Saturday peak hour volume (1,350) is greater than the weekday AM peak hour volume (950).

Intersection Traffic Volumes

Manual intersection turning movement counts were conducted at the study intersections midweek between 7:00 and 9:00 AM and 4:00 and 6:00 PM from September 13 to September 20, 2011. The AM peak hour generally occurred between 7:30 and 8:30 AM. The PM peak hour generally occurred between 4:45 and 5:45 PM. The traffic volumes were adjusted and balanced as necessary to account for counts on different days and volume differences between intersections.

Figures 2.4-16 through 2-4-19 show the Existing 2011 weekday peak hour turning movement traffic volumes at the study intersections for areas east of I-495 and west of I-495, respectively. Vehicle turning movement counts are provided in the Appendix.

Figure 2.4-16: Study Intersections East of I-495 – Existing Conditions 2011 Weekday AM Peak Hour

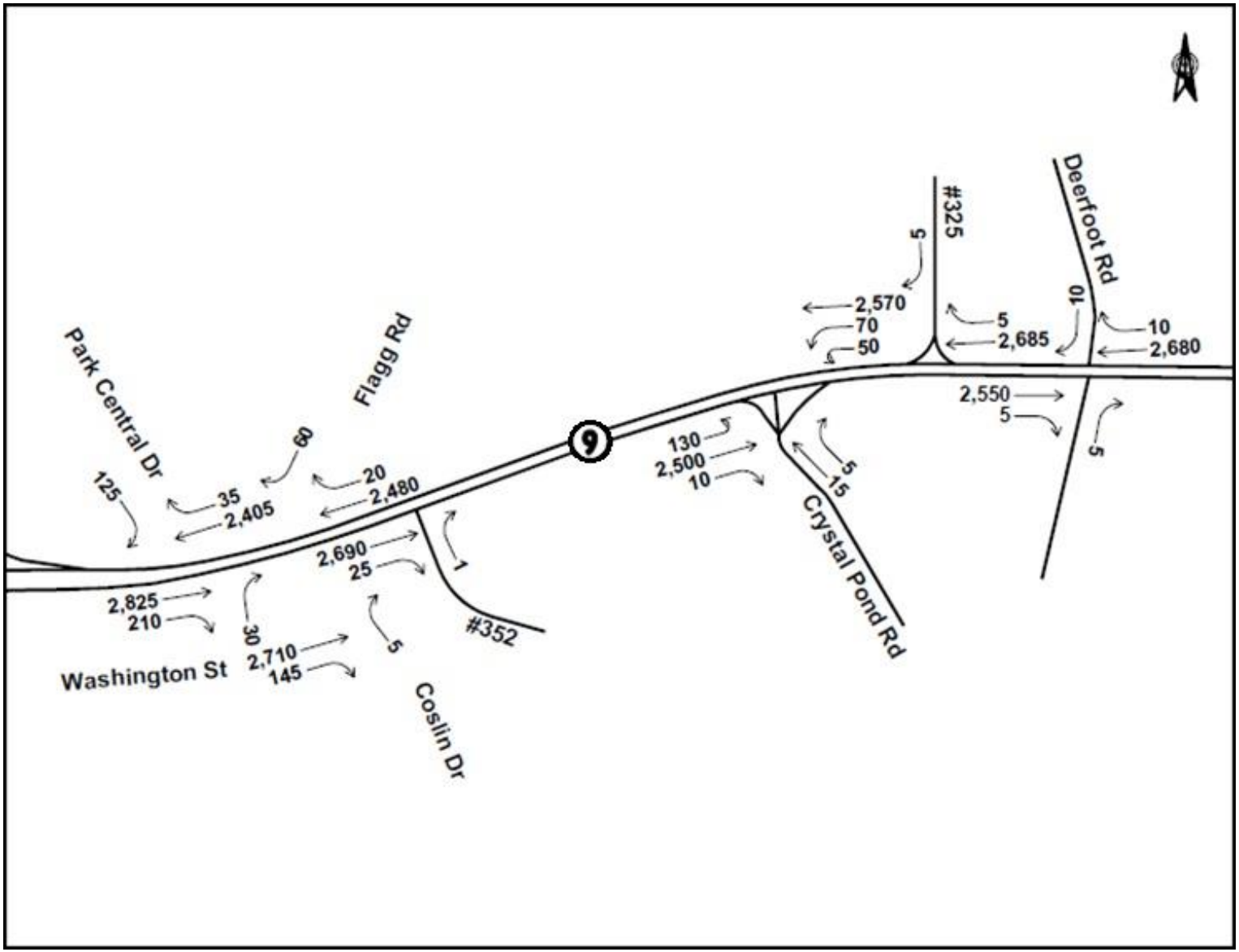


Figure 2.4-17: Study Intersections East of I-495 – Existing Conditions 2011 Weekday PM Peak Hour

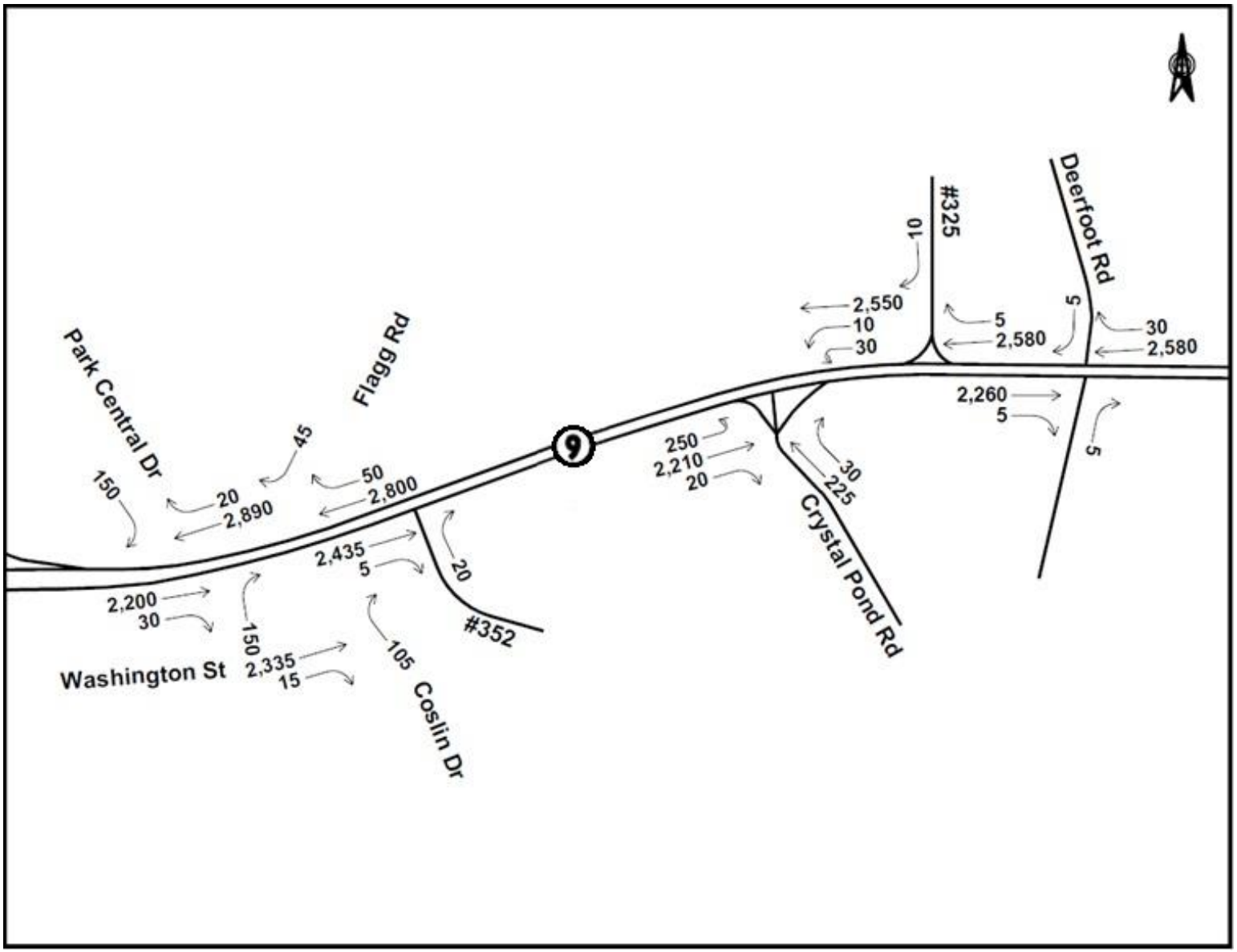


Figure 2.4-18: Study Intersections West of I-495 – Existing Conditions 2011 Weekday AM Peak Hour

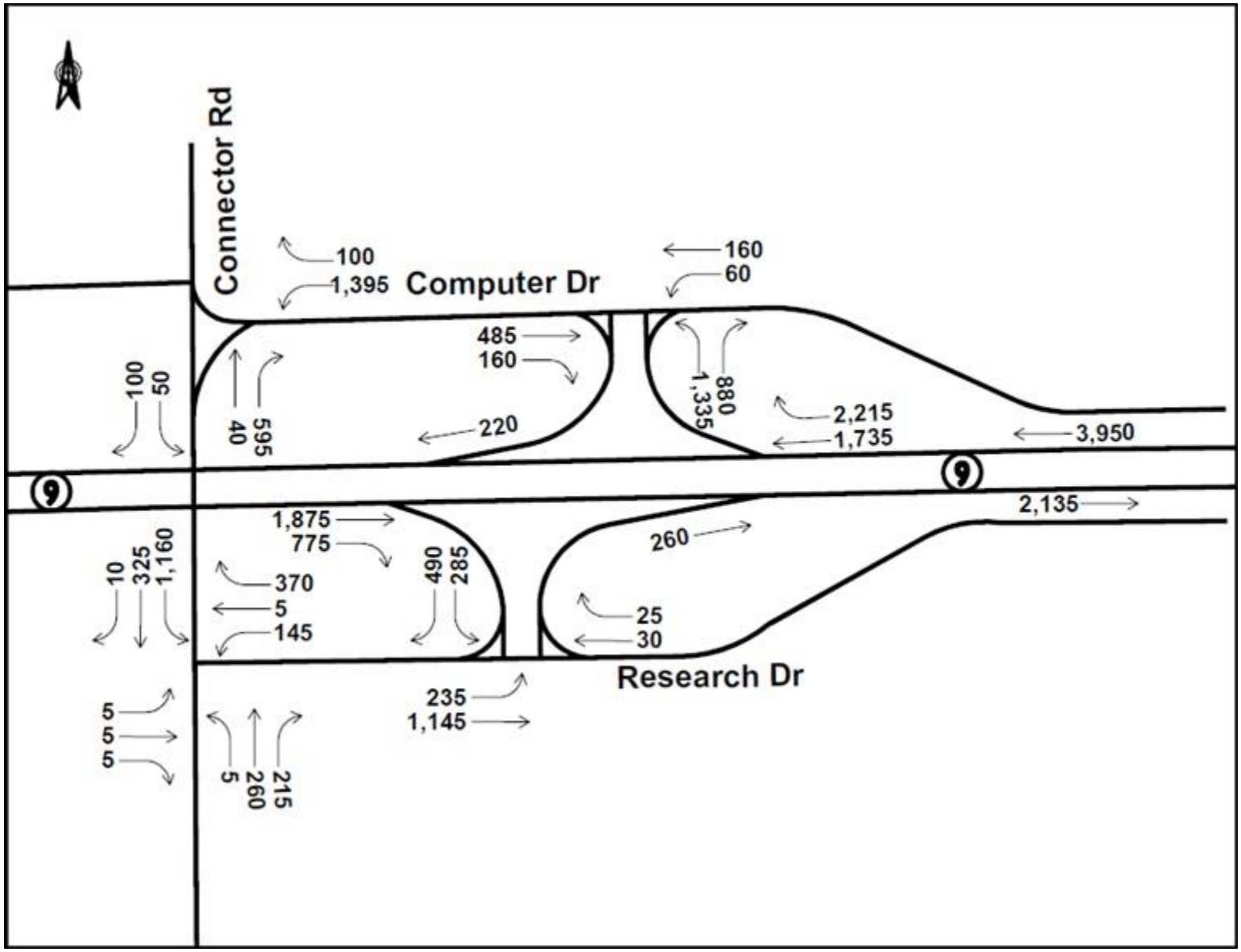
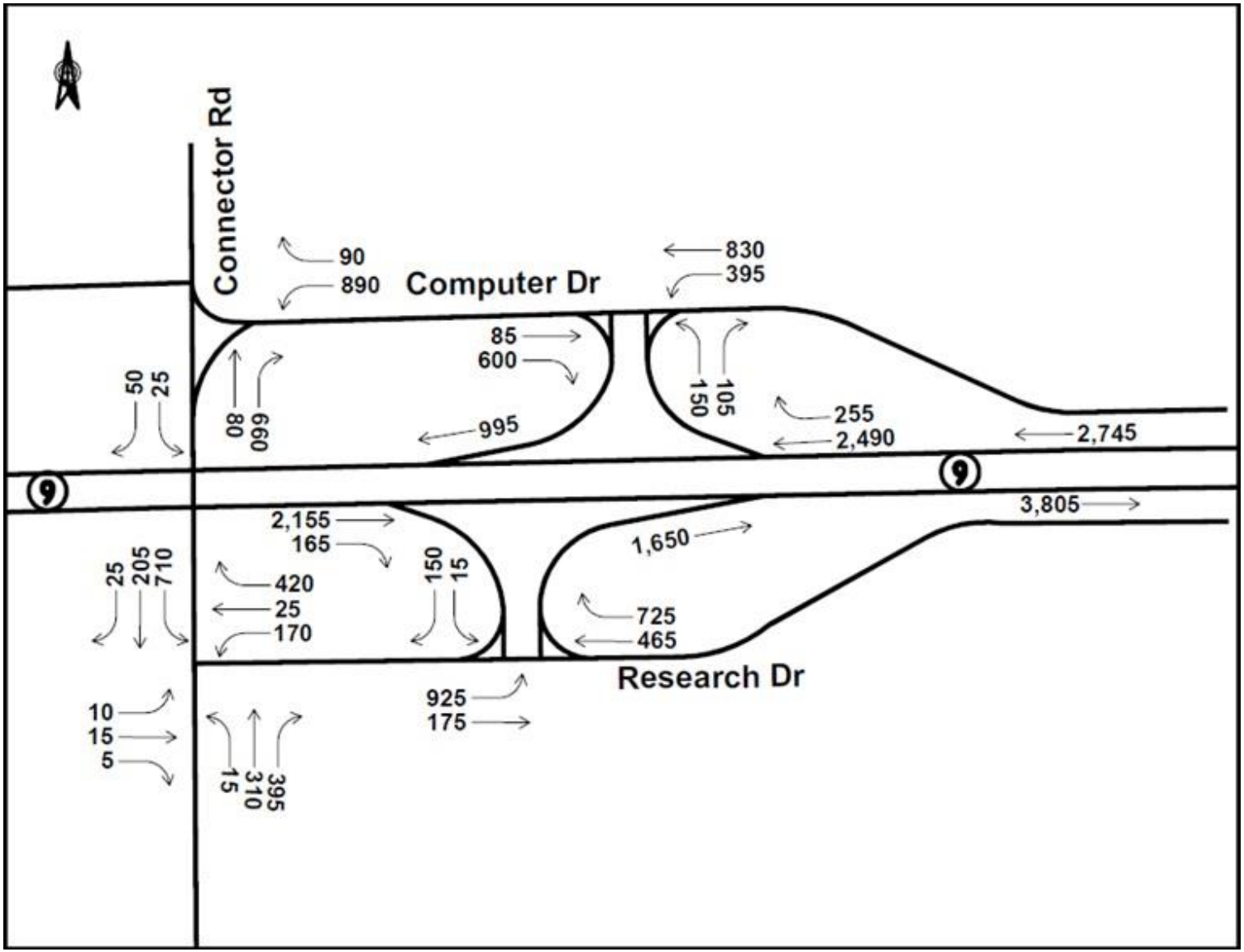


Figure 2.4-19: Study Intersections West of I-495 – Existing Conditions 2011 Weekday PM Peak Hour



2.4.4 Vehicle Classification

Vehicle classification was reviewed for study roadways (I-495 and I-90) and study intersections based on data collected for this study. Information of heavy vehicles on I-495 and I-90 in the study area was provided by Boston MPO/CTPS as part of regional truck study, *Results of the Boston MPO's 2010 Freight Study – A Profile of Truck Impacts,* March 15, 2012. Table 2.4-9 summarizes the percent of heavy vehicles (trucks and buses) for average weekday daily traffic. The table shows that the percent of daily heavy vehicles on I-495 in the study area ranges between 9 and 12 percent, with the highest percent south of I-90. This Boston MPO Freight Study found that this location had the third highest share of trucks in the study region[26]. In addition, the Freight Study found that I-495 south of I-90 had the third highest ratio of tractor-trailer trucks to single-unit trucks (1.9:1.)[27]. On I-90, heavy vehicles represent 11 percent of daily weekday traffic west of I-495 and 6 percent east of I-495.

Table 2.4-9: Existing Heavy Vehicles on Study Interchanges (Year 2011)

Location	Heavy Vehicle Percent of Average Weekday Traffic [1]
I-495 north of Route 9	8.9%
I-495 south of Route 9	9.5%
I-495 south of I-90	12.6%
I-90 east of I-495	6.2%
I-90 west of I-495	11.6%

Note: 1. Includes 6/ wheel trucks and buses
Source: CTPS and Boston MPO.

Truck and bus volumes were collected as part of the vehicle turning movements counts conducted at the study intersections. The counts were taken midweek between 7:00 and 9:00 AM and 4:00 and 6:00 PM from September 13 to September 20, 2011.

Truck and bus traffic accounted for approximately three percent of the total traffic volume during the AM peak and about two percent during the PM peak hour. Truck and bus volume counts are provided in the Appendix as part of the vehicle turning movement counts.

2.4.5 Travel Speeds

Historic and current vehicle travel speeds on I-495 and Route 9 in the study area were reviewed and summarized. Vehicle travel speed data collected by others include:

- Mobility in the Boston Region, Existing Conditions and Next Steps, The 2004 Congestion Management System Report, CTPS ;
- MassDOT Travel Speeds, I-495 West, Fall 2004-Fall 2005; and
- Regional Transportation Plan, 2011, CMRPC.

[26] Results of the Boston Region MPO's 2010 Freight Study – A profile of Truck Impacts, Table 5, page 15, Boston Region MPO, March 15, 2012.
[27] *Results of the Boston Region MPO's 2010 Freight Study – A profile of Truck Impacts,* Table 7, page 21, Boston Region MPO, March 15, 2012.

Table 2.4-10 summarizes the travel speed data collected in the study area by others between 1999 and 2011. The data shows that the average peak period travel speeds on I-495 speeds in the study area have consistently been over 60 MPH between 1999 and 2005. Peak period travel speeds on Route 9 ranged between 35 and 49+ MPH with the fastest speeds occurring west of I-495. The slowest average speeds (35-42 MPH) on Route 9 were recorded east of the Westborough town line. This is most likely a result of the signalized intersection at Crystal Pond Road. The I-495 off-ramps to I-90 reflected the biggest difference in average speeds between peak periods. The northbound I-495 off-ramp to I-90 had an average travel speed 10 MPH slower (56 MPH) than the southbound off-ramp (66 MPH) in the AM peak period with this pattern reversing in the PM peak period. These conditions are reflective of the peak period traffic volume patterns (see Table 2.4-8 Existing Traffic Volumes table).

Spot travel speed observations were conducted in the study area in 2011 and 2012. Observations were made by driving at the prevailing speed of general traffic. These informal observations indicated that travel speeds on several study roadways are currently lower (on given days) than reported historic speed surveys. Locations where congestion and slow travel speeds were observed include:

- I-495 northbound off-ramp to I-90 – AM peak period,
- I-495 southbound on-ramp from I-90 – PM peak period,
- I-495 southbound off-ramp to I-90 – PM peak period,
- Route 9 eastbound east of I-495 – AM peak period, and
- Route 9 westbound west of I-495 (queues extending upstream from Lyman Street) – PM peak period.

Table 2.4-10: Roadway Speeds (MPH)

	AM Peak Period		PM Peak Period	
	NB/EB	**SB/WB**	**NB/EB**	**SB/WB**
Highway Segments				
I-495 between I-90 & Rt.9				
1999-2000 (1)	60+	60+	60+	60+
2004-2005 (2)	64-65	64-66	65-67	62-66
Rt. 9 between I-495 & Southborough TL				
1999-2000	NA	NA	43+	43+
Rt. 9 east of Westborough TL				
1999-2000	NA	NA	35 – 42	35 - 42
Rt. 9 west of I-495				
2001-2010 (3)	40-49	>49	>49	>49
Highway Ramps				
I-495 Off-Ramp to Rt. 9 EB				
1999-2000	59	62	66	66
I-495 Off-Ramp to I-90				
1999-2000	56	66	68	60

Notes:

1 Mobility in the Boston Region, Existing Conditions and Next Steps, The 2004 Congestion Management System Report, CTPS

2 MassDOT Fall 2004 - Fall 2005

3 Regional Transportation Plan, 2011, CMRPC

2.4.6 MassTurnpike Traffic Distribution

The origin distribution of E-ZPass traffic through the I-495/I-90 interchange was reviewed. MassDOT provided vehicle registration information for E-ZPass vehicles entering and exiting the MassPike at I-495 between 7:00 and 9:00 AM for the period between May 14 and May 21, 2011. No ramp directional information was available.

Table 2.4-11 summarizes the E-ZPass vehicle distribution at the I-495/I-90 interchange. The results show that over 50 percent of the weekday AM peak traffic entering the MassPike originated form communities south (34 percent) and west (23 percent) of I-495. A total of 87 percent of traffic exiting the MassPike during the AM period originates from locations east and west of I-495. Saturday and Sunday show similar patterns as the weekday but are generally more balanced.

Table 2.4-11: MassPike/I-495 Interchange Distribution of E-ZPass Vehicles - 7:00-9:00 AM, May 14-21, 2011

Vehicle Registration Origin[1]	Weekday Average[2]		Saturday Average[3]		Sunday[4]	
	Percent Entering MassPike	Percent Exiting MassPike	Percent Entering MassPike	Percent Exiting MassPike	Percent Entering MassPike	Percent Exiting MassPike
East	7%	43%	9%	37%	10%	34%
West	23%	44%	18%	37%	26%	39%
North/Northeast	9%	4%	9%	7%	8%	6%
South	34%	4%	32%	10%	28%	11%
Southeast	9%	2%	10%	4%	7%	4%
Local[4]	18%	3%	22%	4%	20%	6%
TOTAL	100%	100%	100%	100%	100%	100%

Notes:

1. The origins were defined by identifying the zip code community for each Fast Lane vehicle recorded. No data for cash vehicles was provided. Cities and towns were then identified for each zip code and summarized by direction.
2. Average of 5 weekdays between Monday, 5/16/11 and Friday, 5/20/11
3. Average of 2 Saturdays, 5/14/11 & 5/21/11
4. Sunday, 5/15/11
5. Hopkinton, Marlborough, Northborough and Southborough

Source: MassDOT

2.4.7 Crashes

Vehicle crashes in the study area were reviewed for the three most recent years (2007-2009) available from the MassDOT Crash database, which is the standard procedure for planning studies. For this study, the MassDOT Crash data was sufficient to identify issues and potential causes of vehicle crashes. As a result, detailed review of vehicle collision diagrams that is sometimes used for specific safety studies and crash reconstruction efforts was not required for this study.

Crashes at roadways, ramps, and intersections were identified. Crashes reported at each location were summarized by severity, crash type, time of day, day of the week, road surface conditions, and year. It is noted that the level of reporting varies greatly for each crash record. As a result, exact locations could not

be identified for many of the crashes. Crash locations were summarized as best as possible, but even then it is difficult to identify specific locations. This is particularly true for interchange and ramps locations. Where specific crash locations could not be identified, they were classified as "unspecified locations". Table 2.4-12 at the end of this section summarizes the crashes reported in the study area between 2007 and 2009.

The I-495/I-90 interchange experienced the most crashes in the study period with a total of 208. The I-495 southbound off-ramp to I-90 had 82 crashes. About one-quarter (20) of these involved an injury which often indicates high speed. Over one-half (57 percent) of these crashes were rear-end and over one-third (34) occurred during the weekday commuter peak period. The I-495 northbound off-ramp to I-90 had a total 53 crashes during the study period. Approximately one-quarter (14) of these involved an injury and about 40 percent (21) were rear-end collisions. Almost half (45 percent) occurred during the weekday commuter peak period and over one-third (19) occurred on a wet surface. The results for both of these locations suggest that a high proportion of crashes occurred when queues were present during peak commuting periods. Tire skid marks were observed on the I-495 mainline approaches to the I-90 off-ramps. *The 2004 Congestion Management System Report, Mobility in the Boston Region, Existing Conditions and Next Steps*, CTPS, identified the I-495/I-90 interchange as being #32 on the list of Top 60 Crash Locations on Limited-Access Highways in the Boston Region (1997-1999)[28]. The interchange was reported to have a total of 213 crashes between 1997-1999.

A recently completed study, *The MPO Freight Study – A Profile of Truck Impacts (approved by the Boston MPO on March 15, 2012),* identifies the locations with the highest number of truck crashes for three specific facility types – highway interchanges, arterial roadway intersections, and rotaries between 2006 and 2008. The I-495/I-90 interchange has been identified by the study as one of the high-crash locations in the highway interchange category[29]. In addition, the MPO Freight Study shows that the I-495/I-90 interchange is the 2nd highest truck crash location for limited access highways in the region[30].

A Crash Rate was calculated for I-495 in the study area using MassDOT methodology. A total of 12 crashes were identified for main-line I-495 in the study area between 2007 and 2009. The calculated Crash Rate is 0.04 crashes per million vehicle miles traveled (MVMT). This Crash Rate is below the state average for both rural interstates (0.30) and urban interstates (0.58). This further demonstrates that the interchanges in this section of I-495 are more of a safety issue than the mainline segments.

The I-495/Rt. 9 interchange experienced a total of 106 crashes during the study period. The I-495 southbound off-ramp to Route 9 westbound had the highest number of crashes at this interchange with 32. One-quarter (8) of the crashes involved an injury. About one-half (15) of the crashes were rear-end and about one-third (10) occurred during the peak commute periods. A total of 12 crashes (38 percent) occurred on a wet surface. Tire skid marks were observed on the I-495 southbound mainline approach to the Route 9 westbound off-ramp.

[28] Table 3.17, CTPS and MassHighway – Traffic Operations and Safety Unit, *Top 1000 High Crash Locations Report (1997-1999), August 2002.*
[29] *TransReport* . The Newsletter of the Boston Region Metropolitan Planning Organization. May/June 2012. http://archives.lib.state.ma.us/bitstream/handle/2452/119262/ocm10561343-2012-05-06.pdf?sequence=1
[30] Table 12, page 26, Results of the Boston Region MPO's 2010 Freight Study – A Profile of Truck Impacts, Boston Region MPO, March 15, 2012.

Intersection of Route 9/Crystal Pond Road

The signalized intersection of Route 9/Crystal Pond Road had the highest number of crashes of any study intersection with 28 reported crashes during the study period. Almost 40 percent (11) of the crashes involved injury and 89 percent (25) were rear-end crashes. Over 80 percent (23) occurred during the weekday. Vehicle queuing on Route 9 eastbound west of the intersection and restricted sight distance are likely factors in the high number of rear-end crashes at this location. The picture above shows a badly damaged guard rail on the southeast corner of this intersection, which is reflective of a high speed crash. It is noted that this guardrail has been repaired since the picture was taken.

The signalized intersection of Route 9 westbound on/off-ramps/Computer Drive had 12 reported crashes over the study period. The *Westborough Master Plan, Final Report, 2003* indicates that this intersection experienced 18 crashes between 1997 and 1999. The signalized intersection of Connector Road/ Research Drive had 10 reported crashes. All other study intersections had 8 or fewer crashes during the study period.

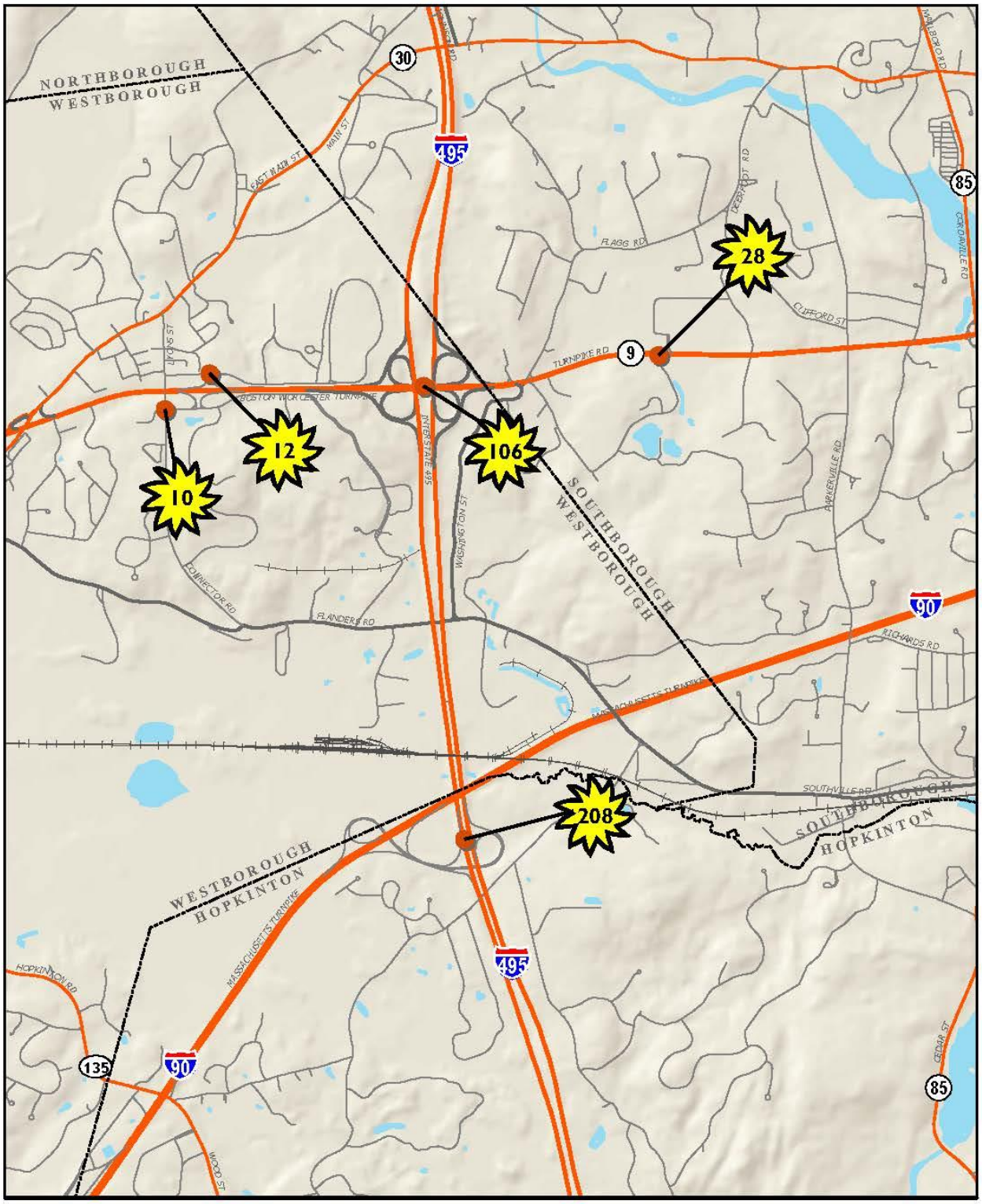
The *Route 9 East (*Shrewsbury-*Westborough) Corridor Profile* conducted by CMRPC in October 2005 reported that the intersection of Connector Road/Research Drive experienced 21 crashes between 2002 and 2004. The calculated crash rate of 0.836 exceeded the MassDOT District 3 Crash Rate of 0.80.

Figure 2.4-20 shows high crash locations in the study area.

The main safety issues at these high crash locations are:

- I-495 SB Off-ramp to I-90; I-495 northbound Off-ramp to I-90; I-495 SB Off-ramp to Rt. 9 WB – high volumes, congestion, queuing, high speeds for roadway geometry
- I-90 to I-495 NB On-Ramp – tight turning radius leads to truck roll-overs
- Rt. 9/Crystal Pond Rd – high volumes, vehicle queuing, sight distance leads to rear-end collisions, particularly eastbound on Rt. 9
- Rt. 9 WB Ramps/Computer Drive – high volumes, queuing, congestion, short stacking area off ramps
- Connector Rd./Research Dr. – high turning volumes, congestion, queuing

Figure 2.4-20: Crash Summary 2007 – 2009



Data provided by MassGIS and MassDOT.

0 0.5 1
Miles

Table 2.4-12: Project Study Area Crash Summary - (2007-2009)

Location	Severity				Crash Type					Time of Day		Day		Road Surface				Year			Total
	Property	Injury	Other/ Not Reported	Fatality	Head-on	Angle	Rear-end	Side-swipe	Other/ Unknown	Weekday Peak Period	Other	Weekday	Weekend/ Holiday	Dry	Wet	Snow/ Ice	Other	2007	2008	2009	
I-495/ Rt. 9																					
Ramps																					
I-495 NB at Off-Ramp to Rt. 9 EB (A)*	6	6	1			1	3	2	7	7	6	10	3	4	4	4	1	3	7	3	13
I-495 NB at Rt. 9 EB On-Ramp (B)	2	1				1	1		1	1	2	3		2		1		2		1	3
I-495 NB at Off-Ramp to Rt. 9 WB (C)	5	1	2		1		3	1	3	2	6	6	2	7	1			3	4	1	8
I-495 NB at Rt. 9 WB On-Ramp (D)	1	1					2			1	1	2		1		1		1	1		2
I-495 SB at Off-Ramp to Rt. 9 WB (E)	21	8	3		2		15	3	12	10	22	27	5	19	12	1		6	15	11	32
I-495 SB at Rt. 9 WB On-Ramp (F)	2	1					1		2	1	2	3		2	1			2		1	3
I-495 SB at Off-Ramp to Rt. 9 EB (G)	11	3	3			4	10	2	1	10	7	17		12	3	2		10	4	3	17
Rt. 9 EB Ramp to I-495 SB (H)	3					1		1	1	1	2	2	1	1	1	1		2	1		3
Subtotal	51	21	9		3	7	35	9	27	33	48	70	11	48	22	10	1	29	32	20	81
Unspecified Locations																					
Rt. 9 EB at I-495 NB	1								1		1	1		1				1			1
Rt. 9 EB at I-495	1								1		1		1		1			1			1
I-495 NB at Rt. 9	11					1	4	3	3	4	7	7	4	6	1	4		1	5	5	11
I-495 SB at Rt. 9	4	1		1		2	1		3	3	3	4	2	3	2	1		3	2	1	6
I-495 NB at Rt. 9 WB Ramps	5	1					3	1	2	1	5	4	2	4	1	1			1	5	6
Subtotal	22	2		1		3	8	4	10	8	17	16	9	14	5	6		6	8	11	25
Total Interchange	**73**	**23**	**9**	**1**	**3**	**10**	**43**	**13**	**37**	**41**	**65**	**86**	**20**	**62**	**27**	**16**	**1**	**35**	**40**	**31**	**106**
I-495 Mainline																					
I-495 SB north of Rt. 9	2	2					2	1	1	3	1	4		4				1	2	1	4
I-495 NB north of Rt. 9	1								1	1		1			1					1	1
I-495 SB between Rt. 9 and I-90	6	1					5	1	1	3	4	6	1	4	1	2		4	2	1	7
Subtotal	9	3					7	2	3	7	5	11	1	8	2	2		5	4	3	12

Table 2.4-12: Project Study Area Crash Summary - (2007-2009) cont'd

Location	Severity				Crash					Time of Day		Day		Road Surface				Year			Total
	Property	Injury	Other/ Not Reported	Fatality	Head-on	Angle	Rear-end	Side-swipe	Other/ Unknown	Weekday Peak Period	Other	Weekday	Weekend/ Holiday	Dry	Wet	Snow/ Ice	Other	2007	2008	2009	
I-495/I-90																					
Ramps																					
I-495 NB at Off-Ramp to I-90 (I)	36	14	3		1	4	21	6	21	24	29	44	9	34	19			17	24	12	53
I-90 to I-495 NB (J)	8	1					2	1	6	3	6	6	3	3	6			4	1	4	9
I-495 SB at Off-Ramp to I-90 (K)	56	20	6			8	47	8	19	28	54	67	15	59	11	12		35	31	16	82
I-90 to I-495 SB (L)	2	1				1			2	1	2	1	2		2	1			2	1	3
I-495 to I-90 EB (M)																					0
I-90 EB Off-Ramp (N)	1								1		1	1			1				1		1
I-495 to I-90 WB (O)																					0
I-90 WB Off-Ramp (P)			1				1			1		1		1					1		1
Subtotal	103	36	10		1	13	71	15	49	57	92	120	29	97	39	13		56	60	33	149
Unspecified Locations																					
I-90 Ramp to I-495	4		1			2	1	1	1	2	3	4	1	4	1			2	2	1	5
I-495 SB at I-90	24	8				2	17	4	9	9	23	26	6	22	8	2		7	15	10	32
I-495 NB at I-90	8	5	1			1	3	3	7	3	11	9	5	6	5	1	2	6	6	2	14
I-90/ I-495	8					1	3	2	2	2	6	7	1	2	5	1		4	3	1	8
Subtotal	44	13	2			6	24	10	19	16	43	46	13	34	19	4	2	19	26	14	59
Total Interchange	**147**	**49**	**12**		**1**	**19**	**95**	**25**	**68**	**73**	**135**	**166**	**42**	**131**	**58**	**17**	**2**	**75**	**86**	**47**	**208**
I-495 & I-90 Mainline																					
I-495 SB between I-90 Ramps	2	1				1			2	2	1	2	1	1	2			3			3
I-495 NB south of I-90	7	4				1	3	1	6	4	7	9	2	8	3			5	3	3	11
I-495 SB south of I-90	2								2	1	1	1	1		2				2		2
I-90 WB east of I-495 Off-Ramp	4						3	1		3	1	4		3	1			1	1	2	4
Subtotal	15	5				2	6	2	10	10	10	16	4	12	8			9	6	5	20

Table 2.4-12: Project Study Area Crash Summary - (2007-2009) cont'd

Location	Severity				Crash					Time of Day		Day		Road Surface				Year			Total
	Property	Injury	Other/ Not Reported	Fatality	Head-on	Angle	Rear-end	Side-swipe	Other/ Unknown	Weekday Peak Period	Other	Weekday	Weekend/ Holiday	Dry	Wet	Snow/ Ice	Other	2007	2008	2009	
Local Intersections (Westborough)																					
Connector Rd./ Computer Dr.	3					1	1		1		3	2	1		1	1	1	3			3
Connector Rd./ Research Dr.	10					7	2	1		2	8	9	1	7	3			7	3		10
Connector Rd. Near Rt. 9	1						1				1		1		1			1			1
Rt. 9 WB On/Off-Ramps/ Computer Dr.	8	3	1		1	3	4	2	2	4	8	10	2	9	2		1	6	3	3	12
Rt. 9 EB On/Off-Ramps/ Research Dr.	2					1		1		2		2		1		1		1	1		2
Research Dr./ Friberg Pkwy																					0
Subtotal	24	3	1		1	12	8	4	3	8	20	23	5	17	7	2	2	18	7	3	28
Local Intersections (Southborough)																					
Rt. 9 WB at Cumberland Farms Driveway	2		1				2		1	1	2	3		2		1		3			3
Rt. 9 EB at Washington St.	3						2	1		2	1	3		1	1	1		1		2	3
Rt. 9 WB at Wendy's Driveway		1					1			1		1			1				1		1
Rt. 9 WB at Flagg Rd	3	1	1			1	4			4	1	5		2	1		2	1	2	2	5
Rt. 9 EB at #344 Driveway	1						1				1	1		1				1			1
Rt. 9 WB at #325 Driveway	7	1					7		1	4	4	6	2	5	1	2		4	2	2	8
Rt. 9 EB at #304 Driveway	3						2		1	1	2	3		1	2				2	1	3
Rt. 9 at Crystal Pond Rd.	16	11	1			1	25	1	1	8	20	23	5	22	6			11	9	8	28
Rt. 9 at Deerfoot Rd.	5	1	2			1	5	2		2	6	7	1	6	2			3	1	4	8
Rt. 9 EB at Coslin Dr.																					0
Rt. 9 EB at #352 Driveway		1					1			1		1		1				1			1
Rt. 9 WB at Park Central Dr.																					0
Subtotal	40	16	5			3	50	4	4	24	37	53	8	41	14	4	2	25	17	19	61

Source: MassDOT

2.4.8 Traffic Capacity Analysis

Traffic capacity analysis was performed for I-495, Route 9, and the I-495/Route 9 and I-495/I-90 interchanges, as well as study area intersections. The results for each of these are discussed separately below.

Highways

Capacity analysis was performed for the following highway areas:

- I-495 mainline segments,
- I-495/Route 9 weave, merge, diverge;
- I-495/I-90 merge, diverge; and
- Route 9 merge, diverge.

Level of Service (LOS) analysis was performed for the AM and PM peak hours. Based on the methodologies defined in the 2010 Highway Capacity Manual, the operating conditions of basic freeway segments, freeway merges and diverges, and weaving segments are evaluated and assigned a LOS[31] rating of A through F. Similar to the intersection capacity analysis, the LOS ratings show the quality of traffic flow on limited access highways and freeways. However, for these facility types the LOS is based on vehicle density in passenger cars per mile per lane (pc/mi/ln), rather than vehicle delay. The calculated vehicle density is based on ramp volumes and for the geometric layout of the highway facility. LOS E and F are generally considered to represent deficient conditions.

Table 2.4-13 summarizes LOS for the I-495 mainline from north of Route 9 to south I-90 and Route 9. The results show that during the AM peak hour, I-495 northbound south of I-90 and Route 9 westbound west of I-495 operate at LOS E conditions. During the PM peak hour, I-495 southbound south of Route 9 and south of I-90 operate at LOS E. LOS E represents congested traffic conditions, nearing capacity, which result in slower travel times. All other mainline segments operate at LOS D or better during peak hours which represent acceptable conditions.

Table 2.4-13: Summary of I-495 Freeway Segment Capacity Analysis - Existing (2011) Conditions

I-495 Northbound Freeway Segment Description	Weekday AM Peak Hour		Weekday PM Peak Hour	
	Level of Service	Density (pc/mi/ln)[1]	LOS	Density (pc/mi/ln)
I-495 NB north of Rt. 9	C	25.0	C	23.9
I-495 SB north of Rt.9	C	24.7	C	23.1
I-495 NB between Rt.9 and I-90	D	34.6	C	20.5
I-495 SB between Rt.9 and I-90	C	18.4	E	40.1
I-495 NB south of I-90	E	36.8	C	21.3
I-495 SB south of I-90	C	18.4	E	36.7
Rt.9 WB west of I-495	E	40.4	D	26.5
Rt.9 EB west of I-495	C	20.8	D	26.5

Note:

1. Level of Service Passenger cars per mile per lane

[31] Level of Service (LOS) – A letter grade designation used to describe given roadway conditions, with "A" being at or close to free-flow conditions, and "F" being at or close to over-saturation of the roadway. B, C, D and E refer to intermediate conditions.

Table 2.4-14 summarizes the LOS for the interchanges of I-495/Route 9 and I-495/I-90, as well as Route 9 ramps at Research Drive and Computer Drive. The following two ramps operate deficiently during the AM peak hour:

- Route 9 westbound on-ramp from I-495 southbound – LOS E, and
- I-495 northbound off-ramp to I-90 – LOS F.

An additional nine study ramps currently operate at LOS D during the AM or PM peak hours, which is nearing deficient conditions. LOS calculations are provided in the Appendix.

Table 2.4-14: Summary of I-495 and Route 9 Ramp Capacity Analysis - Existing (2011) Conditions

Description	Movement	Level of Service	
		Weekday AM Peak Hour	Weekday PM Peak Hour
I-495/Rt. 9 Interchange			
I-495 NB off-ramp to Rt.9 EB	Diverge from I-495	D	C
I-495 NB mainline between on and off-ramps	Weave on I-495	D	C
I-495 NB on-ramp from Rt.9 WB	Merge to I-495	C	C
I-495 SB off-ramp to Rt. 9 WB	Diverge from I-495	D	C
I-495 SB mainline between on and off-ramps	Weave on I-495	C	C
I-495 SB on-ramp from Rt. 9 EB	Merge to I-495	B	D
Rt.9 EB on-ramp from I-495 NB	Merge to Rt.9	C	B
Rt.9 EB mainline between on and off-ramps	Weave on Rt.9	B	C
Rt.9 WB off-ramp to I-495 NB	Diverge from Rt.9	C	D
Rt.9 WB mainline between on and off-ramps	Weave on Rt. 9	C	C
RT.9 WB on-ramp from I-495 SB	Merge to Rt. 9	E	C
I-495/I-90 Interchange			
I-495 NB off-ramp to I-90	Diverge from I-495	F	C
I-90 to I-495 NB on-ramp	Merge to I-495	D	C
I-495 SB off-ramp to I-90	Diverge from I-495	C	D
I-90 to I-495 SB on-ramp	Merge to I-495	B	D
Rt.9/Research Drive/Computer Drive Ramps			
Rt.9 EB off-ramp to Research Dr	Diverge from Rt.9	B	B
Rt.9 EB mainline between Research Dr and I-495 on-ramp	Weave on Rt.9	B	D
Rt.9 WB off-ramp to Computer Dr	Diverge from Rt.9	B	A
Computer Dr to Rt.9 WB on-ramp	Merge to Rt.9	B	C

Intersections

Intersection capacity analysis was performed for the unsignalized and signalized study intersections for the weekday AM and PM peak hours for the existing conditions. Intersection LOS, vehicle delay, and 95th percentile queues were calculated using the Synchro (Version 7) software. This software applies the methodologies defined in the Highway Capacity Manual, Version, 2000 Edition, and Transportation Research Board. The intersection capacity analysis uses traffic volumes, geometrics and traffic control information to determine the average delay (in seconds) per vehicle. The intersection is then assigned a LOS rating based on the average delay per vehicle. The ratings show the quality of traffic flow at intersections and provide an indication of how well an intersection serves the traffic.

Based on the *2000 Highway Capacity Manual* (HCM), the methodology of determining LOS is different for signalized and unsignalized intersections. For a signalized intersection, the operation of each lane or lane group entering the intersection is considered, and LOS is determined based on overall conditions at the intersection. Usually LOS D or better is acceptable Level of Service. For an unsignalized intersection, it is assumed that traffic on the main street is not affected by traffic on the side streets. Unsignalized intersection LOS is only determined for left-turns from the main street into the minor or side street and all movements from the minor street. The overall LOS for an unsignalized intersection is shown for the most critical movement, which is most often the left-turn movement out of the side street. LOS E and LOS F are common for unsignalized intersections and do not necessarily indicate a need for improvements. The level of acceptable traffic conditions has been changing over time as traffic delay and congestion has steadily increased in urban and suburban areas. Whereas LOS D was long considered acceptable for signalized intersections, many communities are now accepting LOS E and F for peak periods. They feel that it is acceptable to live with longer delays for short periods rather than add lanes and encourage more traffic. LOS E and F for minor legs of unsignalized intersections are often accepted because the traffic volume is often low.

Table 2.4-15 summarizes the existing conditions capacity analysis results at the study intersections. Each of the signalized intersections west of I-495 currently operate at acceptable conditions overall (LOS A-D) in both peak hours. However, there are individual movements that operate deficiently (LOS E-F):

- Connector Road/Research Drive (westbound left/through LOS F PM) and
- Research Drive/Rt. 9 Ramps (westbound through LOS F PM).

During the AM peak hour, the Route 9 northbound left turn onto Computer Drive and southbound left turn on Connector Road onto Research Drive experience long queues of over 500 feet. It is noted that during the PM peak period, the vehicle queue on Route 9 westbound extend from the Lyman Street signal west of the study area, and in turn impact operations at the Computer Drive/Route 9 intersection. The northbound Friberg Parkway approach to Research Drive operates at LOS F with long queues in the PM peak hour. The southbound movement at the unsignalized intersection of Connector Road/Computer Drive operates at LOS F during both peak hours; however, this movement has low traffic volume.

On Route 9 east of I-495, the signalized intersection of Route 9/Crystal Pond Road operates at LOS F in the AM peak hour and LOS D during the PM peak hour. Long vehicle queues are experienced on the Route 9 eastbound and westbound approaches for both the AM and PM peak hours.

Due to high traffic volumes on Route 9, the minor approaches (right turn only) at most of the unsignalized study intersections east of I-495 operate at LOS E or F in one or both peak hours. Long queues were observed at the southbound Park Central Drive approach to Route 9 during the PM peak hour. Intersection capacity analysis calculations are provided in the Appendix.

Table 2.4-15: Summary of Intersection Capacity Analysis - Existing (2011) Conditions

Intersection			AM Peak Hour			PM Peak Hour		
Description	Approach	Movement	LOS	Delay (sec/veh)	95th Queue (ft)	LOS	Delay (sec/veh)	95th Queue (ft)
West of I-495								
Computer Dr and Rt.9 WB Ramps (Signalized)	EB	Thru	D	36	230	B	20	34
		Right	A	0	0	A	1	0
	WB	Left/Thru	B	20	78	B	8	174
	NB	Left	D	37	634	C	25	51
		Right	A	2	0	A	0	0
	Overall		C	23		A	7	
Connector Rd and Research Dr (Signalized)	NB	Left/Thru/Right	D	37	159	D	42	247
	SB	Left	C	30	569	C	33	292
		Thru/Right	A	6	128	A	6	91
	WB	Left/Thru	D	55	230	F	194	313
		Right	B	17	34	B	17	6
	EB	Left/Thru/Right	D	46	21	D	46	44
	Overall		C	28		D	45	
Research Dr and Rt.9 EB Ramps (Signalized)	SB	Left	C	29	96	D	36	11
		Right	A	1	0	A	0	0
	WB	Thru	C	32	18	F	110	207
		Right	A	0	0	A	3	0
	EB	Left	A	10	115	B	14	280
		Left/Thru	B	15	335	A	10	145
	Overall		B	13		C	28	
Connector Rd and Computer Dr	SB	Left/Right	F	629	378	F	77	104
Research Dr and Friberg Pkwy	NB	Left/Right	C	15	5	F	76	300
East of I-495								
Rt.9 and Crystal Pond Rd (Signalized)	NB	Left	D	39	13	E	61	154
	WB	Left	D	52	147	E	68	79
		Thru	D	35	809	C	26	789
	EB	U Turn	D	53	156	F	178	462
		Thru	F	189	1422	C	35	1307
		Right	B	10	10	A	7	13
	Overall		F	108		D	39	
Rt.9 and Park Central Dr	SB	Right	F	107	160	F	608	487
Rt.9 and Flagg Rd	SB	Right	E	44	48	F	73	75
Rt.9 and Washington St	NB	Right	D	27	18	E	48	173
Rt.9 and Coslin Dr	NB	Right	C	21	4	D	25	56
Rt.9 and #352	NB	Right	C	19	1	C	18	6
Rt. 9 and #325	SB	Right	C	17	5	C	17	10
Rt.9 and Deerfoot Rd	NB	Right	D	33	11	D	26	6
	SB	Right	F	54	25	D	34	12

2.4.9 I-495/I-90 Toll Plaza Operations

The existing toll lane configurations at the I-495/I-90 toll plazas was reviewed based on information provided by MassDOT (T*echnical Evaluation Report, Pay on Entry or Exit Tolling – Western Turnpike, Interchanges 1-15,* May 2010), site reconnaissance, and a review of aerial photographs.

The lane configurations at the I-495/I-90 toll plaza are:

Entering I-90: 2 E-Z Pass (electronic toll collection), 2 automated ticket lanes, 1 manual lane

Exiting I-90: 4 E-Z Pass, 4 manual lanes. Some lanes are reversible and have the flexibility to be changed dependent on traffic conditions.

The capacity for toll lanes was based on toll booth processing rates documented in the *Pay on Entry or Exiting S*tudy. These rates are comparable to rates found on other facilities in other states. The hourly vehicle capacity at each of these toll lanes is:

- 600 vph per automated ticket lane,
- 300 vph per manual lane ,
- 1,100 vph per E-Z Pass lane (with only 1 or 2 lanes), and
- 1,000 vph per E-Z Pass lane (with 3 or more lanes).

The existing conditions, including the volume-to-capacity ratios and queue lengths of this toll plaza are summarized in the *Pay on Entry or Exit Tolling – Western Turnpike, Interchanges1-15* report. That report shows that that the E-Z Pass traffic currently experiences queues of over one-quarter mile entering the I-90 toll plaza during both the weekday AM and PM peak hours. Queues from the cash lanes can block the E-Z Pass lanes and vice versa. Observations of peak period conditions at the I-495/I-90 toll plaza indicate that the combination of traffic volumes and roadway/ramp geometry is insufficient to accommodate vehicle weaving in this area. The weaving areas at the toll plaza include:

- I-495 northbound/southbound entry to I-90 eastbound/westbound, and
- I-90 eastbound/westbound exit to I-495 northbound/southbound.

In addition, conflicts occur at the toll plaza lanes themselves that is caused by driver confusion, variation in vehicle travel speed between cash and electronic lanes, abrupt lane changes and vehicles backing up, percentage of heavy vehicles, adverse weather conditions, and traffic incidents. These conflicts create additional congestion, delay, queuing, and safety issues.

2.4.10 Future Year 2035 Traffic Volumes

The CTPS regional travel demand model was used to develop year 2035 weekday traffic volumes in the study area. Travel demand models use predicted demographic information to estimate future traffic volumes and other transportation-related conditions. The CTPS model is a traditional 4-Step model that uses EMME/2 computer software and covers 164 communities in eastern Massachusetts. It contains 2,727 traffic analysis zones (TAZs) and 124 external stations, including New Hampshire. The model contains six TAZs in Southborough and Westborough in the study area. The TAZs contain population and employment demographic data that are converted into person trips by trip purpose. The model output includes traffic volumes by link, speed, vehicle-miles-traveled, vehicle-hours-traveled, and transit trips.

The CTPS travel demand model is calibrated to year 2010 existing conditions. Future year 2035 traffic projections were developed based on land use and future infrastructure projects (roadway and transit) that are contained in the Regional Transportation Plan (RTP). CTPS developed two separate 2035 land use scenarios: 1) Regional Transportation Plan (RTP) – representing the adopted land use in the regional transportation plan; and 2) Priority Development Areas (PDA). The RTP contains the land use for 2035 that was adopted by the MPOs and their member communities. The PDA scenario is a Smart Growth land use alternative that concentrates development and employment in areas that currently have infrastructure, and were further infrastructure investments may be made to support additional economic growth. The CTPS regional travel demand model was used to develop year 2035 traffic forecasts for both of these scenarios.

The land use was then reviewed and revisions were made, so that the land use and subsequent projections for associated population and employment are consistent with additional known planned and approved development projects in the immediate study area. Information on future land use was based on discussions with the town planners from Southborough and Westborough and information received at the SAG meetings. The roadway link volumes were then converted to turning movements at the local study intersections. Minor adjustments to volume projections were made at some locations as necessary using this post-processing technique. The roadway link volumes were then converted to turning movements at the local study intersections. Table 2.4-16 summarizes the population and employment projections used for each of the year 2035 alternatives.

Table 2.4-16: Population and Employment Projections

Town	TAZ #s	Existing 2010	No-Build 2035 RTP	Difference	No-Build 2035 PDA	Difference
Southborough	2288/2293					
Employment		3,107	4,354	1,247	5,635	1,281
Population		2,183	2,644	461	2644	0
Westborough	2317-2320					
Employment		9,956	12,116	2,160	14,612	2,496
Population		1,144	1,308	164	1,643	335
Totals						
Employment		13,063	16,470	3,407	20,247	3,777
Population		3,327	3,952	625	4,287	335

Several planned roadway projects were coded into the 2035 regional model The infrastructure improvements that have been proposed by others that are assumed to be in place in the project study area by 2035 include:

- Widening the bridge that carries I-495 northbound on- and off-ramps over I-495 at the I-495/I-90 Interchange from 3 to 4 lanes (two in each direction),
- Close the Washington Street access to Route 9 and realign Washington Street to intersect with Coslin Drive just south of Route , and
- Signal timing improvements at Route 9/Crystal Pond Road to add more green time to the Crystal Pond Raid intersection approach, and lengthen the pedestrian crossing time.

Signal optimization was assumed at Route 9/Crystal Pond because 1) it appears likely some level of development will occur near this intersection by 2035 which would require additional green time to be allocated to the Crystal Pond Road intersection approach at a minimum; and 2) the current signal time provided for pedestrians to cross Route 9 is inadequate. Signal optimization was not assumed for any other signalized study intersection for the No-Build condition.

The Cumberland Farms site located at #344 Turnpike Road (Route 9,) Southborough recently expanded the existing store and modified the site access and circulation. The existing two-way driveway on Route 9 westbound was converted into an entrance only, and the current driveway on Central Park Drive was converted into an exit only

Figures 2.4-21 through 2.4-32 show the year 2035 traffic volumes on study area roadways for RTP and PDA scenarios.

Figure 2.4-21: AM Peak Hour Weekday Traffic Volume – 2035 No Build

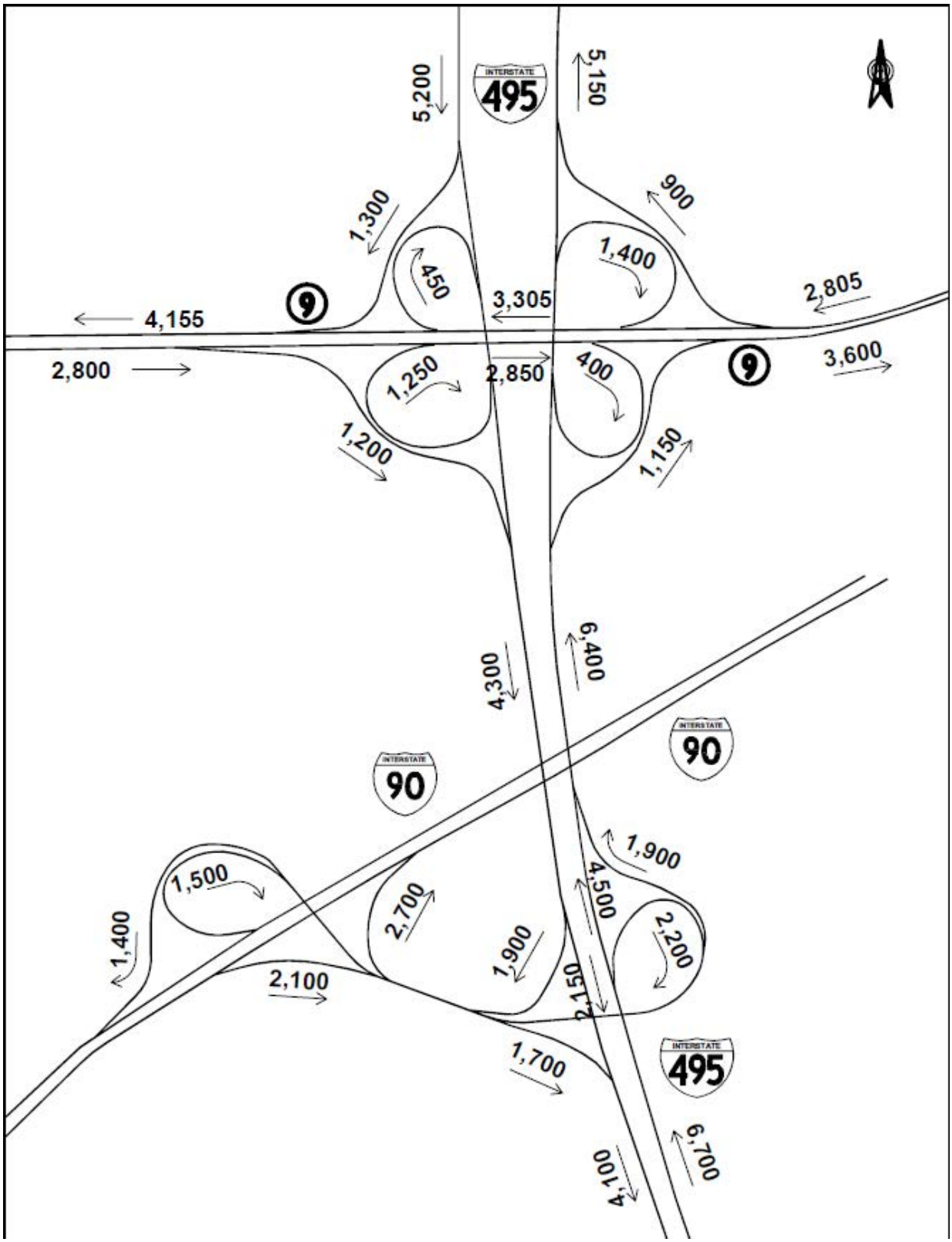


Figure 2.4-22: PM Peak Hour Weekday Traffic Volume – 2035 No Build

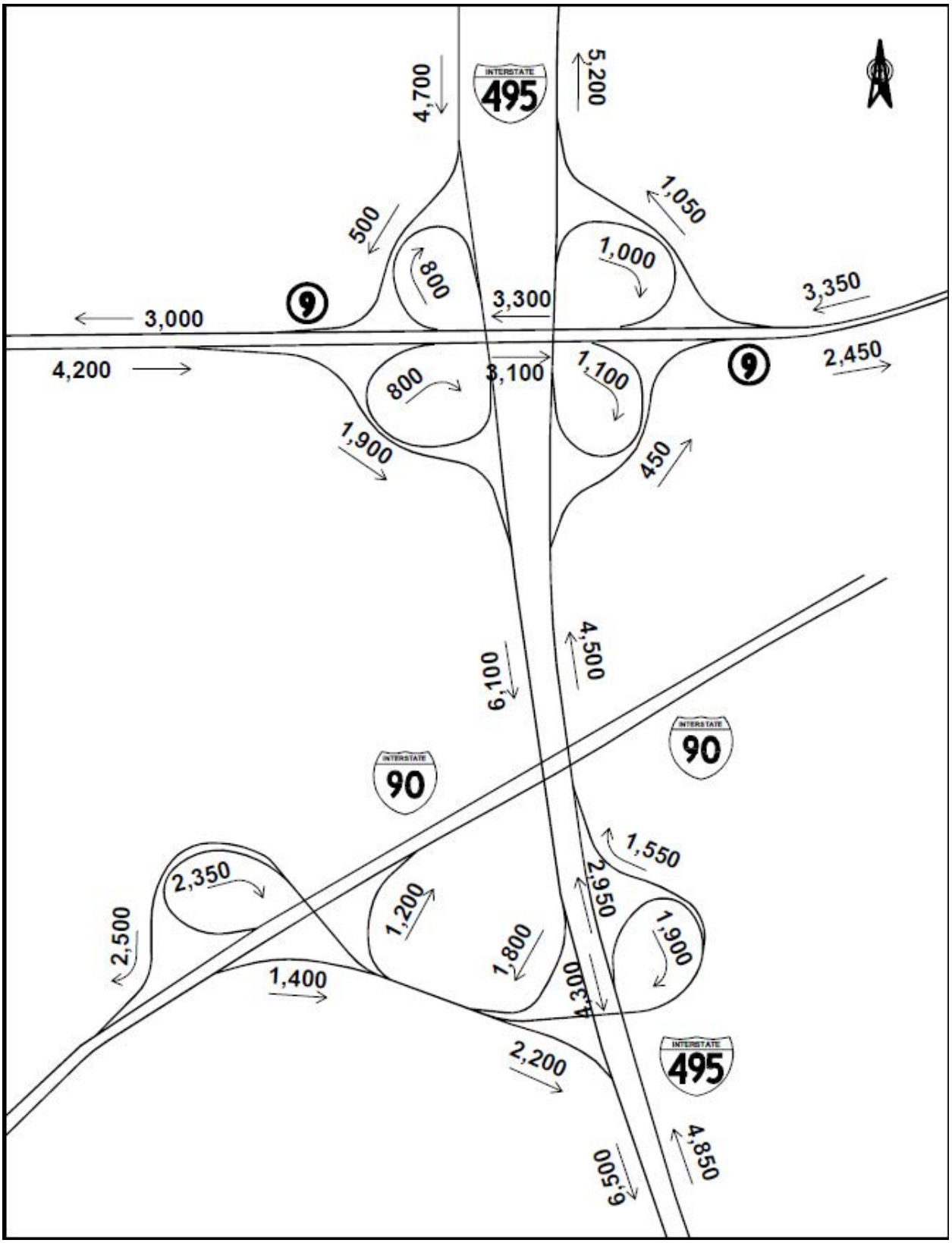


Figure 2.4-23: AM Peak Hour Weekday Traffic Volume – 2035 No Build

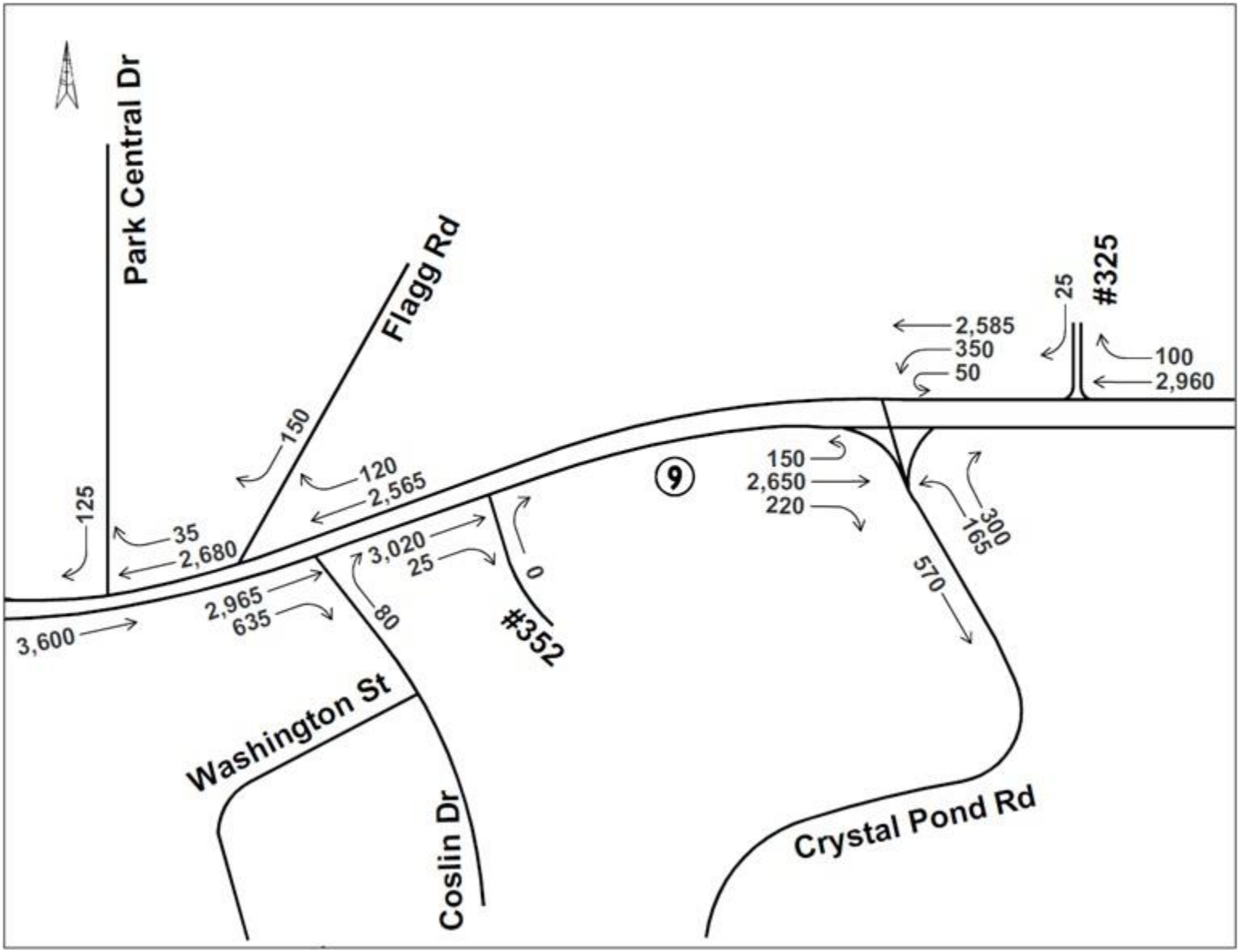


Figure 2.4-24: PM Peak Hour Weekday Traffic Volume – 2035 No Build

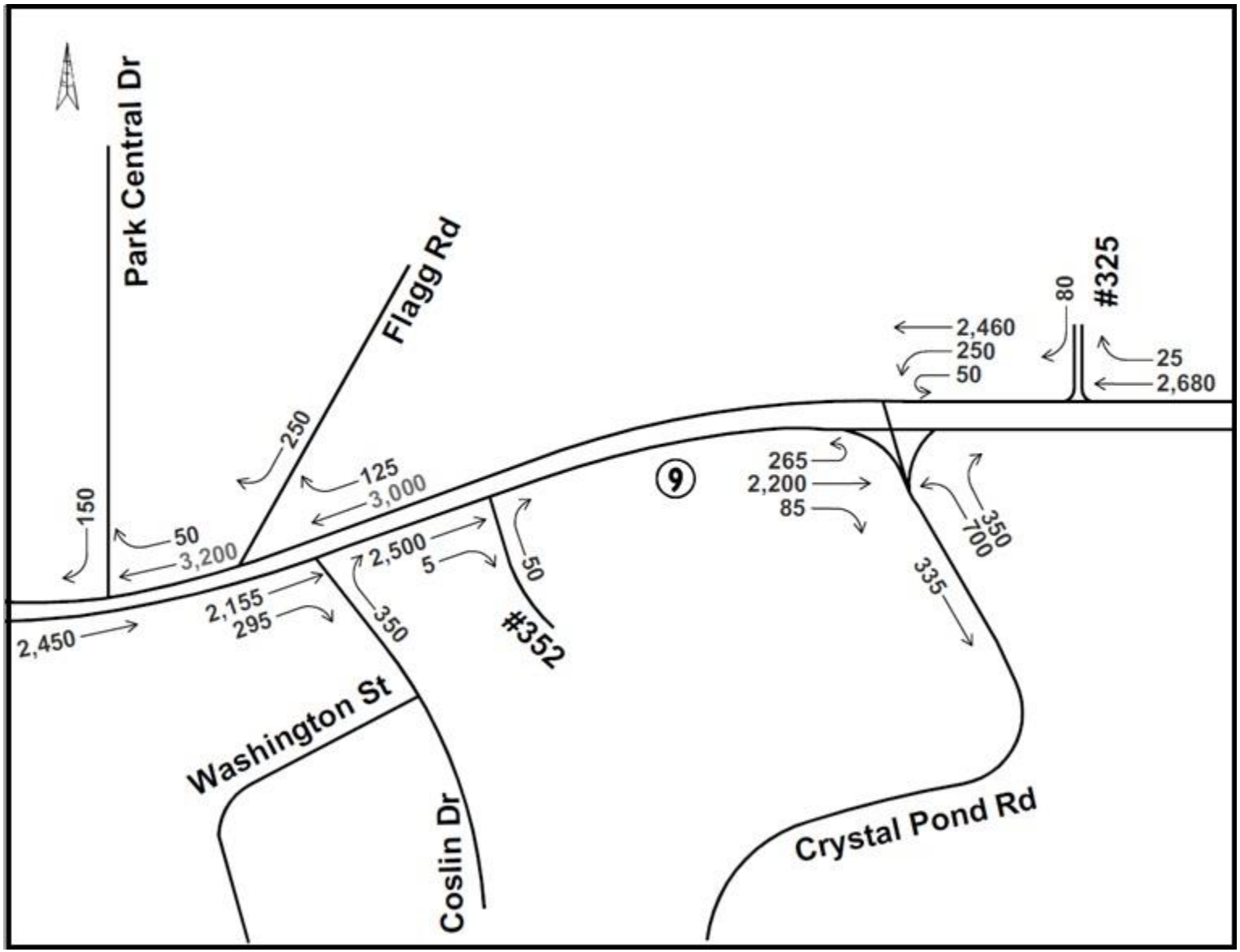


Figure 2.4-25: AM Peak Hour Weekday Traffic Volume – 2035 No Build

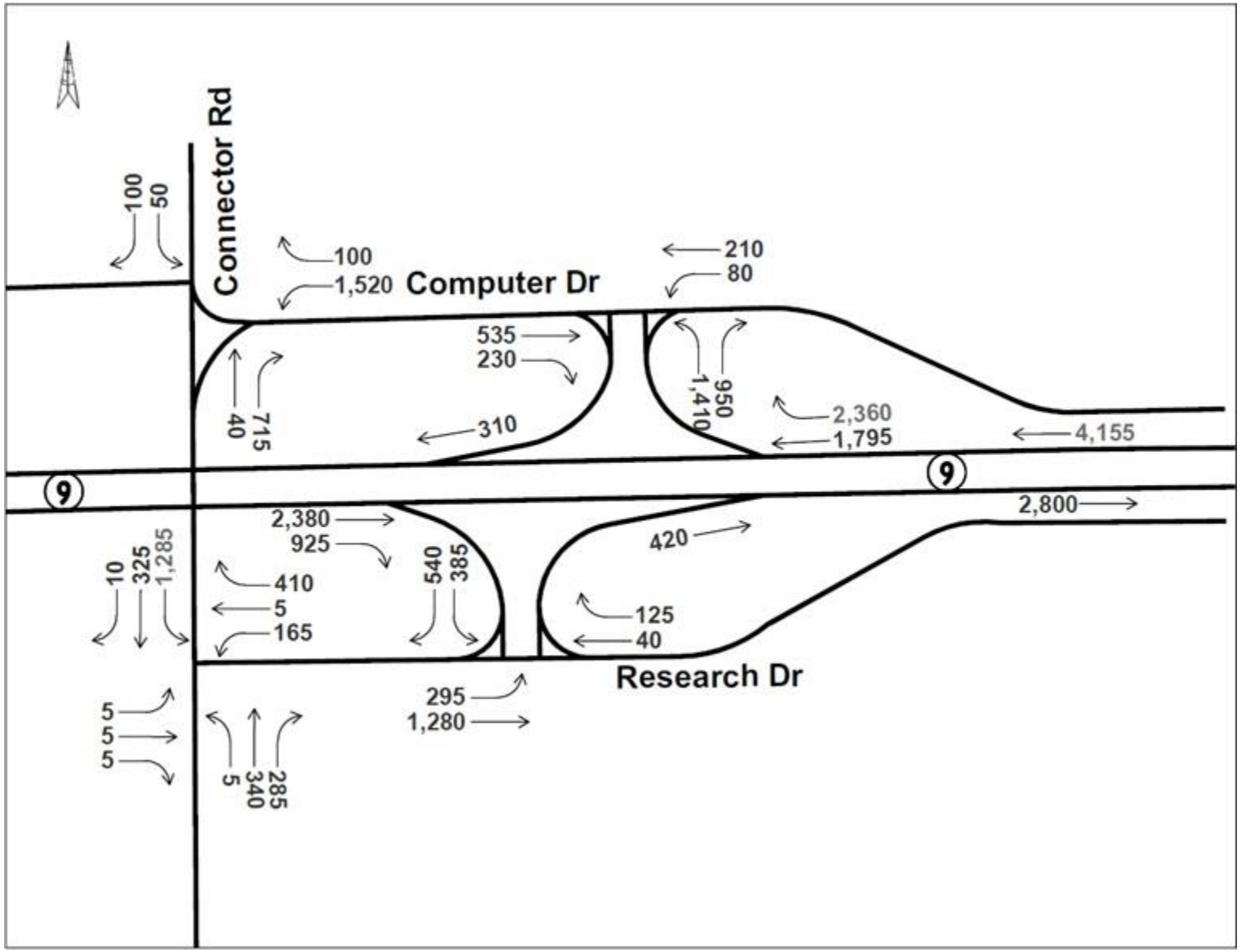


Figure 2.4-26: PM Peak Hour Weekday Traffic Volume – 2035 No Build

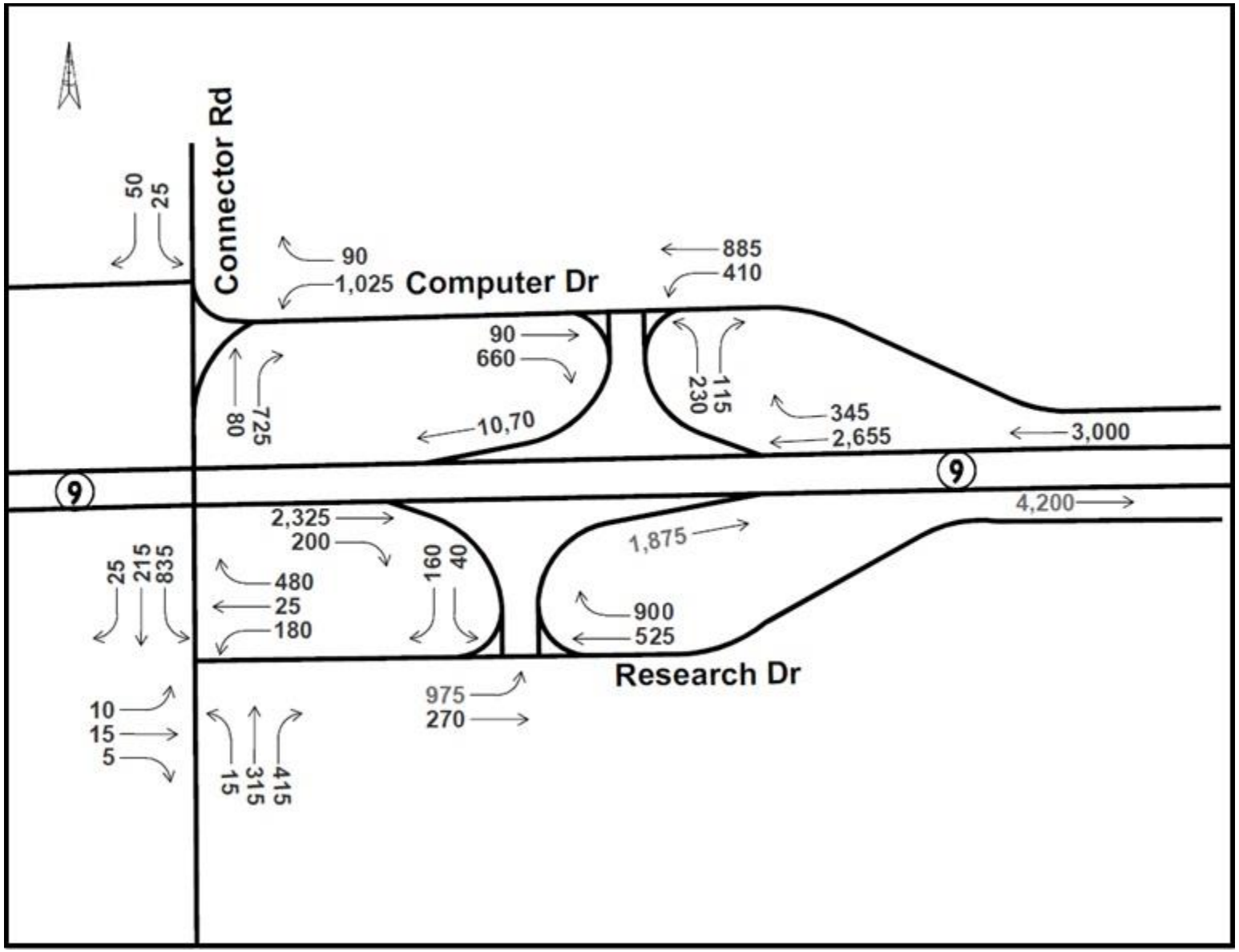


Figure 2.4-27: AM Peak Hour Weekday Traffic Volume – 2035 PDA No Build

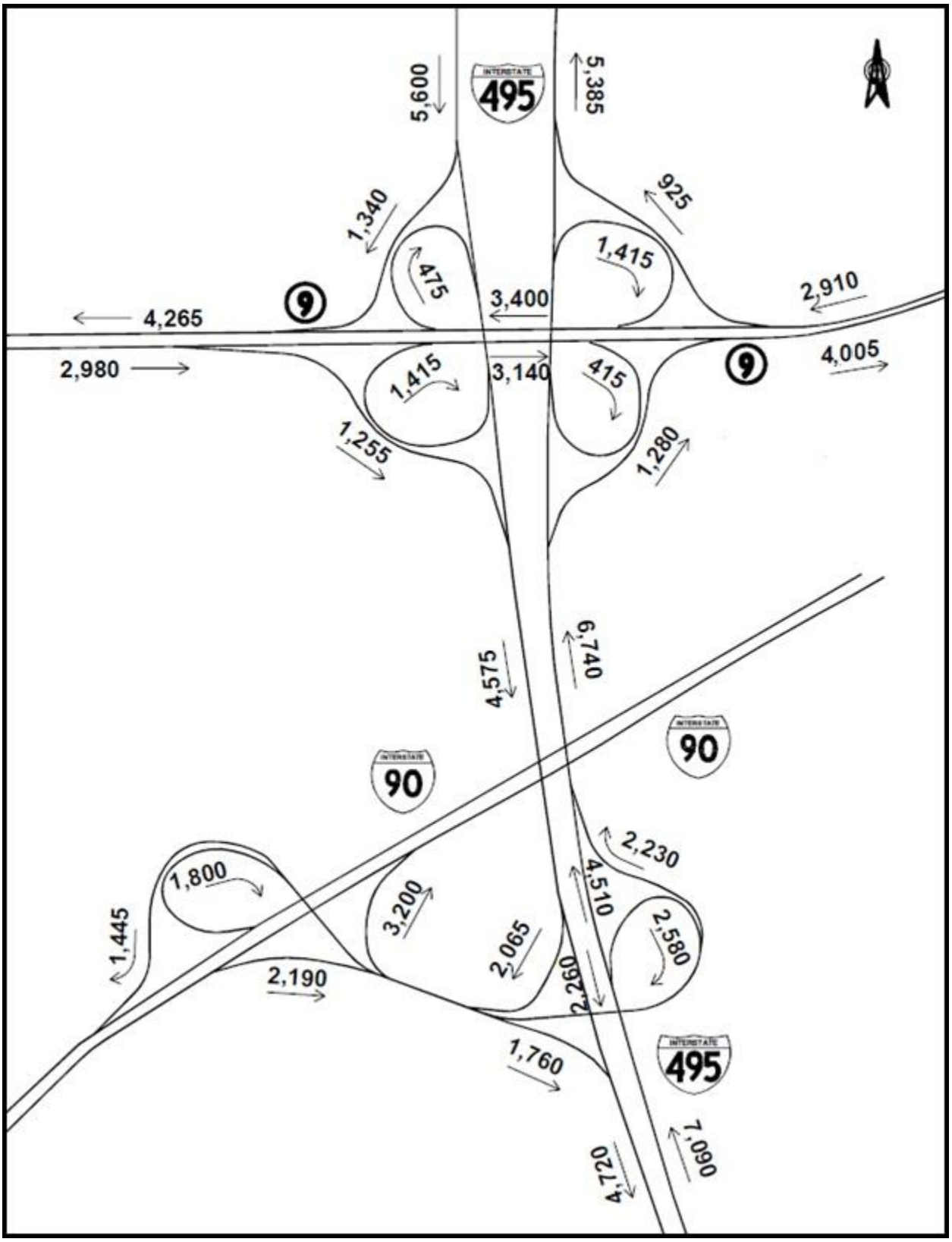


Figure 2.4-28: AM Peak Hour Weekday Traffic Volume – 2035 PDA No Build

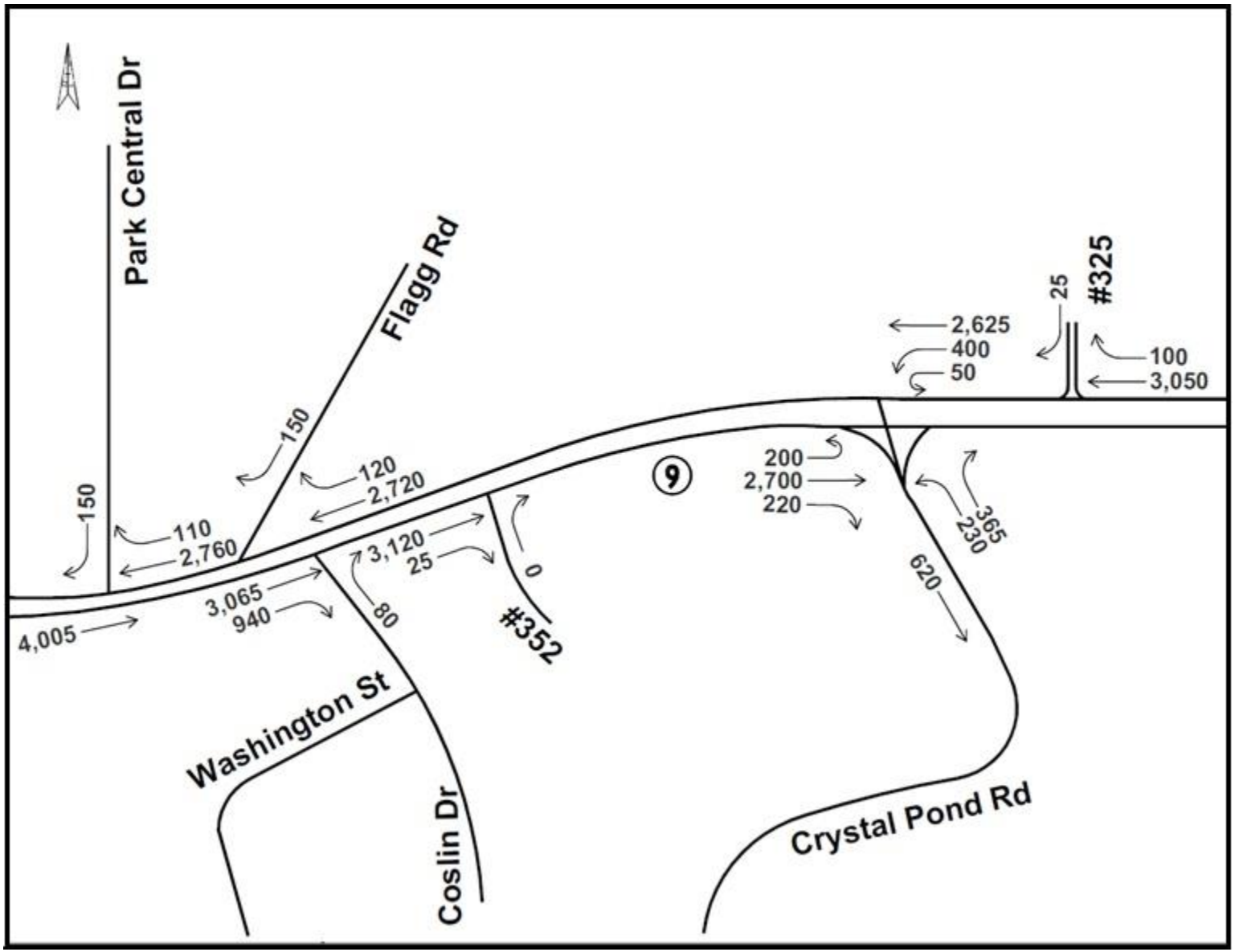


Figure 2.4-29: AM Peak Hour Weekday Traffic Volume – 2035 PDA No Build

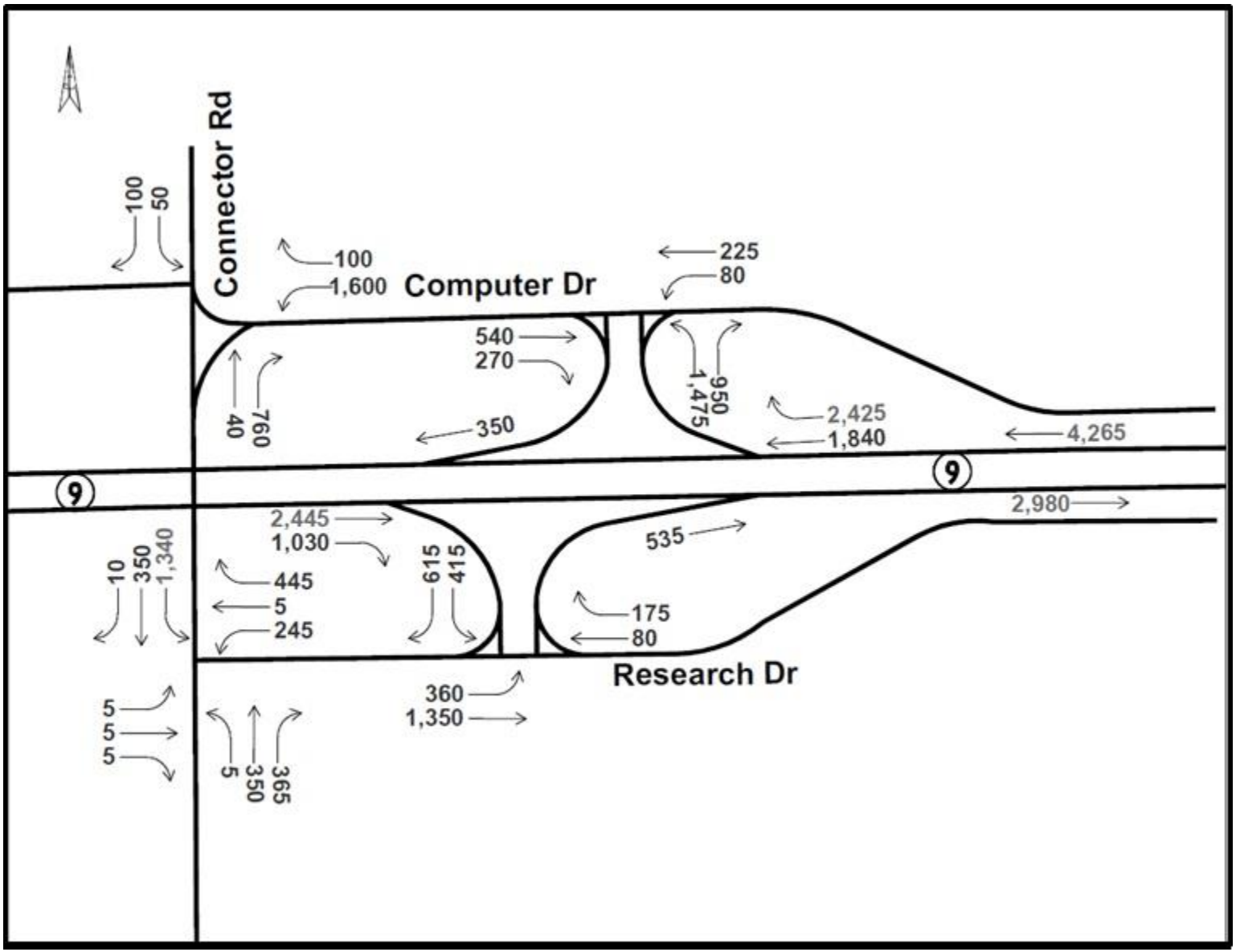


Figure 2.4-30: PM Peak Hour Weekday Traffic Volume – 2035 PDA No Build

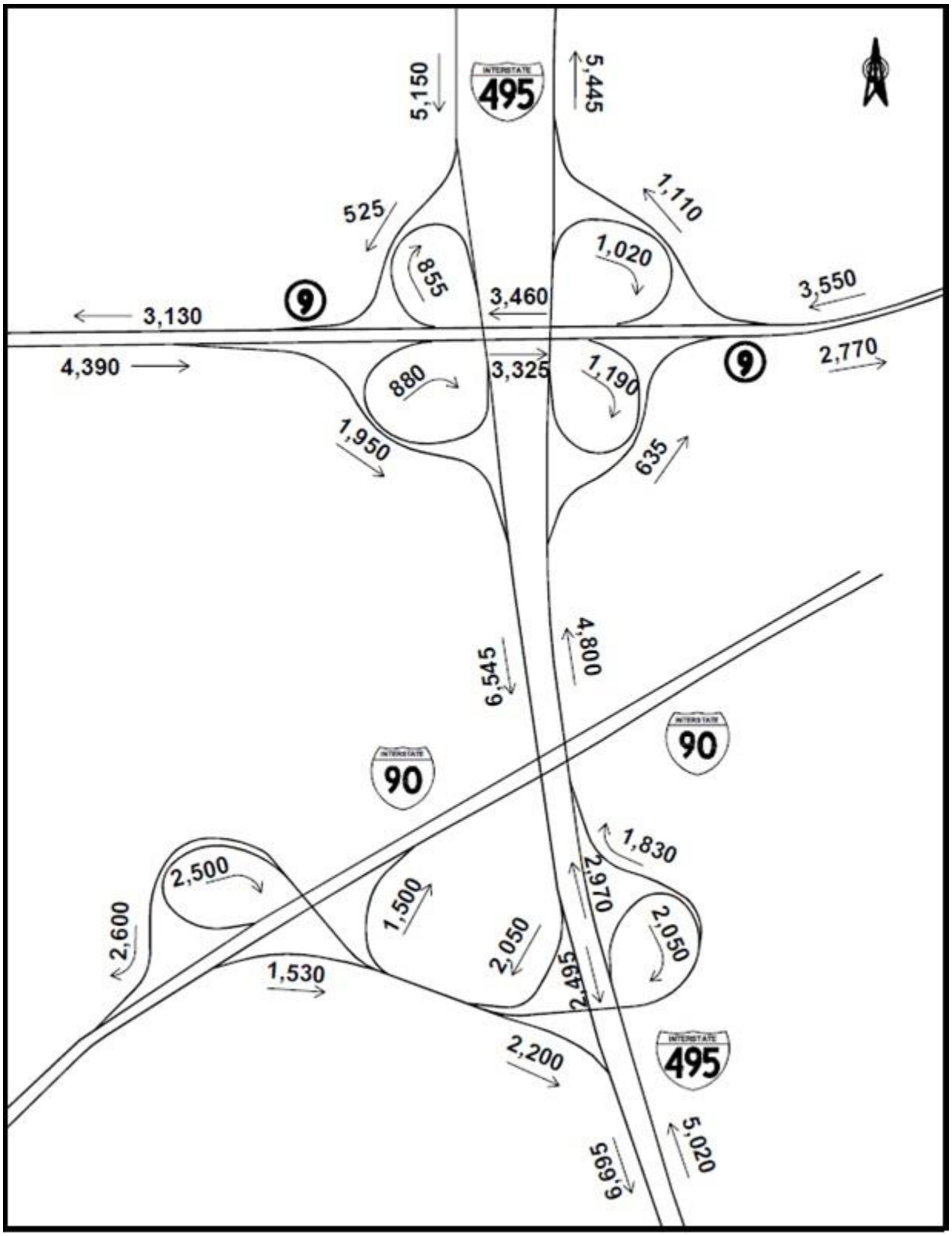


Figure 2.4-31: PM Peak Hour Weekday Traffic Volume – 2035 PDA No Build

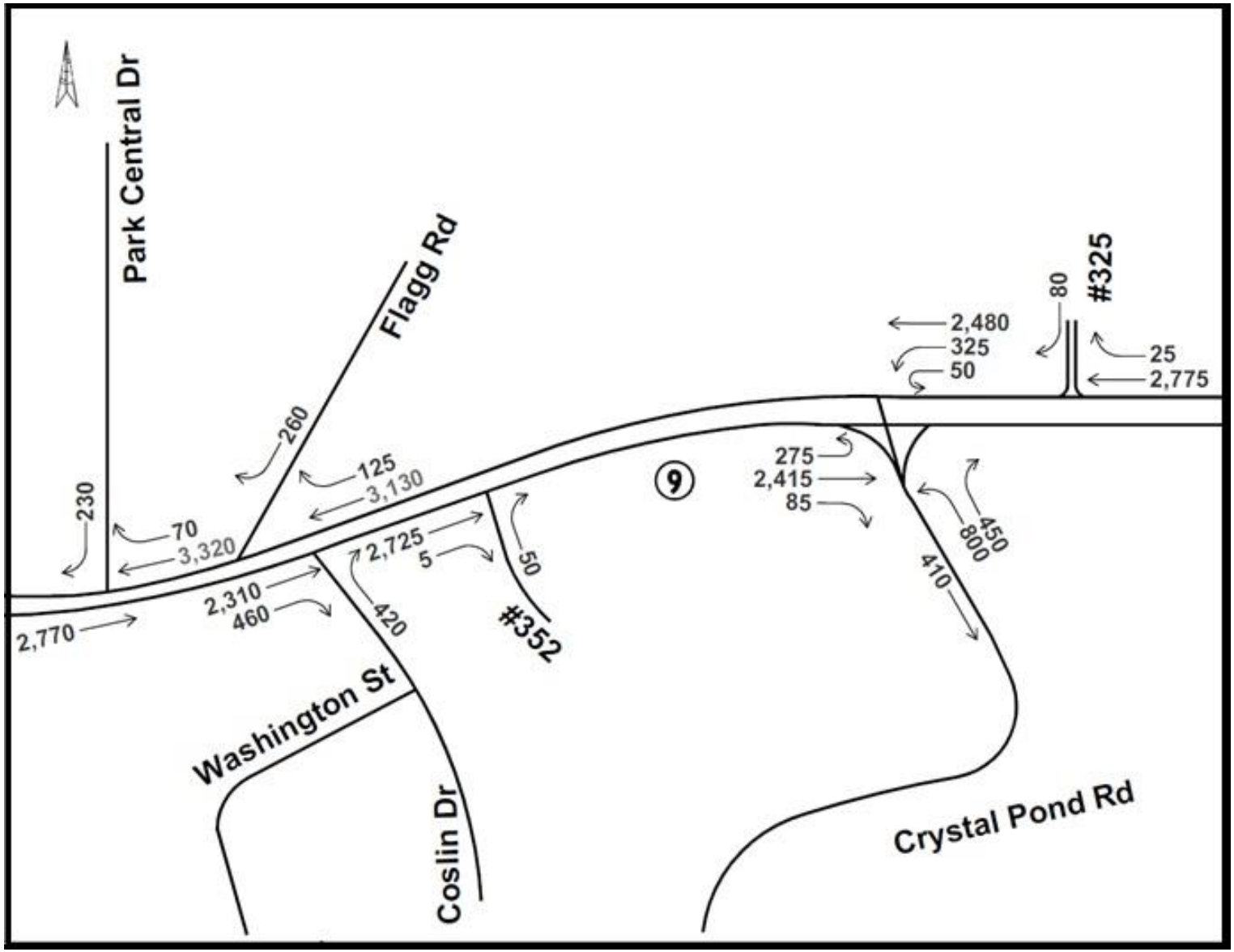


Figure 2.4-32: PM Peak Hour Weekday Traffic Volume – 2035 PDA No Build

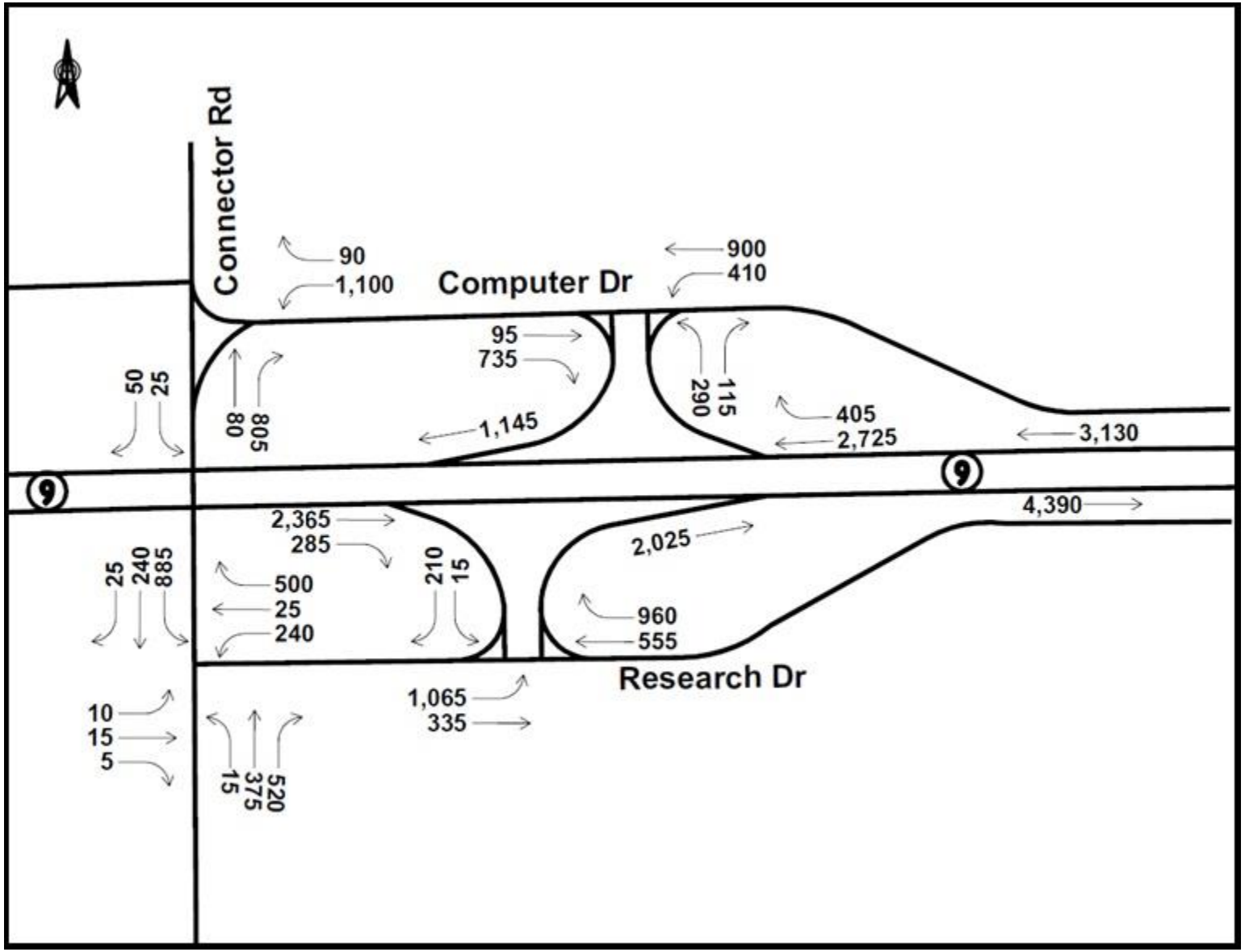
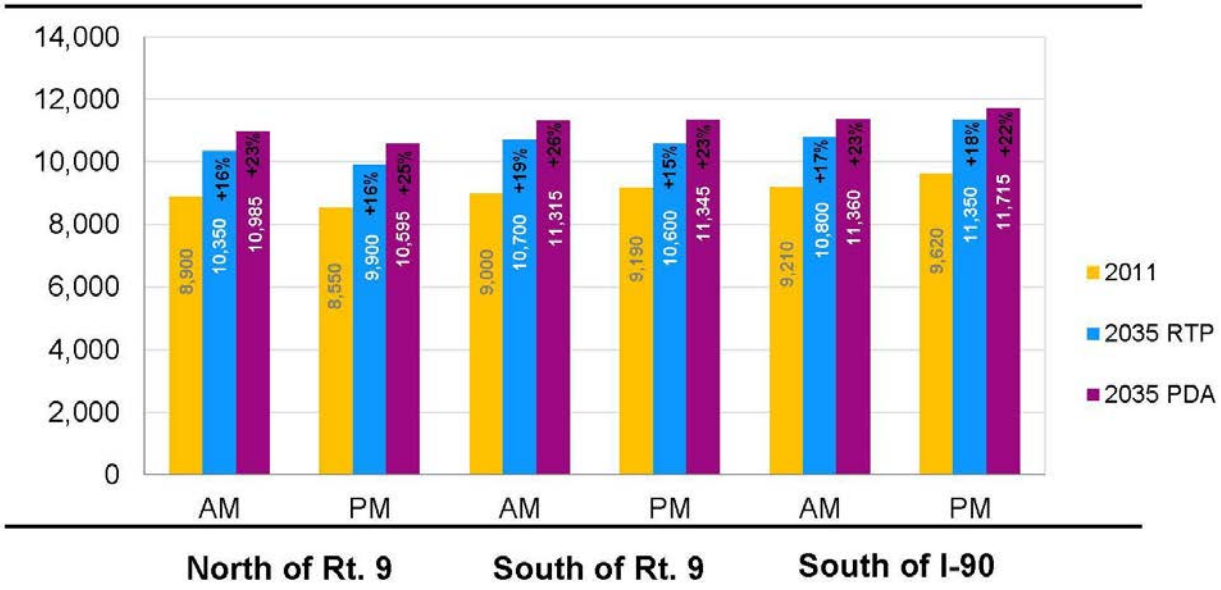


Figure 2.4-33 compares peak hour traffic volumes on I-495 for years 2011 and 2035. The figure shows that year 2035 peak hour volumes are projected to increase by approximately 15 to 20 percent over existing year 2011 volumes. The highest volumes on I-495 in the study are will continue to occur south of I-90.

Figure 2.4-33: I-495 Peak Hour Traffic Volume – Years 2011 & 2035



Due to the increased development in the study area for the No-Build 2035 PDA scenario, traffic volumes are higher than for the RTP scenario. PDA scenario traffic volumes on I-495 are approximately 6 percent higher than RTP scenario volumes in the AM peak hour, and between 3 and 7 percent higher in the PM peak hour.

2.4.11 Future Year 2035 No-Build Capacity Analysis

This section summarizes the capacity analysis results for 2035 No-Build RTP and PDA scenarios. Capacity analysis were performed for year 2035 No-Build traffic volumes assuming the infrastructure improvements identified in Section 2.4.10. Capacity analysis was conducted using the same methodology used for the existing conditions analysis as described in Section 2.4.8.

Table 2.4-17 summarizes Level of Service for the No-Build scenarios for the I-495 mainline and Route 9 within the study area. With year 2035 RTP traffic volumes most of the study mainline segments will deteriorate by one LOS letter grade over existing conditions. The following six segments will operate at deficient (LOS E or F) conditions for the 2035 No-Build RTP scenario:

- I-495 northbound south of Route 9 – LOS E, AM;
- I-495 northbound south of I-90 – LOS F, AM;
- Route 9 westbound west of I-495 – LOS E, AM;
- I-495 southbound south of Route 9 – LOS E, PM;
- I-495 southbound south of I-90 – LOS F, PM; and
- Route 9 eastbound west of I-495 – LOS E, PM.

Most of the remaining study highway segments will operate at LOS D during peak hours. The following segments will deteriorate to LOS F under the PDA scenario:

- I-495 northbound south of Route 9 – LOS F, AM;
- Route 9 westbound west of I-495 – LOS F, AM;
- I-495 southbound south of Route 9 – LOS F, PM; and
- Route 9 eastbound west of I-495 – LOS F, PM.

Table 2.4-17: Summary of I-495 Freeway Segment Capacity Analysis - No-Build RTP & PDA (2035) Conditions

I-495 Northbound Freeway Segment Description	RTP Weekday AM Peak Hour		RTP Weekday PM Peak Hour		PDA Weekday AM Peak Hour		PDA Weekday PM Peak Hour	
	LOS[1]	Density (pc/mi/ln)[2]	LOS	Density (pc/mi/ln)	LOS1	Density (pc/mi/ln)[2]	LOS1	Density (pc/mi/ln)[2]
I-495 NB north of Rt. 9	D	30.0	D	28.8	D	32.0	D	30.7
I-495 SB north of Rt.9	D	30.0	D	27.0	D	33.5	D	30.5
I-495 NB between Rt.9 and I-90	E	43.5	C	24.2	F	48.9	D	26.0
I-495 SB between Rt.9 and I-90	C	23.8	E	40.4	C	25.5	F	46.9
I-495 NB south of I-90	F	48.2	D	26.4	F	55.9	D	27.5
I-495 SB south of I-90	C	22.6	F	46.1	C	23.6	F	49.5
Rt.9 WB west of I-495	E	44.2	D	29.0	F	46.6	D	30.2
Rt.9 EB west of I-495	D	27.3	E	44.3	D	29.1	F	48.6

Note:

1. Level of Service
2. Passenger cars per mile per lane

Table 2.4-18 summarizes 2035 No-Build RTP and PDA Level of Service for the interchanges of I-495/Route 9, I-495/I-90 and Route 9 ramps at Research Drive and Computer Drive. Most ramps will worsen at least one Level of Service letter grade between existing conditions and the RTP scenario. The following ramps will operate at deficient conditions under the RTP scenario:

- I-495 northbound off-ramp to Route 9 eastbound – LOS E, AM;
- I-495 northbound weave between Route 9 ramps – LOS E, AM;
- Route 9 westbound on-ramp from I-495 southbound – LOS E, AM;
- I-495 northbound off-ramp to I-90 – LOS F, AM;
- I-90 to I-495 northbound on-ramp – LOS E, AM;
- I-495 southbound off-ramp to I-90 – LOS F, AM;
- I-90 to I-495 southbound on-ramp – LOS F, PM; and
- Route 9 eastbound mainline west of I-495 – LOS E, PM.

The following ramps will deteriorate to LOS E or F for the PDA scenario:

- I-495 northbound off-ramp to Route 9 eastbound – LOS F, AM;
- I-495 southbound off-ramp to Route 9 westbound – LOS E, AM;
- Route 9 westbound on-ramp from I-495 southbound – LOS F, AM;

- I-90 to I-495 northbound on-ramp – LOS F, AM;
- Route 9 westbound off-ramp to Computer Drive – LOS F, AM;
- I-495 southbound on-ramp from Route 9 eastbound – LOS E, PM;
- I-495 northbound off-ramp to I-90 – LOS F, PM; and
- I-495 southbound off-ramp to I-90 – LOS F, PM.

Capacity analysis calculations are provided in the Appendix.

Table 2.4-19 summarizes the capacity analysis results at study intersections for the No-Build 2035 scenarios. For the RTP scenario, future traffic volumes will generally increase vehicle delay and queuing at most study intersection movements. The intersection of Route 9/Crystal Pond Road will deteriorate to LOS F overall in the PM peak hour and continue to operate at LOS F in the AM peak hour. The minor Stop-controlled movements at Route 9/Coslin Drive, Route 9/#325, and Route 9/Deerfoot Road will deteriorate to deficient conditions in the RTP 2035 No-build scenario.

The following intersections will deteriorate to LOS E or F for the PDA No-Build scenario:

- Connector Road/Research Drive – LOS E, AM; LOS F, PM;
- Research Drive/Friberg Pkwy – LOS E, AM; and
- Route 9/Deerfoot Road – LOS F, AM; LOS E, PM.

Capacity analysis calculations are provided in the Appendix.

Table 2.4-18: Summary of I-495 and Route 9 Interchange Ramp Capacity Analysis - No-Build (2035) Conditions

Description	Movement	RTP LOS[1]		PDA LOS[1]	
		Weekday AM Peak Hour	Weekday PM Peak Hour	Weekday AM Peak Hour	Weekday PM Peak Hour
I-495/Rt. 9 Interchange					
I-495 NB off-ramp to Rt.9 EB	Diverge from I-495	E	C	F	C
I-495 NB mainline between on and off-ramps	Weave I-495	E	D	E	D
I-495 NB on-ramp from Rt.9 WB	Merge to I-495	C	D	D	D
I-495 SB off-ramp to Rt. 9 WB	Diverge from I-495	D	D	E	D
I-495 SB mainline between on and off-ramps	Weave I-495	C	D	D	D
I-495 SB on-ramp from Rt. 9 EB	Merge to I-495	C	D	C	E
Rt.9 EB on-ramp from I-495 NB	Merge to Rt.9	C	B	D	B
Rt.9 EB mainline between on and off-ramps	Weave Rt.9	C	C	C	C
Rt.9 WB off-ramp to I-495 NB	Diverge from Rt.9	C	D	C	D
Rt.9 WB mainline between on and off-ramps	Weave Rt. 9	C	C	D	D
RT.9 WB on-ramp from I-495 SB	Merge to Rt. 9	E	D	F	D
I-495/I-90 Interchange					
I-495 NB off-ramp to I-90	Diverge from I-495	F	D	F	F
I-90 to I-495 NB on-ramp	Merge to I-495	E	C	F	C
I-495 SB off-ramp to I-90	Diverge from I-495	F	D	F	F
I-90 to I-495 SB on-ramp	Merge to I-495	C	F	C	F
Rt.9/Research Drive/Computer Drive Ramps					
Rt.9 EB off-ramp to Research Dr	Diverge from Rt.9	D	C	D	C
Rt.9 EB mainline between Research Dr and I-495 on-ramp	Weave Rt.9	B	E	C	E
Rt.9 WB off-ramp to Computer Dr	Diverge from Rt.9	C	B	F	B
Computer Dr to Rt.9 WB on-ramp	Merge to Rt.9	B	D	B	D

Note:

1. Level of Service

Table 2.4-19: Summary of Intersection Capacity Analysis - No-Build (2035) Conditions

Intersection			RTP No-Build						PDA No-Build					
			AM Peak Hour			PM Peak Hour			AM Peak Hour			PM Peak Hour		
Description	Approach	Movement	LOS	Delay (sec/veh)	95th Queue (ft)	LOS	Delay (sec/veh)	95th Queue (ft)	LOS	Delay (sec/veh)	95th Queue (ft)	LOS	Delay (sec/veh)	95th Queue (ft)
West of I-495														
Computer Dr and Rt.9 WB Ramps (Signalized)	EB	Thru	D	39	265	C	24	37	D	39	270	C	24	40
		Right	A	0	0	A	1	0	A	0	0	A	1	0
	WB	Left/Thru	C	21	100	B	11	216	C	21	105	B	13	239
	NB	Left	D	51	731	C	25	73	E	64	791	C	25	89
		Right	A	2	0	A	0	0	A	2	0	A	0	0
	Overall		C	29		A	10		C	35		B	11	
Connector Rd and Research Dr (Signalized)	NB	L/T/R	D	41	234	D	52	266	D	45	293	F	137	409
	SB	Left	E	63	665	D	37	357	F	86	707	D	39	385
		Thru/Right	A	6	128	A	6	95	A	6	138	A	6	106
	WB	L/T/R	F	88	265	F	239	331	F	256	407	F	428	439
		Right	B	20	35	C	23	10	C	21	36	C	23	10
	EB	L/T/R	D	46	21	D	47	44	D	46	21	D	48	44
	Overall		D	47		D	53		E	71		F	103	
Research Dr and Rt.9 EB Ramps (Signalized)	SB	Left	C	32	130	C	32	22	D	35	154	C	32	35
		Right	A	1	0	A	0	0	A	1	0	A	0	0
	WB	Thru	C	33	22	F	169	244	C	33	37	F	200	262
		Right	A	0	0	A	6	0	A	0	0	A	10	0
	EB	Left	B	11	146	B	18	308	B	13	183	B	24	365
		Left/Thru	B	19	456	B	13	181	C	26	501	B	15	217
	Overall		B	16		D	41		B	19		D	47	
Connector Rd and Computer Dr	SB	Left/Right	F	1056	436	F	161	153	F	*	*	F	268	189
Research Dr and Friberg Pkwy	NB	Left/Right	D	31	47	F	414	936	E	38	57	F	677	1140

Intersection			RTP No-Build						PDA No-Build					
			AM Peak Hour			PM Peak Hour			AM Peak Hour			PM Peak Hour		
Description	Approach	Movement	LOS	Delay (sec/veh)	95th Queue (ft)	LOS	Delay (sec/veh)	95th Queue (ft)	LOS	Delay (sec/veh)	95th Queue (ft)	LOS	Delay (sec/veh)	95th Queue (ft)
East of I-495														
Rt.9 and Crystal Pond Rd (Signalized)	NB	Left	D	55	106	E	76	509	E	56	144	F	108	627
	WB	Left	F	278	812	F	218	587	F	373	924	F	295	740
		Thru	C	24	1092	E	64	1065	C	28	1122	E	74	1093
	EB	U Turn	F	87	307	F	150	495	F	180	431	F	147	506
		Thru	F	222	2157	F	179	1640	F	249	2208	F	257	1897
		Right	B	14	142	B	19	58	B	15	143	B	21	62
	Overall		F	127		F	118		F	150		F	162	
Rt.9 and Park Central Dr	SB	Right	F	191	210	F	939	555	F	358	313	F	(2)	(2)
Rt.9 and Flagg Rd	SB	Right	F	178	232	F	858	635	F	242	265	F	(2)	(2)
Rt.9 and Washington St	NB	Right	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rt.9 and Coslin Dr	NB	Right	F	314	356	F	364	776	F	560	444	F	737	1217
Rt.9 and #352	NB	Right	C	21	1	C	20	18	C	22	1	C	23	21
Rt. 9 and #325	SB	Right	D	26	40	F	81	263	D	27	43	F	93	283
Rt.9 and Deerfoot Rd	NB	Right	E	48	17	D	33	7	F	53	19	E	42	10
	SB	Right	F	83	35	E	37	13	F	93	38	E	40	14

Notes:

1. Level of Service
2. These delays represent LOS F conditions and are so large they cannot be calculated with any degree of confidence..

2.4.12 Intelligent Transportation Systems (ITS)

This section discusses both statewide and regional ITS programs and policies and ITS systems currently in use in the I-495 study area.

State and Regional ITS programs and Policies

MassDOT completed the statewide *ITS Strategic Plan* in February 2010. The vision for MassDOT is to optimize the use of advanced technology (ITS) to create and manage a dynamic intermodal transportation network for all users that is safe and efficient and that supports economic growth in an environmentally responsive manner. The MassDOT ITS Program has adopted the following goals and objectives that are consistent with federal and state policies and guidelines:

- Improve Incident Management
- Reduce incident response and clearance times
- Improve incident management procedures

- Improve Congestion Management
- Improve real-time traveler information to the public
- Integrate arterial traffic management with freeway management
- Promote greater transit usage
- Enable real-time traffic management at special events
- Address impacts of trucks on congestion

- Improve safety and Security Management
- Improve safety within work zones
- Incorporate weather data into existing information systems
- Update emergency and disaster recovery plans
- Improve security of critical infrastructure

- Improve Operations and Maintenance Cost Effectiveness
- Enable and promote resource sharing among agencies
- Leverage private sector data resources
- Collect and manage data to enhance operations performance management

The MassDOT ITS Strategic Plan recommends specific strategies to address the goals/objectives and provides a framework for real-time information sharing among transportation management and public safety agencies that creates a common operating picture for coordinated response and interagency decision-making.

The benefits from ITS Systems[32] include:

- Improve freeway speeds by 8-13 percent, improve travel time, reduce crash rates and improve trip time reliability with delay reduction from 1-22 percent;
- Between 80 and 84 percent of motorists believe weather information enhances their safety;
- ITS in Work Zones improve safety by reducing vehicle speeds by 4-6 mph and reduces the number of speeding vehicles by 25-78 percent;
- ITS can reduce the duration of incidents and delays by 30 to 40 percent;
- Real-time traveler information improves reliability by 5-13 percent; and

[32] Intelligent Transportation Systems Benefits, Costs, Deployment, and Lessons Learned: 2008 Update, from ITS Strategic Plan. 2010. MassDOT.

- ITS has been found to reduce commercial vehicle operations costs.

MassDOT also recently completed the *Regional Transportation Operations Strategy (RTOS), Boston Metropolitan Region,* March 2010. The purpose of this strategy is to develop a regional plan in order to leverage the existing ITS programs through joint collaboration and resource sharing, and to improve performance of the overall multimodal transportation system.

Consistent with the National ITS Architecture, MassDOT Office of Transportation Planning completed the Regional ITS Architectures in 2005. The Commonwealth's 13 MPO regions were grouped into four regions for purpose of defining component systems and their interconnections. The study area for the I-495/Route 9 Interchange Improvement Study falls within Metropolitan Boston region. There has also been significant investment in Operations Control Centers (OCC) by individual transportation and public safety agencies.

The primary goal of the RTOS is to enable transportation and transportation agencies within the Boston Metropolitan Region to operate from a shared vision and common operating framework. To accomplish this goal the RTOS identifies strategies and the commitment and resources to complete those strategies during the next three to five years.

ITS Technology in I-495 Study Area

Mass511 System. The Federal Communications Commission designated 511 as a traffic information telephone number on July 21, 2000. The Mass511 service provides traffic and travel information on Massachusetts roads and is provided by a public-private partnership with Sendza, at no cost to the state. The 511 service provides real-time traffic updates for major Massachusetts roadways, including routes and highways in Western and Central Massachusetts, and the South Coast. I-495, I-90, and Route 9 are all included in the Mass511 system. In the study area, a Mass511 video camera is located at the I-90/I-495 interchange (11A) which provides real-time traffic conditions looking west on I-90.

Motorists can receive updates through Mass511.com, Twitter mobile messages, and by phone (Dial 511 Metro Boston 617-986-5511). For example, a sample message would say: "Traffic Update: Hopkinton - I-495 Northbound at Exit (22) I-90/ Mass Pike: Accident: All lanes open. Traffic still very heavy."

Emergency Roadside Assistance. MassDOT provides emergency roadside assistance (CaresVan), sponsored by MAPFRE / Commerce Insurance, for motorists whose vehicles break down on their roadways. The patrols provide rapid response clearance of disabled vehicles and removal of road debris. I-495, I-90, and Route 9 are served by this program.

Changeable Message Sign. There are two portable electronic changeable message signs on I-495 in the vicinity of the study area:

- Northbound I-495 at milepost 56.2 approximately 1.5 miles south of I-90, and
- Southbound I-495 north of I-90.

Typically these signs are use to display roadway incidents that impact travel time. They are at times also used to display public service announcements.

2.5 Transit and Transportation Demand Measures

This section describes the existing commuter rail, fixed bus route, and demand responsive transit services in the study area. Tables and figures are provided to summarize and depict the key features of the existing transit network. Data from prior studies such as the *I-495 Study – I-290 to I-90* by CMRPC

(2009) and the *I-495 Transit Study* by CTPS (2007) were used for existing transit conditions to the extent relevant.

An expanded study area has been identified for the transit analysis to encompass the relevant transit infrastructure and services, which include the fixed route bus services of the WRTA and MWRTA, the MBTA Worcester Commuter Rail Line, and the available paratransit and Transportation Management Association (TMA) services.

Based on Census Journey to Work data (Census 2000)[33] the existing commuting pattern for the study area shows that employees working in Westborough live mainly west of I-495. The largest number of employees commutes from residences in the City of Worcester and from other cities and towns in Worcester County. A relatively small number of employees in Westborough are commuting from cities and towns to the east, such as Framingham, Natick, and Boston. The Census Journey to Work data for the study area shows that employees working in Southborough live mainly in the towns of Southborough and Framingham and other cities west of I-495. The largest number of employees commutes from residences in Southborough and from other cities and towns in both Worcester and Middlesex counties.

There are a number of challenges to providing transit service in the study area. The first challenge is that the study area spans two separate Regional Transit Authority (RTA) service areas. Westborough is in the Worcester RTA and Southborough in the MetroWest RTA. Neither RTA currently provides fixed-route service in the study area. There are two MBTA commuter rail stations on the MBTA Framingham/Worcester Line that serve the study area. The Westborough station is located approximately 4 miles west of I-495 and the Southborough station is located approximately 2 miles east of I-495. The existing service schedule is oriented to serving commutes to and from Boston. There are six morning peak period trains serving commuters from Worcester to Boston, that also stop at the Westborough and Southborough train stations. There are four peak period trains from Westborough and Southborough to Worcester in the evening. However, there is only one peak period outbound train to Worcester in the morning and two peak period inbound trains to Boston in the evening that could serve reverse commutes from Boston to the study area..

2.5.1 Fixed Route Bus Service

As stated in the previous section, the study area is split between the Worcester Regional Transit Authority (WRTA) on the west and the MetroWest Regional Transit Authority (MWRTA) on the east. Westborough is within the WRTA area, but there are no routes currently serving the town. The WRTA service area includes over half a million in population and serves 35 communities, including Worcester. The MWRTA serves a population of over 200,000 and includes 11 member communities (Refer to Figures 2.5-1 and 2.5-2 depicting the WRTA and MWRTA jurisdictional boundaries in the study area and general route structure).

[33] Journey to Work data is not yet available from 2010 Census

Figure 2.5-1: Existing Transit – Regional Context

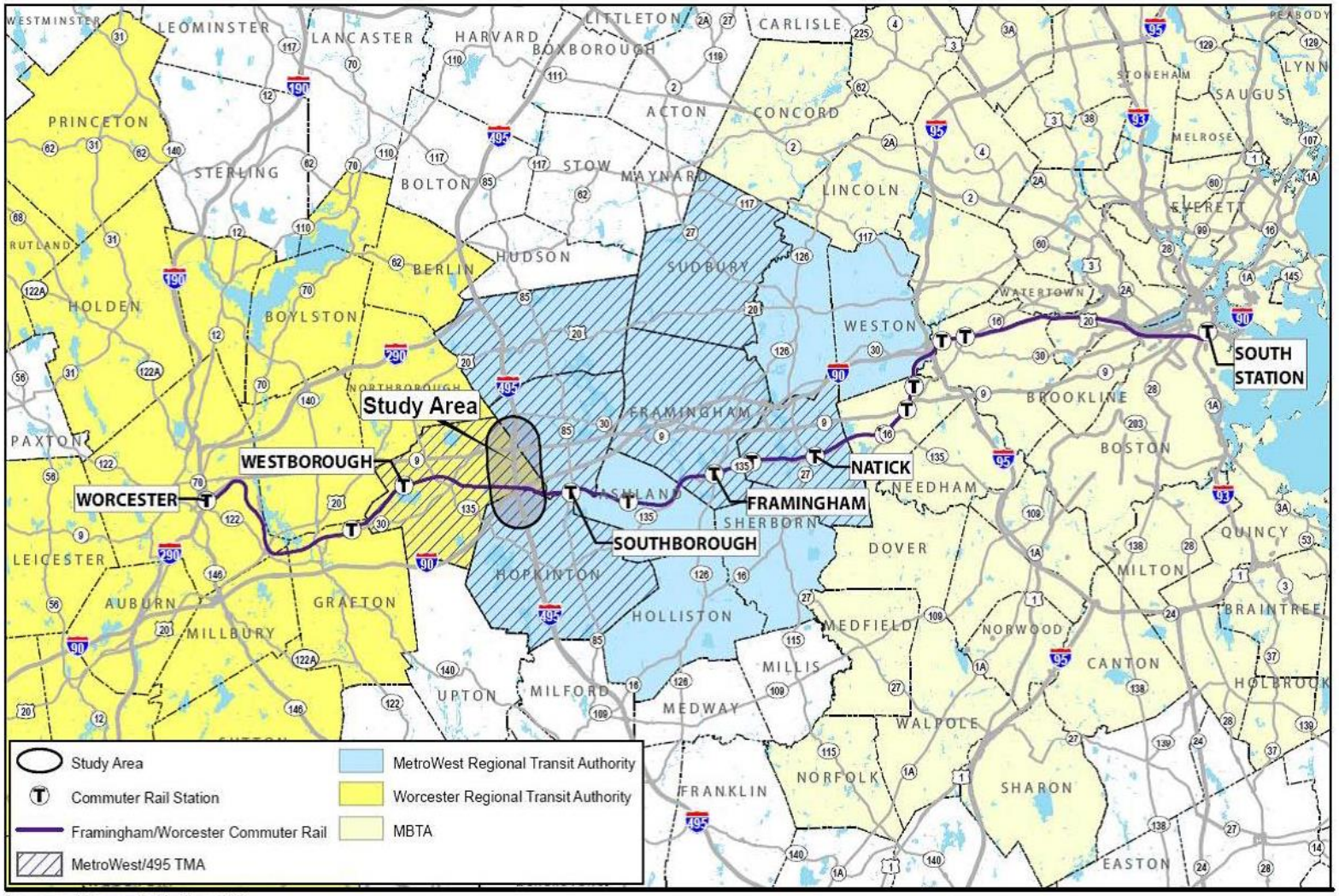
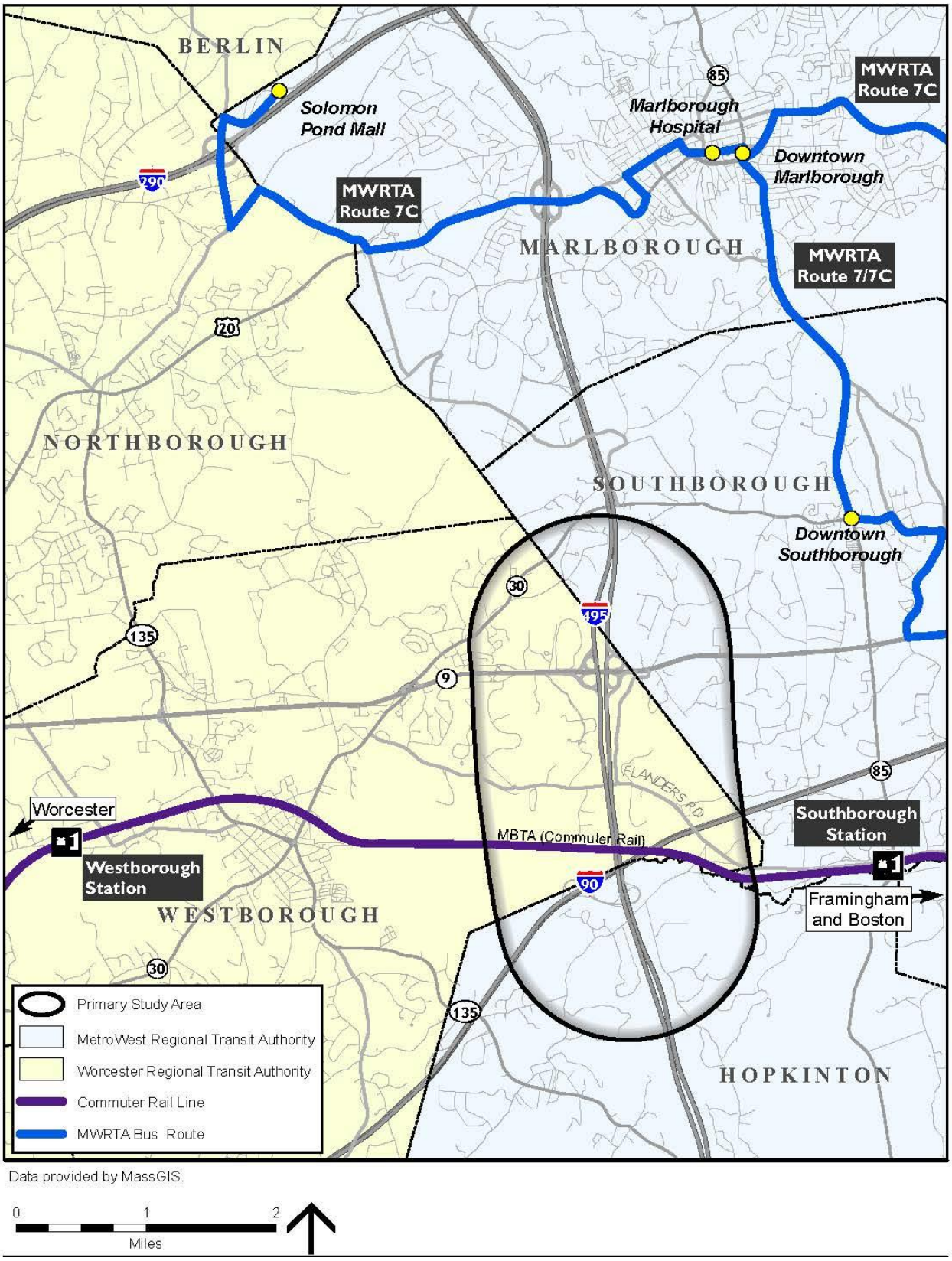


Figure 2.5-2: Existing Commuter Rail and Bus Routes in the Study Area



WRTA Existing Transit Service

The WRTA provides transit services to the City of Worcester and eleven (11) surrounding communities on the 23 WRTA fixed routes. All fixed routes are oriented to Downtown Worcester basically serving the population within or going to the Worcester Urbanized Area. The communities that are served by WRTA fixed routes include the towns of: Auburn, Brookfield, East Brookfield, Holden, Leicester, Millbury, Oxford, Shrewsbury, Spencer, Webster and West Boylston.[34] In 2009, WRTA had annual fixed route ridership of 3,176,036 Unlinked Passenger Trips.[35] According to the FY 2009 National Transit Database (NTD) Report, the WRTA had a daily ridership of 11,800 riders.[36] WRTA provides service seven days a week with limited service on Saturday and Sunday.[37]

Route 15 is the only WRTA fixed route currently serving the area east of Worcester (refer to Table 2.5-1). Route 15 serves Worcester City Hall and Shrewsbury Center via Shrewsbury Street and Route 9 with intermediate stops at Union Station, Christoforo Colombo Park, UMass Medical Center, White City Plaza, Shrewsbury Towers, Shrewsbury Town Hall, and Shrewsbury Senior Center. Route 15 completes its service by making a loop at Julio Drive in Shrewsbury, which is approximately seven (7) miles from the I-495/Route 9 study area. Note that while Westborough is within the WRTA jurisdiction, it is not currently served by a WRTA fixed bus route.

Table 2.5-1: Existing WRTA Fixed Route Schedule

Route	Description	Span of Service		Headway (mins)	
		Weekdays	Saturday	Peak Period	Off-Peak Period
Route 15	Shrewsbury Center via Shrewsbury St. and Route 9	5:20 AM – 8:50 PM	12:05 PM – 5:55 PM	60	60

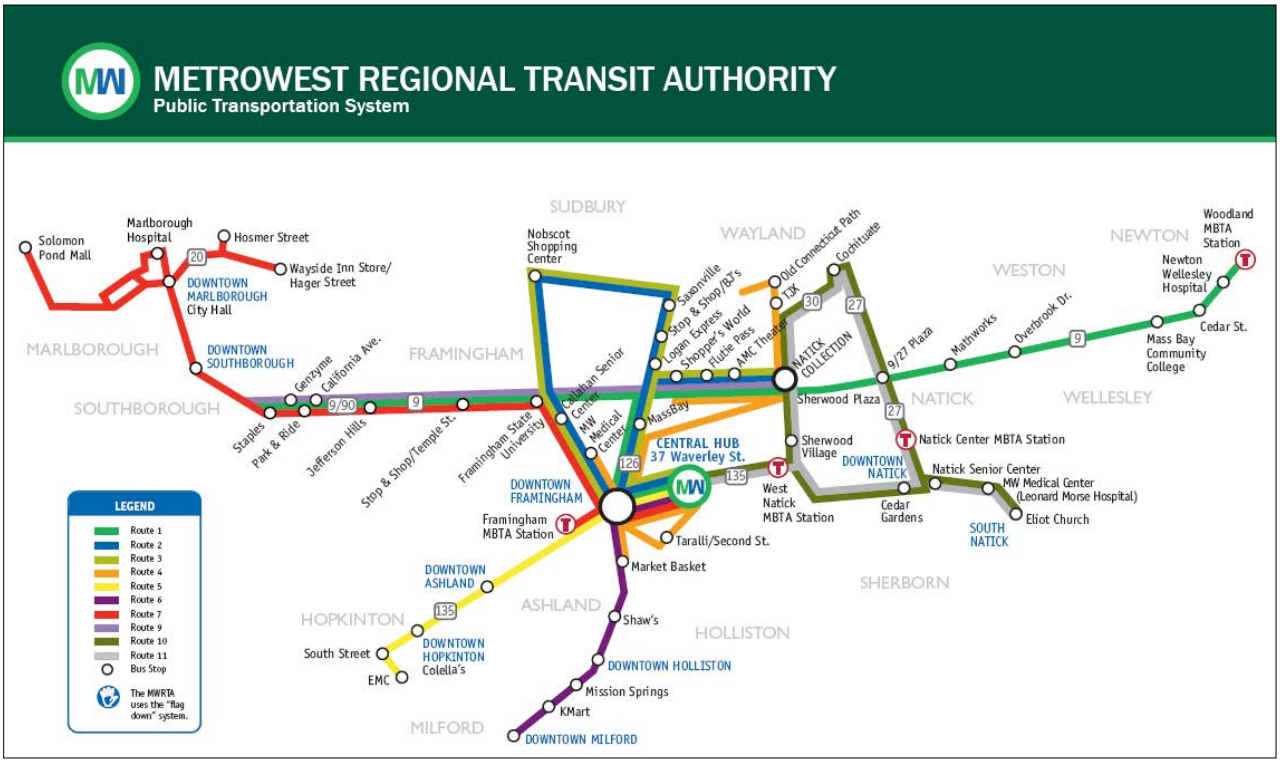
Source: Worcester Regional Transit Authority (WRTA) Routes and Schedules

MWRTA Existing Transit Service

The study area is not currently served by any existing MWRTA fixed bus route. Southborough and Marlborough are within the MWRTA area and are currently served by two bus routes (refer to Figure 2.5-3). The MWRTA currently provides transit service to eight member communities on the 11 MWRTA fixed routes. These communities include: Marlborough, Southborough, Framingham, Ashland, Hopkinton, Holliston, Milford, and Natick.[38] In 2009, MWRTA had annual fixed route ridership of 282,624 Unlinked Passenger Trips. The MWRTA had a total ridership of 34,858 (includes Fixed Route, Dial-A-Ride and ADA transportation) for the month of March 2011.[39]

[34] Worcester Regional Transit Authority website.
[35] Annual Report 2009. Worcester Regional Transit Authority.
[36] 2012 Regional Transportation Plan (RTP). Chapter III b. Public Transportation. Central Massachusetts Regional Planning Commission (CMRPC)
[37] Worcester Regional Transit Authority (WRTA) Schedules and Route Maps.
[38] MetroWest Regional Transit Authority website. http://www.mwrta.com/
[39] MWRTA News. MetroWest Regional Transit Authority website.

Figure 2.5-3: Existing MetroWest Regional Transit Authority Route



Source: MWRTA

Route 7 - Southborough/Marlborough Line and Route 7C – Inner City Marlborough currently serve Southborough and Marlborough. MWRTA Route 7 serves Framingham, Southborough, and Marlborough, with significant service coverage along State Highway Route 9 and State Highway Route 85. (See Table 2.5-2) Major stops include Marlborough City Hall, Staples Drive, Framingham State College, the Danforth Museum, and Downtown Framingham. Route 7C begins at the Central Hub in Framingham and follows Route 7 through Framingham and Southborough to Marlborough City Hall. It begins its inner city route to Lincoln and Pleasant Streets, the Hospital, and onto the Solomon Pond Mall. It also serves Route 20 to the Post Road shopping Center and Hager Street. Saturday service is available for both routes.

Table 2.5-2: Existing MWRTA Fixed Route Schedule near the Study Area

Route	Description	Span of Service		Headway (mins)	
		Weekdays	Weekends[1]	Peak Period	Off-Peak Period
Route 7	Southborough/Marlborough Line	5:45 AM – 7:55 PM	9:30 AM – 5:30 PM	45	45
Route 7C	Inner City Marlborough	6:45 AM – 7:55 PM	8:30 AM – 4:35 PM	90	90

Source: MetroWest Regional Transit Authority (MWRTA) Routes and Schedules

Note: 1. MWRTA weekend service is available only on Saturdays.

Two shuttle services – Route 1 Green Line Shuttle and Natick Commuter Shuttle provide connections to MBTA train stations. The Route 1- Green Line Shuttle provides service between Framingham and the MBTA Woodland Green Line Station in Newton. The Natick Commuter Shuttle picks up and drops off commuters at the Downtown Natick T Station and operates in coordination with the AM and PM inbound and outbound commuter train schedules between Natick and Boston.

Future Bus Services

According to the Central Massachusetts Regional Planning Commission (CMRPC)'s 2012 Regional Transportation Plan, there was no plan for expanding transit networks within the WRTA service area[40]. The WRTA and MWRTA have discussed the need for fixed route service linkages along Route 9, which traverses the two regions. The WRTA plans on starting shuttle service between the Westborough MBTA Commuter Rail Station and business parks at Computer and Technology Drives along Route 9 in Westborough in the fall of 2013. The service would run two peak morning trips, a midday trip and two peak evening trips. Funding for the service would be provided by the Town of Westborough MBTA assessment which the WRTA can access to support the service.

The MWRTA received a Job Access and Reverse Commute (JARC) grant from the MassDOT Community Transit Grant Program for State Fiscal Years 2013 and 2014 to fund an extension of their Route 1 Green Line Shuttle to the Westborough Technology Park, which is within the WRTA service area. This service will connect to the WRTA commuter rail service, and will begin operations in the fall of 2013 when the WRTA commuter rail shuttle service begins.

2.5.2 MBTA Commuter Rail Service

The MBTA currently operates commuter rail service on the Worcester Line, which has existing station stops in Westborough and Southborough, located approximately 4 miles west of I-495 and 2 miles east of I-495, respectively, as shown in Figure 2.5-2. These MBTA commuter rail stations are important regional transit nodes for east/west commuting through the study area, currently functioning as suburban Park-and-Ride facilities for residents of the broader area around the I-495/Route 9/I-90 crossroads to commute to/from employment in Boston. The existing MBTA schedule provides 17 inbound trains per weekday serving these stations from Worcester to Boston, and 16 outbound trains per weekday serving the stations from Boston to Worcester[41]. The MBTA plans to add an additional 7 trains per day by October 2013, for a total of 20 inbound and 20 outbound trains per day. [42]

The service schedule is oriented to serving commuters to Boston. There are six peak period trips in the morning originating in Worcester that serve the Westborough and Southborough train stations, and four peak period trips in the evening in the opposite direction. However, there is only one peak period outbound train to Worcester in the morning and two peak period inbound trains to Boston in the evening that could serve reverse commutes from Boston. The Commonwealth of Massachusetts has purchased a number of rail lines from CSX, including the mainline between Framingham and Worcester, and plans to increase commuter rail service on the line

Figures 2.5-4 and 2.5-5 show the existing Westborough and Southborough commuter rail stations, respectively. Field visits to the Southborough station in summer of 2011 showed the parking lot filled to capacity (as seen in Figure 2.6-5). MWRTA does not currently provide fixed route bus service to the

[40] 2012 Regional Transportation Plan (RTP). Chapter III b. Public Transportation. Central Massachusetts Regional Planning Commission (CMRPC).
[41] MBTA Worcester Line commuter rail schedule, effective April 29, 2013
[42] http://www.mbta.com/about_the_mbta/news_events/?id=25689

Southborough commuter rail station, though the station is located within their jurisdiction. MWRTA serves the Framingham, West Natick, and Natick commuter rail stations located well to the east of the study area. Similarly, the Westborough commuter rail station parking lot is near capacity (see Figure 2.6-4). WRTA does not currently provide fixed route bus service to the Westborough commuter rail station, though the station is located within their jurisdiction. WRTA bus routes serve the Worcester commuter rail station located well to the west of the study area.

Figure 2.5-4: Existing Westborough Commuter Train Station

Figure 2.5-5: Existing Southborough Commuter Train Station

2.5.3 Paratransit

WRTA paratransit service and Elder Shopper service provide paratransit service for elderly and disabled within ¾ mile of fixed bus routes within the WRTA service area. The MWRTA provides several paratransit services to its service areas: MWRTA ADA Paratransit Service, Dial-a-Ride service, MetroWest RIDE (MW RIDE), and MWRTA's Grocery Program. MWRTA ADA Paratransit service is available to all areas of member towns in the MWRTA service area. The WRTA and MWRTA coordinate with each other for providing paratransit services to customers who live in one service area but would like to enter another service area.

2.5.4 Private Carriers

Cavalier Coach Trailways, a private intercity bus carrier, had operated limited commuter bus service from Marlborough to Boston via Framingham, Southborough, Sudbury, Wayland, and Weston along Route 20. That service ended in October, 2011. [43]

Peter Pan Bus Lines and Greyhound Lines provide regional services from New York, Hartford, Springfield, and Worcester to Boston. The service from Hartford and New York is jointly operated with Greyhound Lines as a pooled service. Peter Pan Bus Lines and Greyhound Lines have a total of twelve (12) round-trips on both weekdays and weekends between Worcester and Boston but have no stops within the study area communities.

2.5.5 Transportation Demand Management Measures

Transportation demand management (TDM) measures are alternative transportation measures that are used to improve congestion and environmental impacts by reducing the number of single-occupant autos by employees commuting to and from work. TDM programs that are currently active in the I-495 and Route 9 area are described below.

The MetroWest/495 Transportation Management Association (TMA)

The MetroWest/495 Transportation Management Association (TMA) promotes carpooling, vanpooling, taking public transit, biking, and walking to work for nearly 40,000 employees of more than 30 member companies in MetroWest. The TMA is a member-based organization with services only available to employees of the member companies in Framingham, Hopkinton, Marlborough, Natick, Southborough, Sudbury, and Westborough. Two chambers of commerce host the TMA's office – the MetroWest Chamber of Commerce and the Marlborough Regional Chamber of Commerce. Companies that join the TMA also join one of the Chambers of Commerce. The two Chambers of Commerce merged their TMA organizations in 2000 to gain economies of scale and better serve the region. The TMA's free online database (transaction.vivacommute.com) makes it easy to find commuters who live and work near a co-worker. This online database is maintained by TransAction Ridematching. By creating new profiles in the database, commuters can see a list of other commuters that live close to their home and also travel to the same destination.

The MetroWest/495 TMA's five key efforts include:

1) Promoting a free, secure ride-matching database for employees of member companies,

[43] http://www.metrowestdailynews.com/news/x1499152091/MetroWest-Cavalier-commuter-bus-service-ends-this-month

2) Offering a free Guaranteed Ride Home to people who leave their cars at home at least two days a week,
3) Educating employees on benefits of giving their cars a break,
4) Promoting public transit in the region, and
5) Promoting local, state-wide and national efforts to change American's habit of driving alone to work.[44]

The MetroWest/495 TMA provides various programs to the member companies, including carpooling, free Guaranteed Ride Home, bike to work, public transit, vanpooling, and teleworking. The TMA also offers several prizes and contests as incentives for the commuters who participate in their programs. To help new bike commuters get started and acknowledge existing bikers, many TMA member companies offer an annual Bike to Work Day in the month of June, where the TMA member companies host a Bike Information Table or Bike Workshop. The MetroWest/495 TMA encourages preferential parking and offers periodic promotions as parking incentives for commuters. An effort is made to ensure guaranteed parking is available for those who carpool.

Table 2.5-3 summarizes the number of employees of six member companies that participate in various MetroWest/495 TMA programs. It shows that Staples has the largest number of commuters (498 employees) participating in the TMA programs. According to the table, the highest number of employees in the program (404) commutes to their work through Ridematching (a service to find other employees who want to share a commute), Carpools, Guaranteed Ride Home and Biking programs are also popular among the employees of the member companies. There are currently no vanpoolers.

Table 2.5-3: Employees at Member Companies with MetroWest/495 TMA Programs

Companies	Carpools	Ridematching	Biking	Guaranteed Ride Home	Transit [1]
EMC	58	0	28	67	72
Staples	200	197	29	72	-
Computer Associates	14	52	18	51	-
National Development	2	25	2	6	-
Genzyme	62	92	32	54	-[2]
Bose	15	38	40	25	-[2]
Total	**351**	**404**	**149**	**275**	**72**

Source: MetroWest/495 TMA

Notes 1. MWRTA Dial-a Ride service from Southborough commuter rail station
2. MWRTA Dial- a Ride service is available to Genzyme and Bose employees. No data available on the number of employees that use the service.

Guaranteed ride home, telework, and vanpooling programs provided through the MetroWest/495 TMA are summarized below.

Guaranteed Ride Home

Employees of TMA member companies who regularly carpool, vanpool, take public transit, ride a bike or walk to work are eligible for free Guaranteed Ride Home program by registering on the online database.

[44] MetroWest/495 Transportation Management Association website. http://www.metrowest495tma.org/

Commuters can use the service up to four times a year. Guaranteed Ride Home for bike commuters is also available in case of emergencies during the day, mechanical failure, or the unexpected need to work late. Members who signed up for a Guaranteed Ride Home can directly contact Tommy's Taxi for a ride which is reimbursed by the TMA.

Telework and Flexible Work Schedules:

Telework, or telecommuting, consists of allowing employees to work remotely outside of the central workplace. Telework can reduce commuter travel and congestion and improve the quality of life for employees. TMA member companies, including Computer Associates (Framingham) and Hewlett Packard (Marlborough), allow employees to telework.

Flexible work schedules enable employees to condense their work schedules and eliminate some commuting time. Raytheon offers a 9/80 schedule in which employees work eight nine-hour days, one eight-hour day, and have every other Friday off.

Vanpooling

The MetroWest/495 TMA supports individuals and groups interested in commuting together to form a vanpool. The TMA publicized the availability of the route and invites people to join the vanpool. Commuters using vanpooling program co-lease a 7-to-15 person van on a month-by-month basis, designate drivers, and agree on a schedule and pickup points.

Vanpooling is provided to the commuter groups through the following vendors:

- Easy Street;
- Enterprise, national chain with offices in MetroWest;
- HT Drummond Inc., Halifax, Massachusetts;
- The Rideshare Company, Windsor, Connecticut;
- Verc Car and Van Rental, Plymouth, Massachusetts; and
- VPSI, national chain with an office in Woburn, Massachusetts.

MassRides

MassRides is the Massachusetts Department of Transportation's statewide travel option program providing free assistance to commuters, employers, students, and other travel markets. MassRides runs a ride-matching program where commuters can register on-line, scan the database, and form a carpool with others who have similar commuting needs.

MassRides and MassDOT have partnered and launched the NuRide program in April 2011. NuRide is the nation's largest rewards program for individuals who take greener trips – walking, biking, carpooling, vanpooling, transit, and telework/telecommuting. NuRide is free and supported by sponsors who provide special offers and rewards to NuRide members for taking greener trips. The NuRide program is consistent with GreenDOT policy that was adopted by MassDOT in June 2010.

The TMA coordinates with NuRide and encourages its members to enroll in the NuRide program to gain access to the Ridematching service. TMA members are also encouraged to log their carpool, vanpool, walk and bicycle trips on the NuRide system which provides summarizes of vehicle-miles and pollutants saved for each company.

Dial-A-Ride (Formerly The Local Connection)

Commuters can call Dial-A-Ride service to request a ride from commuter rail in Southborough to destinations in Westborough, Southborough, and Marlborough. Depending on the distance traveled, the fare is either $2 or $3. As of July 1, 2008, First Transit and the MWRTA began managing TLC and changed the name to Dial-A-Ride. Dial-A-Ride provides transportation to the following TMA member companies in Westborough: EMC, Bose, and Genzyme on Computer Drive/ Route 9.

2.6 Summary

An understanding of study area conditions, both now and in the future, provides the basis for development and evaluation of alternatives to address future needs within the study area. The area in Westborough and Southborough around the I-495/ Route 9 Interchange is a regional employment center with large office/industrial parks and significant areas of industrially zoned land with potential for future development. It has been designated as a Priority Development Area (PDA) by the MetroWest Compact Plan, and is an important factor in the economic development plans for the MetroWest region. The ability of the transportation infrastructure to support this desired development is a key factor in achieving these economic development objectives.

The analysis shows that study area highways carry high peak period commuter traffic volumes. I-495 carries approximately 100,000 vehicles per weekday, and serves as an inter-regional and interstate travel link. Route 9 provides access to the office and industrial parks located along the corridor. Average weekday traffic on Route 9 is approximately 63,000 vehicles west of I-495 and 55,000 vehicles east of I-495. The peak travel direction in the morning is northbound on I-495 to I-90 eastbound and Route 9 westbound. In the evening, the pattern is reversed. By 2035, traffic on I-495 is projected to increase by 15-19 percent under the Regional Transportation Plan (RTP) scenario and 22-27 percent under the higher growth projections of the PDA scenario.

The traffic capacity analysis show that the worst traffic conditions occur in the peak travel direction. Today, I-495 northbound between Route 9 and I-90 as well as Route 9 westbound west of I-495 operate at deficient conditions (Level of Service (LOS) E) in the morning peak. During the evening peak, I-495 southbound between Route 9 and I-90 as well as Route 9 eastbound west of I-495 operate at LOS E. The interchange ramps with the worst traffic problems are the I-495 southbound off-ramp to Route 9 westbound (LOS E) and the I-495 northbound off-ramp to I-90 (LOS F).

Traffic operations get worse in 2035 based on the projected growth in traffic. For the RTP scenario, the LOS for I-495 northbound goes to F for the segment south of I-90, and to E for the segment south of Route 9 in the morning peak. The Route 9 westbound west of I-495 is LOS E. In the evening peak, I-495 southbound is LOS E south of Route 9 and LOS F south of I-90. Route 9 eastbound west of I-495 is LOS E. Under the PDA scenario, I-495 northbound south of Route 9 and Route 9 westbound west of I-495 deteriorates to LOS F in the morning peak, and I-495 southbound south of Route 9 and Route 9 eastbound west of I-495 deteriorates to LOS F in the evening peak. The interchange ramps serving these travel directions are similarly affected.

Today, each of the signalized intersections west of I-495 currently operate at acceptable conditions overall (LOS A-D) in both peak hours. However, there are individual movements that operate deficiently. During the AM peak hour, the Route 9 northbound left turn onto Computer Drive and southbound left turn on Connector Road onto Research Drive experience longs queues of over 500 feet. The northbound Friberg Parkway approach to Research Drive operates at LOS F with long queues in the PM peak hour. On Route 9 east of I-495, the signalized intersection of Route 9/Crystal Pond Road operates at LOS F in

the AM peak hour and LOS D during the PM peak hour. Long vehicle queues are experienced on the Route 9 eastbound and westbound approaches for both the AM and PM peak hours.

Future traffic volumes will generally increase vehicle delay and queuing at most study intersection movements. For the RTP scenario, the intersection of Route 9/Crystal Pond Road will deteriorate to LOS F overall in the PM peak hour and continue to operate at LOS F in the AM peak hour. Under the PDA scenario the following intersections will deteriorate to LOS E or F: Connector Road/Research Drive (LOS E, AM; LOS F, PM), Research Drive/Friberg Pkwy (LOS E, AM) and Route 9/Deerfoot Road (LOS F, AM; LOS E, PM).

The analysis of roadway geometrics found that none of the I-495/Route 9 and I-495/I-90 ramps or four weaving areas at the I-495/Route 9 interchange meet current highway design speed standards[45]. The acceleration lane distance for I-90 and I-495 northbound is also substandard. There are weaving, queuing, and signage issues at the I-90 toll plaza. On Route 9, there are sight distance issues for Route 9 eastbound approaching Crystal Pond Road and sub-standard driveway spacing for businesses on Route 9 westbound east of I-495.

The I-495 off ramps to I-90 is an historic Top 60 Crash Location, with 208 recorded between 2007-2009. About half were rear-end crashes. During that same time period, I-495/Route 9 had 106 crashes, with most on I-495 southbound to Route 9 westbound. Route 9 Eastbound at Crystal Pond road had 28 crashes, with 90 percent rear-end crashes.

There are few options besides travelling by single-occupancy vehicle in the study area. The study area is spans two Regional Transit Authority (RTA) service areas. Westborough is in the Worcester RTA and Southborough in the MetroWest RTA. Neither currently provides any fixed-route service in the study area, although the WRTA is planning on starting a shuttle service from the MBTA commuter rail station in Westborough to business parks on Route 9 in the fall of 2013, and the MWRTA is planning on expanding their Route I Green Shuttle from its current terminus in Framingham to the Westborough Technology Park, once the WRTA commuter rail shuttle begins service. This will allow transfers between the two transit services. The MBTA provides commuter rail service on the Worcester Line, with existing station stops in Westborough and Southborough, located approximately 4 miles west of I-495 and 2 miles east of I-495. The service schedule is oriented to serving commuters to/and from Boston. There are six peak period trips in the morning originating in Worcester that serve the Westborough and Southborough train stations, and four peak period trips in the evening in the opposite direction. However, there is only one peak period outbound train to Worcester in the morning and two peak period inbound trains to Boston in the evening that could serve reverse commutes from Boston. The MetroWest/495 Transportation Management Association (TMA) promotes carpooling, vanpooling, taking public transit, biking, and walking to work for employees of their member companies in MetroWest.

A review of the environmental conditions within the study area shows few environmental constraints in the vicinity of the I-495/Route 9 interchange and along Route 9 between Connector Road on the west and Crystal Pond Road on the east. There are some areas of wetlands on the north and south sides of Route 9 to the east of Crystal Pond Road. The I-495/I-90 interchange is located within the Cedar Swamp Area of Critical Environmental Concern (ACEC) that contains multiple environmental resource areas (protected species habitat, wetlands, water resources and water supply, and archeological sites) that pose constraints on potential improvement alternatives. The potential for environmental impacts relative to these resource areas will be a consideration for proposed improvements to this interchange.

[45] There are no weaving areas at the I-495/I-90 Interchange. Weaving areas occur at the I-90 toll plaza

The understanding of existing and future conditions as documented in this chapter provides the basis for the development and evaluation of alternatives to address the needs of the study area presented in Chapter 3. Travel demand on the I-495 corridor is high, due to the fact that the Interstate fulfills a variety of critical functions. I-495 has been a major influence on development within the multiple communities it passes through, and the I-495/Route 9 interchange provides access to a regional employment center along the Route 9 corridor. Over time, I-495's role in connecting MetroWest corridor communities to a wider transportation system contributed to their growth and economic well-being. However, the travel demand from the I-495 corridor communities has combined with travel outside this corridor to stress the capacity of I-495 and its interchanges with other highways. The analysis conducted for this study shows that there are multiple traffic capacity and safety issues within the study area on the I-495 mainline and Route 9 and I-90 interchange ramps, as well as within the Route 9 corridor. The expected growth in population and employment in the area will generate additional traffic, exacerbating already congested conditions. Given the multiple areas of concern with the study area, it is challenging to find one alternative to address all the issues; rather, the solution may call for a broad range of multi-modal alternatives, each targeted to address a specific issue. Collectively these alternatives may work together to form a master plan for meeting the needs of the I-495/Route 9 study area.