I-84 HARTFORD PROJECT

CONNECTICUT DEPARTMENT OF TRANSPORTATION

I-84 Hartford Project

State Project No. 63-644

Analysis, Needs, and Deficiencies Report

July 27, 2015

TranSystems

EXPERIENCE | Transportation

Analysis, Needs, and Deficiencies Report

July 27, 2015

Prepared For:

The Connecticut Department of Transportation

Prepared By:

The I-84 Hartford Program Management Team

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1.0 Introduction

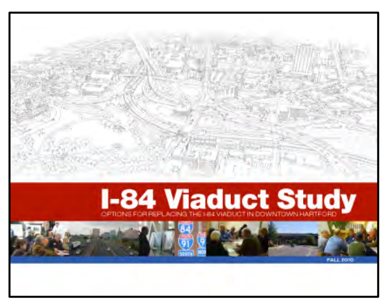
The *I-84 Hartford Project* (the Project) was initiated by the Connecticut Department of Transportation (CTDOT) to address structural deficiencies on Interstate 84 (I-84) and its interchanges between Flatbush Avenue and Interstate 91 (I-91) in the City of Hartford. This report presents the data collection and analysis used to define the needs and deficiencies within the study area and to help guide the development of alternatives.

1.1 Project Background

Construction for I-84 through Hartford began in 1959 and was completed in October of 1969. The final layout of the highway was determined after a long planning effort that started as early as the 1930's. Much of the interstate consists of a series of viaducts (long, multi-span bridge structures) carrying I-84 over what is now Amtrak's Hartford Line (formerly known as the New Haven-Hartford-Springfield line) railroad and several city streets. Several interchanges also consist of bridge structures. The bridges are now reaching the end of their service lives (the period of time a bridge is expected to be in operation) and are in need of major rehabilitation or replacement. The deterioration of these bridges is mainly due to leaky joints and, as a result, they require costly maintenance and rehabilitation efforts by CTDOT to keep them in a "state of good repair."

I-84 Viaduct Structures near Broad Street; Source: Skycomp, 2013

The Project is preceded by multiple reports, evaluations and studies for potential rehabilitation and/or replacement. Most recently, *The I-84 Viaduct Study*, published in 2010 by the Capitol Region Council of Governments (CRCOG), evaluated several concepts for replacing the viaduct structures. The concepts focused on the environs surrounding the highway and had an emphasis on improved aesthetics, neighborhood connectivity and reducing the highway's footprint to provide for economic development (see Section 1.4 for a discussion on prior studies and reports).



The I-84 Viaduct Study: Source: CRCOG, 2010

1.2 Study Areas

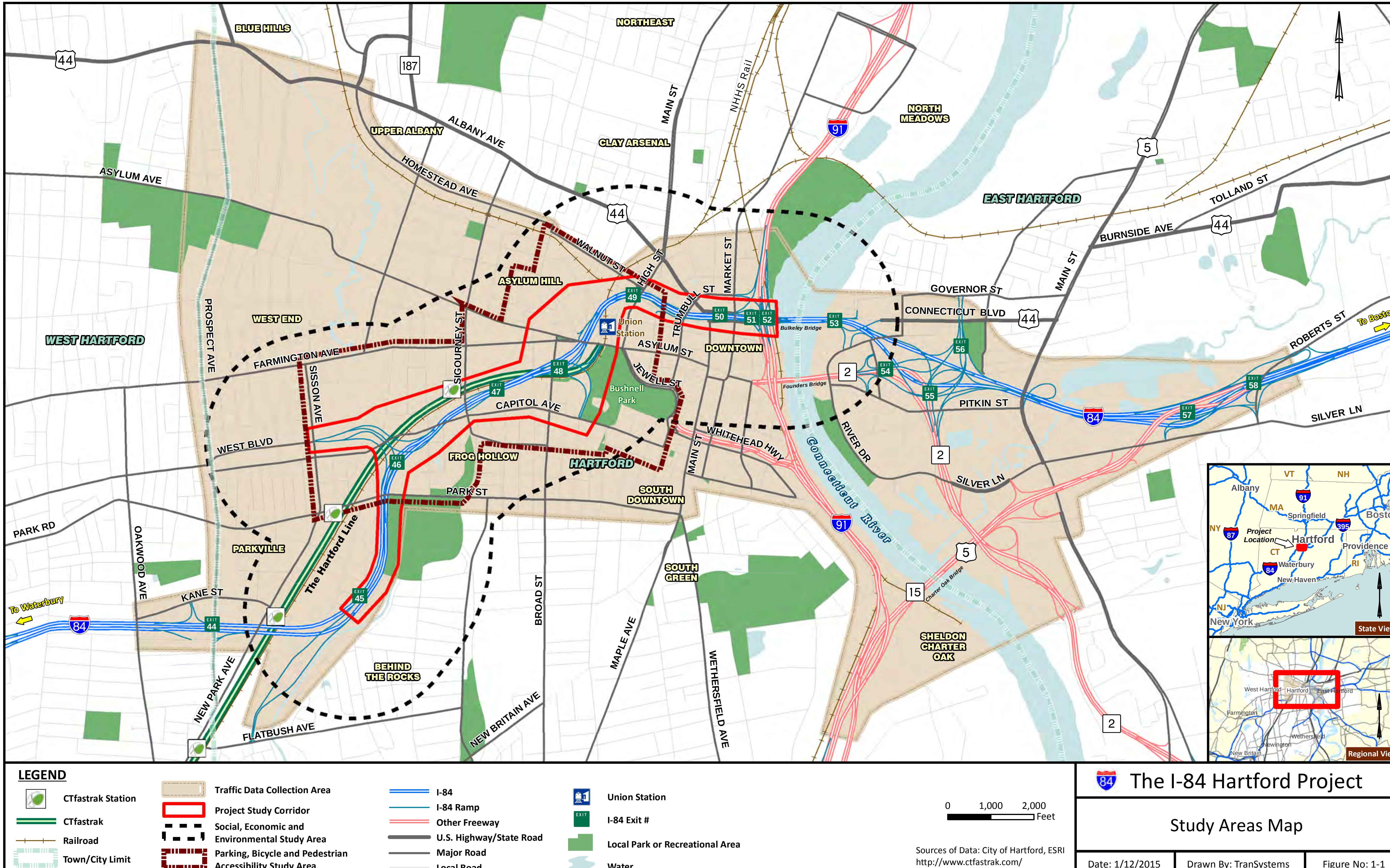
The City of Hartford is the capital of Connecticut, and the largest employment center in the State. Known as the "Insurance Capital of the World", three of the top five employers in Hartford are in the insurance industry. Downtown Hartford is home to approximately 110,000 jobs with employment concentrated in the insurance, financial, legal, and government sectors[1].

I-84 bisects the city, and within Connecticut, it serves as a critical east-west transportation link between New York and Massachusetts. It provides connectivity to and from Interstate 91 (I-91) in Hartford, a major north-south section of interstate highway between New Haven and Massachusetts; and Route 2 in East Hartford, a major east-west expressway serving eastern Connecticut. Locally, commuters use I-84 and its interchanges to access Hartford's business districts, State Capitol and downtown areas.

The study areas for the needs and deficiencies analysis are defined on Figure 1-1: Study Areas Map, following. As shown in Figure 1-1, the study areas include the Project Study Corridor; the Traffic Data Collection Area; the Social, Economic and Environmental Study Area; and the Parking, Bicycle and Pedestrian Accessibility Study Area. Each of these is unique in order to evaluate and analyze different resource components of the needs and deficiencies in a comprehensive fashion. The study areas were determined based on the Project's potential to impact the resource component to be evaluated.

The Project Study Corridor, extending along I-84 from the Flatbush Avenue interchange (Interchange 45) to the I-91 interchange (Interchanges 51 and 52), was used for accident data and safety analysis, roadway geometry review, and the existing and future structural conditions assessment. The Parking, Bicycle, and Pedestrian Accessibility Study Area is an expansion of the Project Study Corridor and includes significant employers and developments. The Social, Economic, and Environmental Study Area encompasses a 2,500-foot buffer area around the Project Study Corridor. The Traffic Data Collection Area extends well beyond the Project Study Corridor and serves to gather information to help evaluate potential bypass or diversion routes around Hartford, including Routes 5/15 (the Charter Oak Bridge) over the Connecticut River, and evaluate other roadway connections whose operations may be affected by the Project.

[1]Connecticut Economic Resource Center (CERC), City of Hartford Profile, 2014.

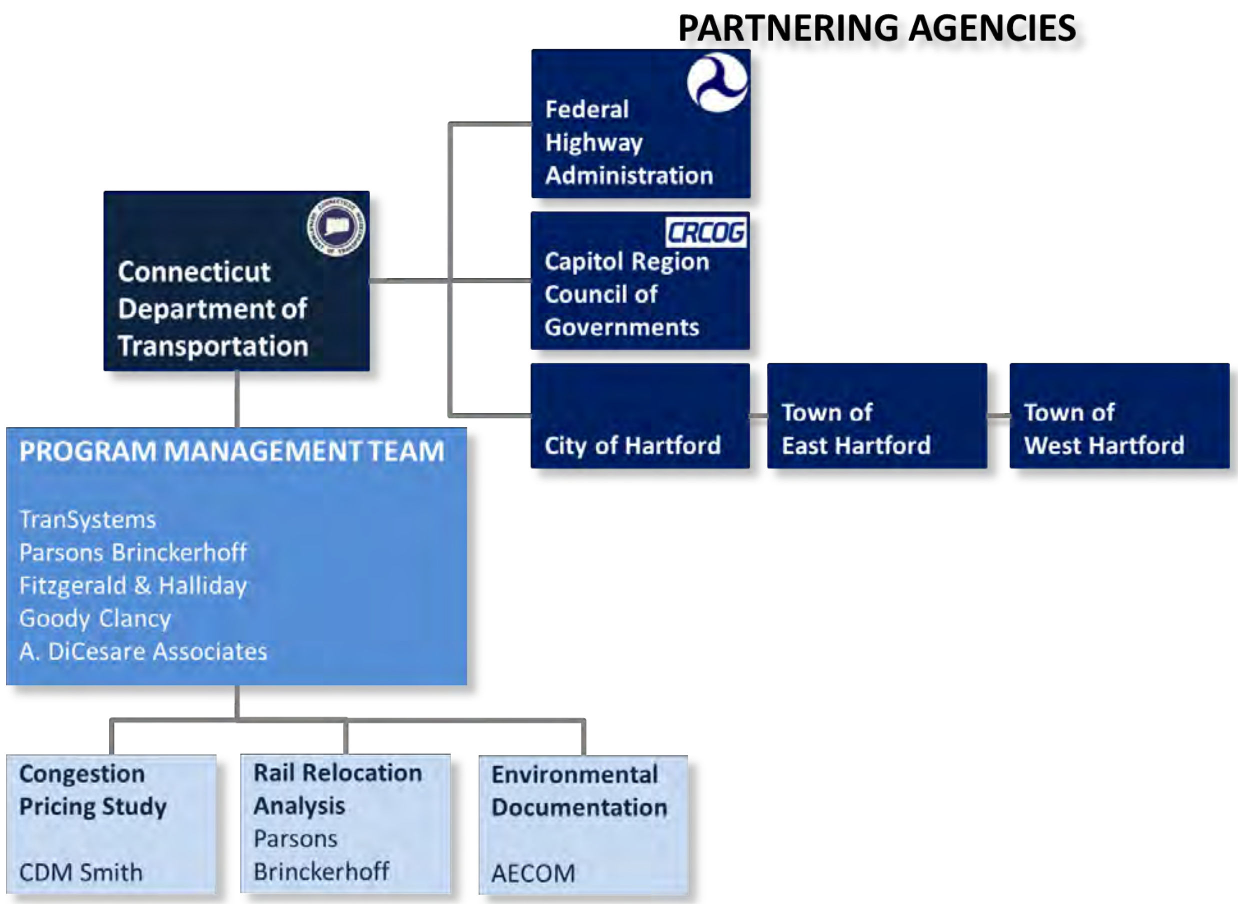


BLUE HILLS
NORTHEAST
UPPER ALBANY
ALBANY AVE
HOMESTEAD AVE
CLAY ARSENAL
NORTH MEADOWS
EAST HARTFORD
ASYLUM AVE
ASYLUM HILL
WALNUT ST
HIGH ST
MAIN ST
MARKET ST
NHHS Rail
TOLLAND ST
BURNSIDE AVE
GOVERNOR ST
CONNECTICUT BLVD
ROBERTS ST
To Boston
WEST END
WEST HARTFORD
PROSPECT AVE
FARMINGTON AVE
SISSON AVE
SIGOURNEY ST
Union Station
ASYLUM ST
DOWNTOWN
TRUMBULL ST
Bulkeley Bridge
Founders Bridge
JEWELL ST
Bushnell Park
CAPITOL AVE
PITKIN ST
SILVER LN
WEST BLVD
FROG HOLLOW
HARTFORD
WHITEHEAD HWY
RIVER DR
Connecticut River
PARK ST
SOUTH DOWNTOWN
PARK RD
OAKWOOD AVE
PARKVILLE
The Hartford Line
KANE ST
SOUTH GREEN
To Waterbury
BROAD ST
MAPLE AVE
WETHERSFIELD AVE
Charter Oak Bridge
SHELDON CHARTER OAK
BEHIND THE ROCKS
NEW PARK AVE
FLATBUSH AVE
NEW BRITAIN AVE
Albany
VT
NH
MA
Springfield
Boston
NY
Project Location
Hartford
Providence
CT
RI
Waterbury
New Haven
NJ
New York
State View
West Hartford
East Hartford
Farmington
Wethersfield
Newington
New Britain
Regional View
LEGEND
CTfastrak Station
CTfastrak
Railroad
Town/City Limit
Traffic Data Collection Area
Project Study Corridor
Social, Economic and Environmental Study Area
Parking, Bicycle and Pedestrian Accessibility Study Area
I-84
I-84 Ramp
Other Freeway
U.S. Highway/State Road
Major Road
Local Road
Union Station
I-84 Exit #
Local Park or Recreational Area
Water
0 1,000 2,000 Feet
Sources of Data: City of Hartford, ESRI
http://www.ctfastrak.com/
The I-84 Hartford Project
Study Areas Map
Date: 1/12/2015
Drawn By: TranSystems
Figure No: 1-1

1.3 Project Team

The I-84 Hartford Project team consists of several agencies, municipalities and consultants. The Project Team is illustrated in Figure 1-2. CTDOT is the owner of the facility and, with the oversight of the Federal Highway Administration (FHWA), will be the lead decision-maker for the Project. FHWA will provide technical and fiscal oversight to ensure that the Project follows the applicable federal regulations.

Figure 1-2: Project Team



TranSystems Corporation (TSC) will serve as the lead consultant for the Program Management Team, which consists of Parsons Brinckerhoff (PB), Fitzgerald & Halliday, Inc. (FHI), Goody Clancy (GC) and A. DiCesare Associates (ADA). Program Management Team responsibilities have been broken down as follows:

- TSC – Prime consultant, program management, highway and bridge design, traffic analysis,
- PB – Project controls, highway and rail design, cost estimation, constructability review,
- FHI – Public involvement, transportation planning, environmental/socioeconomic review,
- GC – Urban planning, economic development coordination, and
- ADA – Structural condition review, structural design.

CTDOT retained AECOM to perform environmental data collection, screening analysis, and to develop and lead the NEPA documentation process in coordination with the Program Management Team. CTDOT also retained CDM Smith to conduct the I-84 Viaduct Value Pricing Study. This includes: traffic and toll revenue analysis of six proposed tolling scenarios, toll operational analysis, and financial analysis. This study is funded under the Federal Highway Administration (FHWA) Value Pricing Pilot Program (VPPP) to evaluate whether value pricing using electronic tolling, in combination with other transportation system improvements, can reduce traffic congestion. CDM Smith will be working closely with the Program Management Team throughout the Project. Additionally, the Project Team will be working with PB's Rail Relocation Analysis team for the Hartford Line (formerly New Haven-Hartford Springfield) rail program.

1.4 Prior Studies and Reports

The bridge structures through the Project Study Corridor have a long history of poor condition ratings and have been rehabilitated numerous times since their construction. As such, CTDOT and other organizations have studied replacement and rehabilitation options in prior studies and reports. The rehabilitation report is a 1995 rehabilitation study commissioned by CTDOT which evaluated replacing the viaduct in kind between Laurel Street and Broad Street. The study also included options for improving deficient highway geometry, including shoulder widths and horizontal alignment.

CTDOT in cooperation with CRCOG completed a Major Investment Study (MIS) in 1999 which evaluated transportation alternatives designed to reduce congestion in the I-84 corridor between Hartford and Farmington. The MIS recognized the difficulties in adding through capacity to the I-84 corridor and focused on providing alternate solutions to increase mobility. Key recommendations included:

- Construction of the CT*fastrak* busway from New Britain to Hartford (which began service on March 28, 2015);
- Redesign of the Prospect, Flatbush, Sisson, and Sigourney interchanges;
- Improvements to local bus service;
- Transportation Demand Management; and
- Zoning regulations to support Transit-Oriented Design (TOD).

The interchange redesign recommendations were ultimately programmed for further study, overseen by CTDOT under the *I-84 West Side Access Study (*WSAS*)*, completed and published in 2001. The WSAS recommended a build alternative which included major reconfiguration for the Flatbush and Sisson interchanges. The proposed improvements to these interchanges centered on removing unnecessary elements which were originally intended to carry future, never-constructed highways, and creating more traditional interchanges focused on delivering users to the street network more efficiently. At both interchanges, significant state right-of-way would be returned to the City of Hartford. Following the WSAS, no projects were initiated to reconstruct the Flatbush or Sisson interchanges. The I-84 Hartford Project will evaluate improvements to the Sisson interchange. The Flatbush interchange marks the limits of the Project Study Corridor, and the ramp system is considered outside of the project limits.

Faced with continuing structural deterioration and escalating maintenance expenditures, CTDOT initiated an internal study to evaluate rehabilitation and replacement alternatives for the viaduct structures between Laurel Street and Broad Street. Completed in 2004, the draft report evaluated three rehabilitation alternatives and one replacement alternative. The replacement alternative consisted of the construction of a new viaduct structure with some geometric improvements, including improved horizontal alignment and widened shoulders. Following the 2004 draft report, a group of local advocates encouraged the undertaking of a broader study, focusing on new alternatives which could address the connectivity and economic development problems the structures create. These local advocates along with the City of Hartford formed the Hub of Hartford Committee (the Hub).

The Hub served as the advisory committee for the *I-84 Viaduct Study* overseen by CRCOG and CTDOT, completed in 2010. The study explored a broad range of possible project alternatives that would improve the I-84 infrastructure, while considering economic development opportunities, neighborhood connectivity, community cohesion, livability, and mobility. The study documented how I-84 is a visual and physical barrier, dividing employment centers, communities, and neighborhoods within Hartford. With the goal to “reduce the visual and environmental impacts of the highway; promote walkable, bikeable environments that support transit use and enhance transit access; and reconnect the City across the highway,” the study screened six preliminary concepts down to four potential alternative concepts which were recommended for further study.

2.0 Existing Transportation Conditions

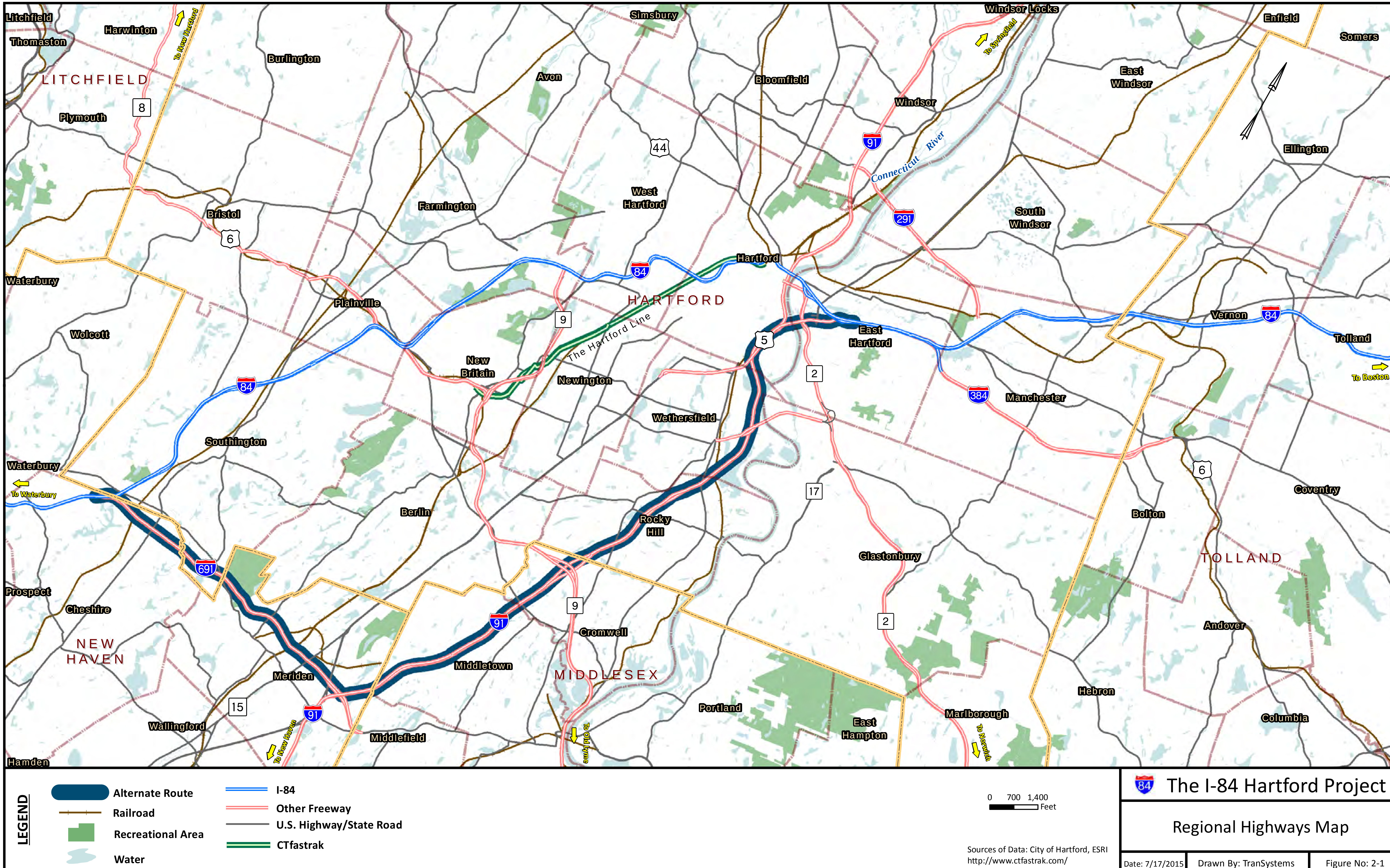
The existing transportation conditions within the I-84 Hartford study areas have been analyzed to identify the needs and deficiencies that the Project will address. Assessment of the existing conditions establishes a baseline to which anticipated future conditions can be measured and various improvement alternatives can be compared.

2.1 Overall Transportation Network Summary

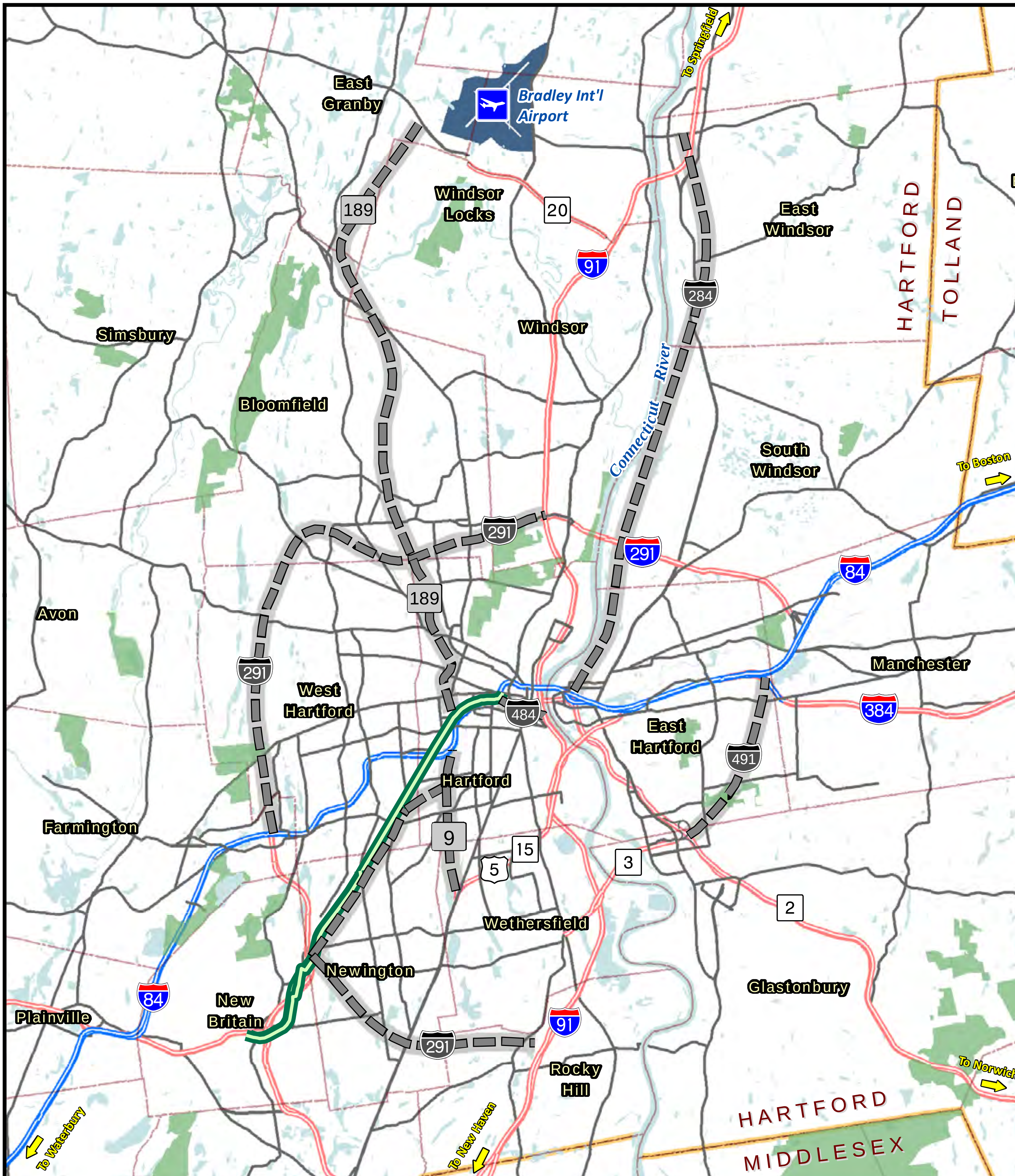
The transportation system in the study areas consists of I-84 and other major highways, the local roadway network, several transit modes, and bicycle and pedestrian paths and routes. Befitting its status as a major employment center, Hartford serves as a major transportation hub and offers transportation connections to destinations worldwide via Bradley International Airport, located approximately 15 miles north of Downtown Hartford.

Overall, the transportation system in Hartford is heavily influenced by the 1950s/1960s era of automobile-centric urban planning, with both I-84 and I-91 cutting through downtown areas. Transportation officials within the State are seeking to enhance transit options and enable pedestrian and bicycle mobility. The CT*fastrak* bus rapid transit system, which opened on March 28, 2015, provides fast and reliable transit access between Hartford and communities to the south, east, and west. Efforts are underway to improve the regional rail system, including the introduction of commuter rail service to the Hartford region.

The existing regional transportation system depends heavily on Interstates 84 and 91, together two of New England's crucial transportation arteries, which provide regional east-west and north-south connectivity. An alternate route around the City of Hartford is available for east-west travelers, via I-691, I-91, the Charter Oak Bridge, and the Wilbur Cross Highway (US 5/CT 15). This alternate route is approximately three miles longer than taking I-84 directly through Hartford. CT Route 2 provides a freeway connection from Hartford to points south and east. The existing freeway network through the Hartford area is a fraction of what was originally planned. Figure 2-1, following, presents the existing highway network, highlighting the I-691/I-91 alternate route. Figure 2-2 on page 2-3 illustrates the planned freeways which were never constructed (all routes approximate). As discussed further in Section 2.1.1, the I-84 interchanges with Sisson Avenue (Interchange 46) and Capitol Avenue (Interchange 48) were originally designed as to accommodate direct connections to other planned freeways. Having never been constructed at these locations, there is an overbuilt network of direct connection ramps to local streets. In the following sections of Chapter 2, the existing conditions of the transportation facilities within the Project Study Corridor are discussed in detail.



Litchfield
Harwinton
Thomaston
LITCHFIELD
Burlington
Avon
Simsbury
Bloomfield
Windsor Locks
To Springfield
Windsor
Enfield
Somers
East Windsor
Ellington
Plymouth
8
44
91
Connecticut River
Farmington
West Hartford
Bristol
6
291
South Windsor
Waterbury
Plainville
84
Hartford
HARTFORD
9
The Hartford Line
5
East Hartford
Vernon
Tolland
To Boston
Wolcott
New Britain
Newington
2
384
Manchester
Wethersfield
Southington
Waterbury
To Waterbury
17
Berlin
Rocky Hill
Bolton
Coventry
Glastonbury
TOLLAND
691
Prospect
Cheshire
Cromwell
Andover
NEW HAVEN
Middletown
MIDDLESEX
Meriden
Hebron
Portland
Marlborough
East Hampton
Columbia
15
Wallingford
To New Haven
Middlefield
To Old Lyme
To Norwich
Hamden
To New Hartford
LEGEND
Alternate Route
Railroad
Recreational Area
Water
I-84
Other Freeway
U.S. Highway/State Road
CTfastrak
0 700 1,400 Feet
Sources of Data: City of Hartford, ESRI
http://www.ctfastrak.com/
The I-84 Hartford Project
Regional Highways Map
Date: 7/17/2015
Drawn By: TranSystems
Figure No: 2-1



LEGEND

- Proposed Regional Freeways (Not Constructed)
- CTfastrak
- Railroad
- Recreational Area
- Water
- I-84
- Other Freeways
- U.S. Highway/State Road
- Major Road
- Local Road

The I-84 Hartford Project

Planned Hartford Area Freeways

Date: 7/17/2015	Drawn By: TranSystems	Figure No: 2-2

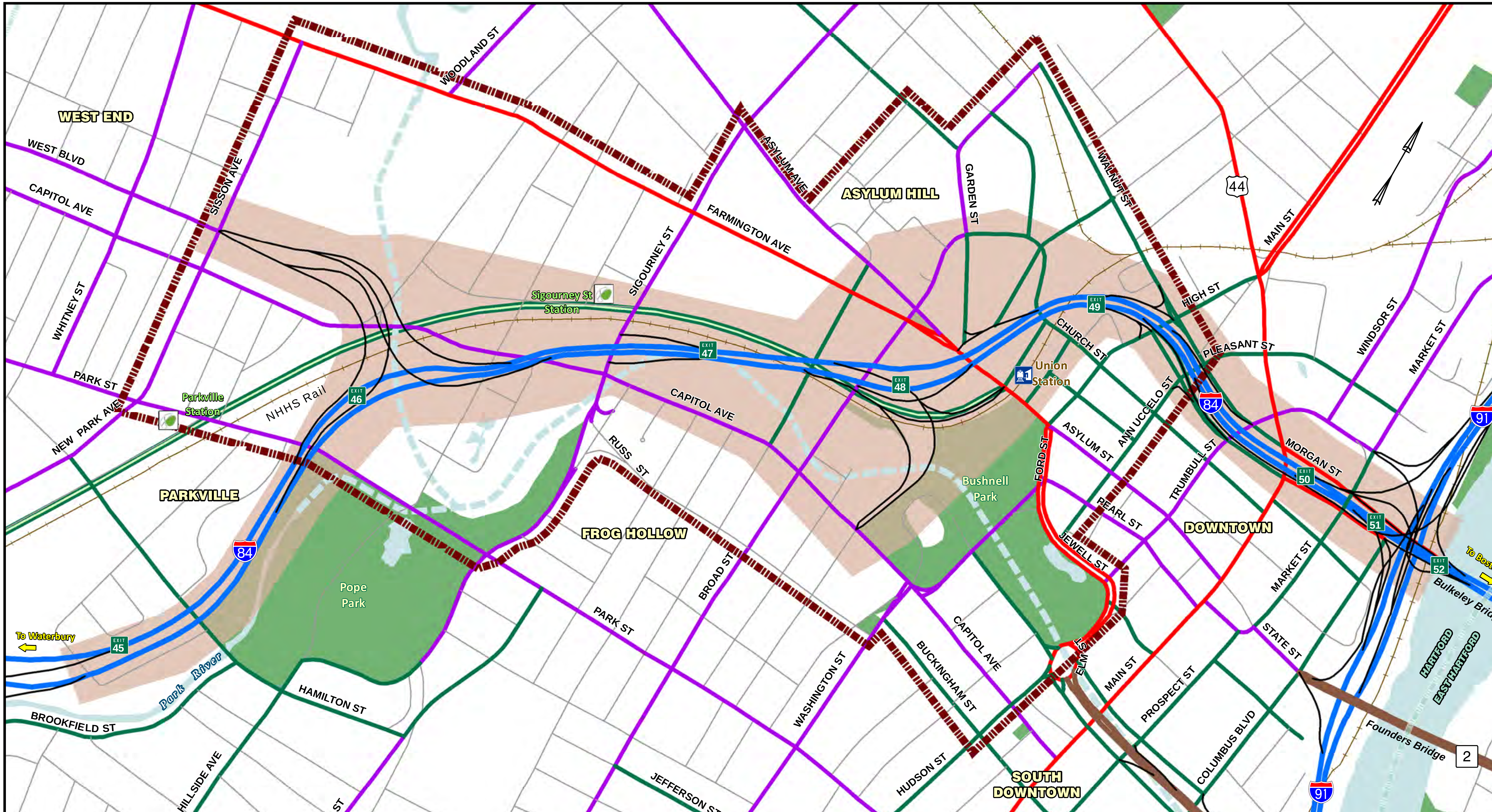
2.1.1 Mainline and Interchange Ramps

I-84 within the Project Study Corridor includes 4.86 miles of mainline roadway, which is divided between 2.28 miles in the westbound direction and 2.58 miles in the eastbound direction. Total travel lanes vary from two to five lanes in each direction. The Project Study Corridor includes seven interchanges consisting of twenty-two ramps of varying lengths and complexities. These interchanges are listed in Table 2-1 below. The majority of the roadways were designed and constructed between the 1950s and 1980s; maintenance and rehabilitation continue through the present. Two interchanges within the Project Study Corridor were originally constructed with future freeway connections in mind: Interchange 46 (Sisson Avenue) and Interchange 48 (Capitol Avenue/Asylum Street), specifically the eastbound off-ramps, 48A/B. Interchange 46 remains broadly as constructed in the 1960s, whereas Interchange 48 was modified in the 1980s once the planned freeway connections had been abandoned. The I-84 mainline and its interchanges within the Project Study Corridor are illustrated in Figure 2-3, following. The roadway geometry features of these facilities are analyzed in detail in Section 2.5: Roadway Geometry Review.

Table 2-1: I-84 Interchanges within the Project Study Corridor

I-84 Interchange #	Connection(s) To	Directions Served	# of Ramps	Style
46	Sisson Avenue	Eastbound and Westbound On- and Off-Ramps	4	Three-Leg Directional
47	Sigourney Street	Eastbound On-Ramp and Westbound Off-Ramp	2	Partial Diamond
48	Capitol Avenue/Broad Street/Asylum Street	Eastbound and Westbound On- and Off-Ramps*	6	Complex
49	Ann Uccello Street/ High Street	Eastbound Off-Ramp and Westbound On-Ramp	2	Partial Diamond
50	Main Street (US 44)/ Trumbull Street/ Morgan Street	Eastbound and Westbound On- and Off-Ramps	4	Diamond
51	I-91 Northbound	Eastbound Off-Ramp and Westbound On- and Off-Ramps	3	Semi-Directional
52	I-91 Southbound	Eastbound On- and Off-Ramps and Westbound On-Ramp	3	Semi-Directional

* Two ramps either split or come together for the eastbound off-ramp and the westbound on-ramp



LEGEND

- Principal Arterial - Interstate (Urban)
- Principal Arterial-Other Expressway (Urban)
- Principal Arterial-Other (Urban)
- Minor Arterial (Urban)
- Collector (Urban)
- Local (Urban)
- CTfastrak Station
- CTfastrak
- Railroad
- Project Study Corridor
- Parking, Bicycle and Pedestrian Accessibility Study Area
- I-84 Exit #
- Union Station
- Park
- Water
- Park River Conduit
- Ramp
- Town/City Limit

0 500 1,000 Feet

Sources of Data: City of Hartford, ESRI
http://www.ctfastrak.com/

The I-84 Hartford Project

Project Study Corridor Map

Date: 6/27/2014	Drawn By: TranSystems	Figure No: 2-3

2.1.2 Local Road Network

Within the Project Study Corridor, I-84 passes through six of Hartford's neighborhoods. From west to east, they are Parkville, Behind the Rocks, the West End, Frog Hollow, Asylum Hill, and Downtown. In many places, the boundary between these neighborhoods coincides with the highway. These divisions are exacerbated at locations where the highway and its ramps are carried on the elevated structures that constitute the majority of the Project Study Corridor.

The local road network is shown by functional classification on Figure 2-3, previous. Through the study areas, illustrated on Figure 1-1, there is a predominant availability of east-west mobility and a general lack of north-south mobility. Due to recent safety concerns with the at-grade CT*fastrak* crossing, Flower Street is no longer a through north-south connection. The north and south legs of Flower Street operate independently and are closed to through traffic at the railroad and CT*fastrak* crossings, including all bicycles, pedestrians, and automobiles.

There are several arterial roads bringing traffic from West Hartford and the West End and Parkville neighborhoods of Hartford towards Downtown, including Farmington Avenue, Asylum Avenue, Albany Avenue (US 44), Park Street/Road, and Boulevard/West Boulevard. However, there are just two arterials conveying north-south traffic in the western part of the corridor: Sigourney Street and Broad Street. The road network in Downtown Hartford generally consists of a grid network, including some one-way streets and turn restrictions. Community stakeholders have noted that connectivity to and from I-84 and transit uses (CT*fastrak* stations and Union Station) and the surrounding areas can and should be improved[1]. Additional deficiencies for transit operations, and pedestrian and bicycle accessibility are discussed in the following sections.

The Project Team has undertaken extensive data collection throughout the local road network to help evaluate what impacts may be caused during construction and by the final build condition. For a review of data collection efforts within the Project Study Corridor, see Section 2.2: Existing Traffic Data; for a review of existing traffic operations, see Section 2.4: Existing Traffic Operations. In Appendix 2, there is a review of data collection and traffic operations within the entire Traffic Data Collection Area.

2.1.3 Corridor Parking Analysis

The Project Team has compiled and evaluated existing parking conditions. A Parking, Bicycle, and Pedestrian Accessibility Study Area (the Study Area for the duration of this section), illustrated on Figure 2-3, previous, was defined by the Project Team for this analysis. This Study Area was used to evaluate off-street and on-street parking.

The Study Area has a considerable amount of on-street curbside parking and off-street parking facilities, both publicly and privately owned. The parking areas affected by the proposed alternatives studied for this corridor may vary; therefore both qualitative and quantitative analyses were conducted to

[1] See Stakeholder Interview Summaries, Appendix A.3.1.

determine existing and future parking needs for the Study Area. The Study Area contains approximately 22,826 parking spaces in a combination of off-street and on-street parking facilities. The vast majority of the total parking capacity is made up of private (employee) off-street parking lots and garages. Study Area parking is presented in Table 2-2, below.

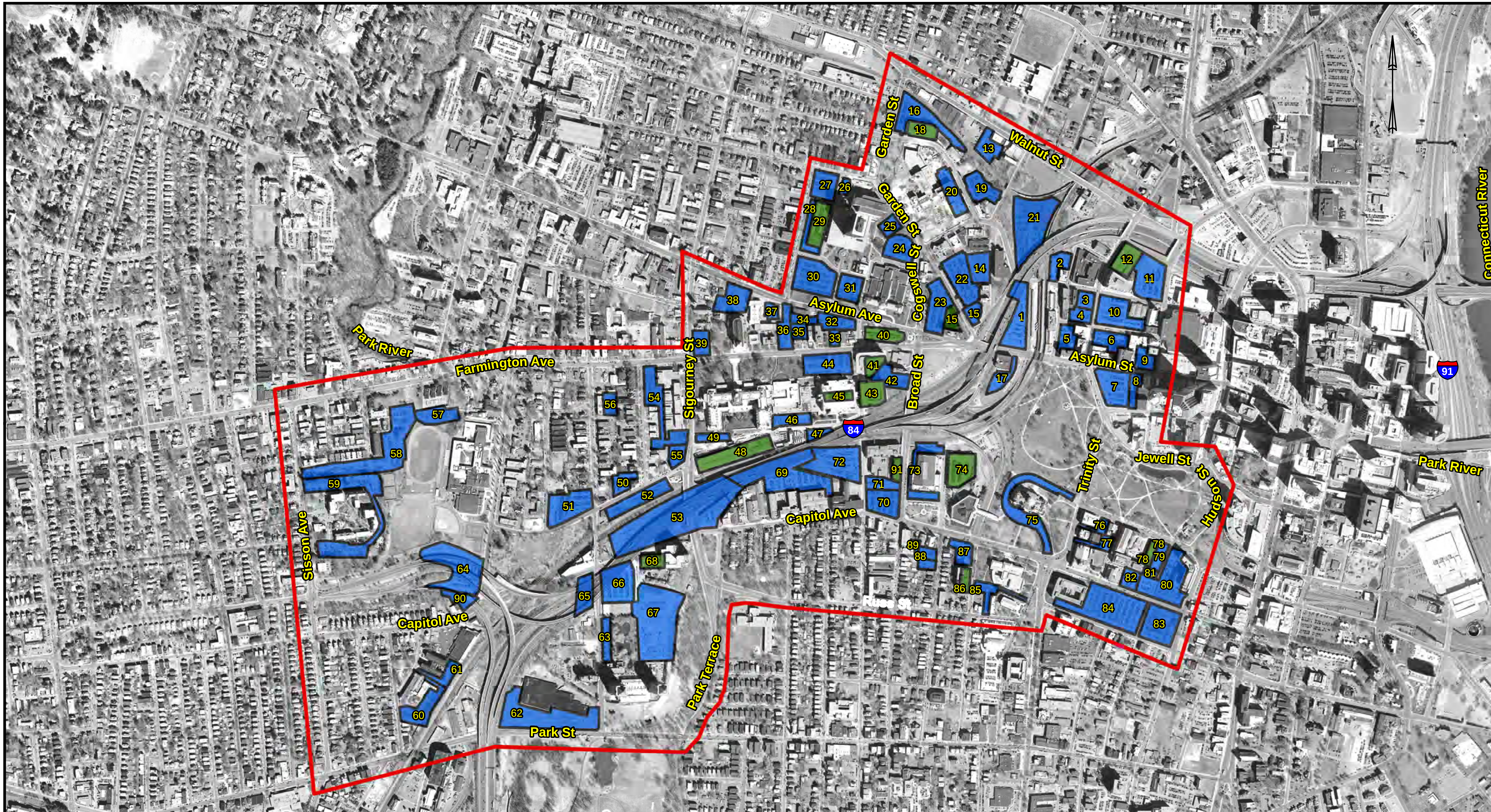
Table 2-2: Existing Parking within the Study Area

Off-Street Parking	
Public Parking	
Type	*# of Spaces*
Surface Lots	1,522
Structures	1,504
Total Public	**3,026**
Private Parking	
Type	*# of Spaces*
Surface Lots	12,154
Structures	6,480
Total Private	**18,634**
Total Off-Street Parking:	**21,660**
On-Street Parking	
Type	*# of Spaces*
Metered- Coin	56
Metered- Pay-to-Park	192
Unmetered	970
Total On-Street Parking:	**1,218**
Total Parking	**22,826**

As more in depth analysis of options is conducted, potential impacts to existing parking areas will be documented and potential solutions highlighted. In addition, the City of Hartford undertook a parking study is to review existing parking and determine future parking needs within the Downtown neighborhood. The study looked at challenges and opportunities of the City's owned parking sites and infrastructure as well as recommendations for changes of parking, pricing, and transportation policies.

Off-Street Parking Facilities

Off-street parking facilities within the Study Area were evaluated and documented via aerial photo survey, field reconnaissance, and interviews with Project Stakeholders. Interviews with Project Stakeholders were conducted in the summer and fall of 2013 and are included in full in Appendix A.3.1. This information was supplemented by data gathered in field visits and aerial photography review conducted during 2014. Off-street parking facilities with a capacity of over 20 parking spaces were included in this analysis. Based on this criterion, 14 parking structures and 78 parking lots have been evaluated. There are no City- or State-designated Park & Ride lots within the Study Area. Figure 2-4, following, illustrates the surface parking lots and parking garages identified within the Study Area. Each surface parking lot and parking structure was assigned an identification number that correlates to the Surface Parking Lots and Parking Structures Inventory in the Parking Analysis Appendix, Appendix A.3.2.



LEGEND

- Parking Lot
- Parking Garage
- Parking, Bicycle and Pedestrian Accessibility Study Area

0 750 1,500 Feet

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

The I-84 Hartford Project

Off-Street Parking Facilities Map

Date: 7/22/2015	Drawn By: Parsons Brinckerhoff	Figure 2-4

Inventory data include property owners, lessees, lease terms, operators, operating hours, capacity, Americans with Disabilities Act (ADA) capacity, utilization, and ingress/egress points, as available. Additional information on off-street parking facilities was gathered through interviews with Project Stakeholders including The Hartford, Aetna, CT Department of Administrative Services (DAS), and The Hartford Courant to detail current capacity and usage of their off-street parking facilities and future parking needs. Summaries of major off-street parking facilities within the Study Area are included below.

The Hartford

The Hartford, located between Asylum Avenue, Cogswell Street, and Garden Street, currently has about 6,000 employees. The Hartford is in the process of selling its Simsbury location and 700 employees will relocate to the Hartford campus. All employees are provided a parking space for free. The Hartford has fourteen lots with approximately 2,400 parking spaces and two garages with an unconfirmed number of parking spaces. The Hartford's parking lots are identified as lot No. 16, No. 19, No. 20, No. 21, No. 22, No. 23, No. 24, No. 25, No. 26, No. 27, No. 28, No. 30, No. 31 and No. 32 and the garages No. 18 and No. 29 in Figure 2-4: Off-Street Parking Facilities Map. The Hartford leases lot No. 33, off Farmington Avenue and west of Asylum Avenue, to Bank of America and the Junior Achievement of Southwest New England on a long-term lease. The Hartford leases lot No. 21 (The Hartford's North Transportation Lot) from Spruce Reality, LLC. Utilization data on lot No. 21 was collected on Tuesday, June 24, 2014 with the lot approximately 49% utilized.

The Hartford feels they may have significant needs for future parking though they have no set plans defined to increase parking at this time.

Aetna

Aetna is located between Farmington Avenue, Broad Street, and Sigourney Street. The company estimates 4,500 employees travel by car to the campus and utilize on-campus parking. In addition, the company receives about 180 visitors per day. Aetna has a progressive parking policy – employees must pay for a parking spot. Those who choose to use transit are provided a stipend, which has resulted in increased participation in transit programs. Despite this, Aetna has more employees who pay for a parking spot than they have parking spots. They oversell parking spots and operate them on a first come first serve basis. Aetna has not had any complaints or concerns raised from their employees regarding parking, as they estimate that on any given day a certain number of employees are not on campus due to flex work schedules, paid sick leave or paid time off. Their garages and "primary" surface lots are 100% utilized, and employees pay a premium for these closer parking spots. Remote surface lots are less utilized, at approximately 80% on any given day.

Aetna has three parking garages - the Sigourney Street garage with 1,650 spaces, Flower Street garage with 1,150 spaces, and the Atrium underground garage with 212 spaces. All of their garages provide two electric vehicle spaces. Aetna's three garages are identified as lot/garage No. 43, No. 45 and No. 48 respectively, in Figure 2-4, previous.

Aetna also has ten surface parking lots that provide approximately 1,820 employee and visitor spaces. These lots are identified as lots No. 44, No. 46, No. 47, No. 49, No. 50, No. 51, No. 52 and No. 53, in Figure 2-4, previous.

Lot No. 53, located beneath I-84 is a mixed lease/owner lot with partial ownership to the Connecticut Department of Transportation (CTDOT), the City of Hartford, and Aetna. Of 1,100 parking spaces, Aetna owns approximately 375 of them with the remaining 725 located within the CTDOT right-of-way for I-84 or the City of Hartford right-of-way for the Park River Conduit. The lease with CTDOT is a 20 year lease that was signed in 1995 and expires on February 28, 2015 with four rights to renew - (2) 5 year renewals and (2) 10 year renewals that ultimately expire in 2045. There is a 180-day termination clause for either party to terminate the lease at any point for any reason.

The Woodbine Lot (No. 67), off Laurel Street and south of Capitol Avenue, is leased to the State of Connecticut. The lot is leased for three calendar years with an option to extend for one year then an option to extend for 6 months. The Office of the Attorney General (OAG) signed the lease on March 6, 2012.

Aetna has commented that their parking needs are currently met sufficiently, though their future parking needs may increase.

CT Department of Administrative Services (DAS)

According to DAS, 1,200 state employees are located in the Capitol Avenue complex (located on the north side of Capitol Avenue, from Columbia Street to Babcock Street) and another 1,400 employees are located in the 25 Sigourney Street building. The State intends to move all 1,400 employees from the Sigourney Street building to two separate locations in Hartford by 2016 with no plans to re-populate the building. The Sigourney Street building, owned by the State, needs significant work as it has been designated a “sick” building. The State will determine whether to attempt to rehabilitate or sell this property within the next one to two years. The parking structure at the Sigourney Street location, with a total capacity of 910 spaces, is also in poor condition. The lower section of the garage, which connects the garage to the adjacent building, has been closed indefinitely, rendering 863 spaces inaccessible. The State will determine whether the garage will be demolished.

The State is required per union contract to provide one parking spot per employee. The State (not including CTDOT owned lots) owns or partially owns three parking garages and nine parking lots within the Study Area. Three surface lots are located partially within the I-84 right-of-way. The State leases the sections below I-84 from CTDOT. These lots are located between Flower Street and Sigourney Street; between Sigourney Street and Laurel Street; and on the corner of Forest Street and Capitol Avenue (beneath the Interchange 46 (Sisson Avenue) ramps). The combined parking capacity currently used by DAS is approximately 3,600 spaces at locations within the Study Area. Surface lots are identified as lots No. 64, No. 65, No. 66, No. 69, No. 70, No. 73, No. 75, No. 84 and No. 87; the garages are No. 40, No. 41, and No. 68 in Figure 2-4, page 2-8.

The State also currently leases a parking lot from Aetna, (Woodbine Lot, No. 67, with a capacity of 667 spaces) located off Laurel Street south of Capitol Avenue. The lot is leased for three calendar years with an option to extend for one year then an option to extend for 6 months. The OAG signed the lease on March 6, 2012. Including parking lots leased to Aetna, the State-owned parking capacity within the Study Area is approximately 5,000 spaces, not including the closed section of the garage at 25 Sigourney Street.

State employees are provided shuttles between parking lots and State offices. DAS indicated that the State would lose approximately 1,000 parking spaces if the I-84 were lowered to grade. Generally, DAS owned and operated lots are fully utilized (see I-84 Surface Parking Lot Parking Garages Inventory Appendix, located in Appendix A.3.2). Based on current and future parking needs, this loss would negatively affect their parking needs.

The Hartford Courant

The Hartford Courant, the State's most widely distributed newspaper, is located at 285 Broad Street. Employees park in a parking lot to the west of the building, off of Flower Street (Lot No. 72) which provides 410 parking spaces. Approximately 60 of the parking spaces are in a parcel leased from Amtrak underneath I-84. There is no current signed lease between Amtrak and the Hartford Courant. The past lease ended in 2012 and due to the construction of the CT*fastrak*, the lease was not renewed. Amtrak has plans to restart negotiations with the Courant later this year. The Courant has already lost several spaces to CT*fastrak*, and is interested in the possibility of having a garage built. These parking lots are identified as lots No. 71 and No. 72 in Figure 2-4, page 2-8.

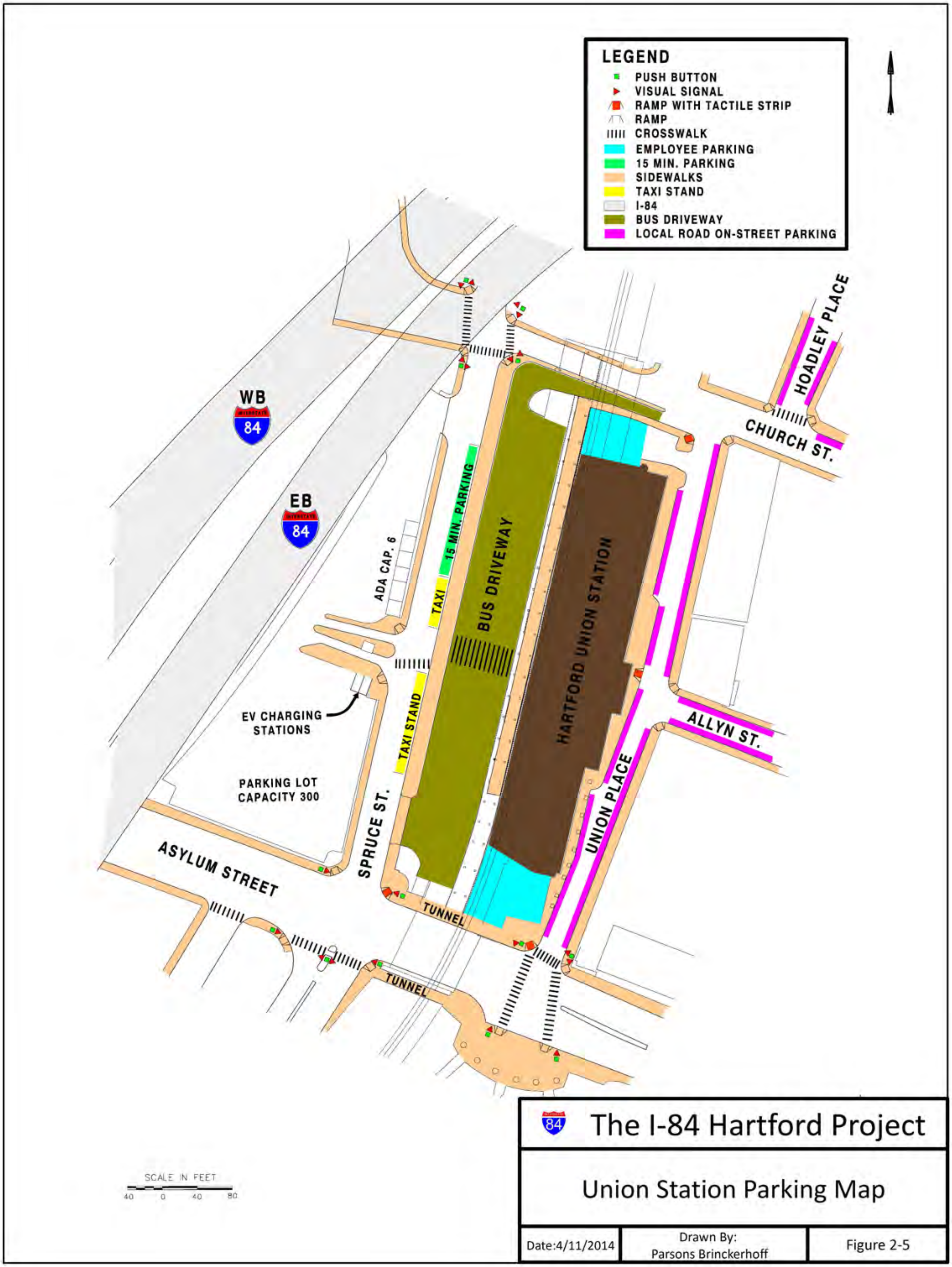
The Hartford Courant estimates utilization of lot No. 72 to be between 63% and 73% during working hours, Monday through Friday, 8:00 AM to 5:00 PM. Lot No. 71 is approximately 36% utilized during working hours.

Union Station

Hartford's Union Station is located on at 1 Union Place, between Asylum and Church Streets. The historic Union Station is served by Amtrak's Hartford line. In addition to rail service, the station serves as a local transportation hub, serving inter-city, regional and local buses, including CT*fastrak* bus rapid transit service (BRT), which opened on March 28, 2015. Existing services will be augmented with the introduction of commuter rail service on the Hartford Line. For further information on these transportation modes see Section 2.1.4: Bus Transportation and Section 2.1.5: Rail Transportation.

The parking lot adjacent to Union Station was inventoried for parking capacity, ingress and egress off Spruce Street, passenger drop-off and pick-up operations, and pedestrian walkways. Figure 2-5, following, illustrates different on-street and off-street parking amenities at the station.

The Union Station lot is owned by the Connecticut Department of Transportation (CTDOT) as part of the I-84 right-of-way. It is leased by the Greater Hartford Transit District (GHTD) and operated by Pro Park.



The I-84 Hartford Project

Union Station Parking Map

Date:4/11/2014	Drawn By: Parsons Brinckerhoff	Figure 2-5

There is a 40-year lease agreement that expires on January 1, 2022. There are (2) 20 year renewals options after the 2022 expiration. There is no early termination clause.

This lot also has two free electric vehicle spaces available, sponsored by the GHTD. These are the only known public electric spaces throughout the Study Area. According to the GHTD, the parking lot is consistently filled to capacity. On Tuesday, June 24, 2014 at 9:50 AM, utilization data was collected with the lot approximately 57% utilized.

A more detailed report, the *NW Corridor Transit Planning Project: Part 2 – Union Station Planning Final Report,*[2] completed for the Capitol Region Council of Governments (CRCOG) in April 2010, identifies existing conditions at and around Union Station. Parking information from that report has been included in Appendix A.3.2.

On-Street Curbside Parking

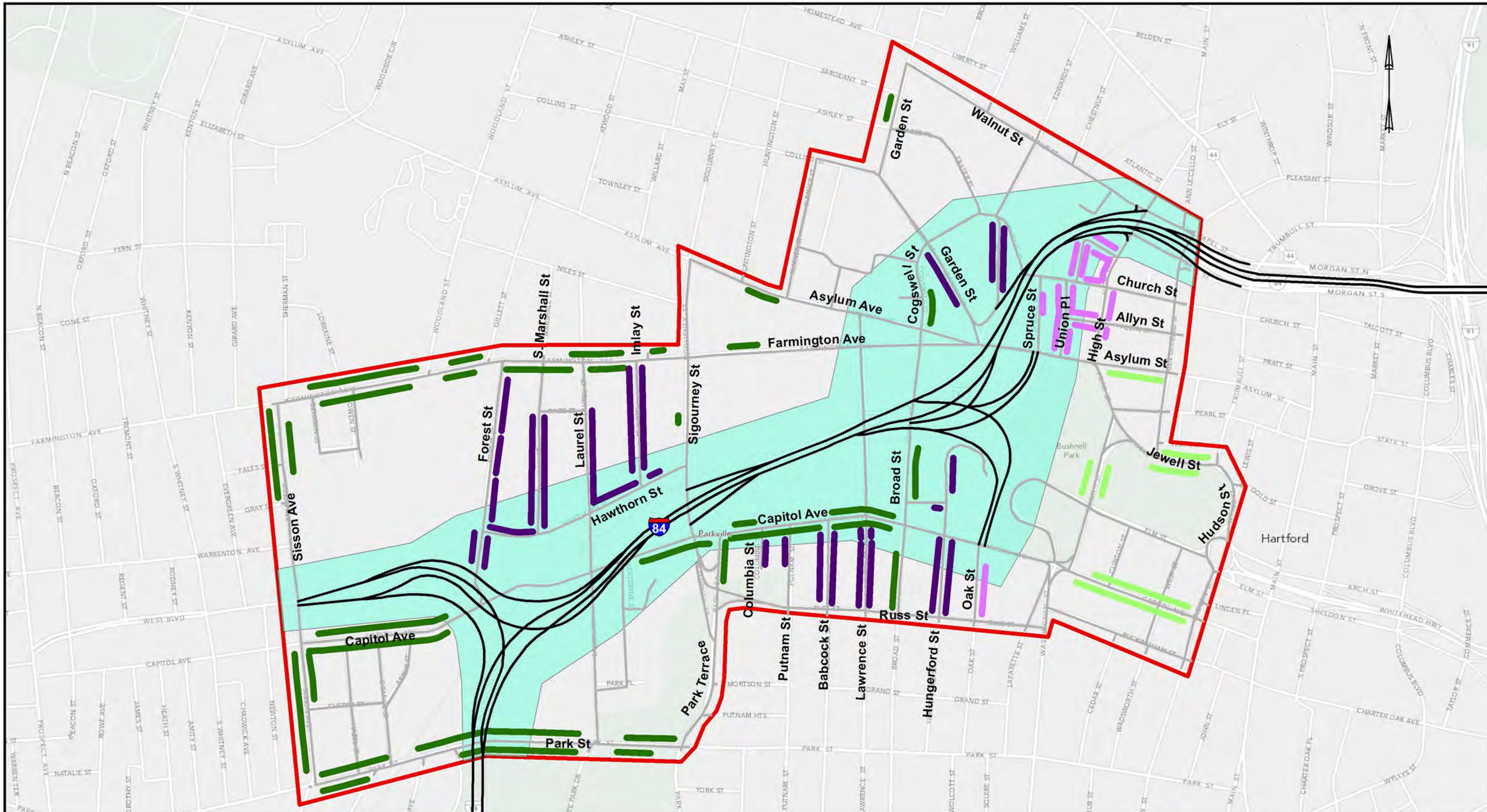
On-Street parking within the Study Area was evaluated and documented via aerial photo survey, field reconnaissance, and coordination with the City of Hartford conducted from 2013 up to the publication of this report. According to the Hartford Parking Authority (HPA), there are approximately 1,800 metered parking spaces throughout the City. Of these, 248 spaces are located within the Study Area. Locations of metered spaces are High Street, Church Street, Union Place, Spruce Street, Hadley Place/Foot Guard Place, Allyn Street, Asylum Street, Jewell Street, Capitol Avenue, Oak Street, and Trinity Street. These locations are illustrated on Figure 2-6, following.

The majority of metered spaces throughout the Study Area are part of the Pay to Park system, with approximately 192 spaces. Pay to Park is a solar powered pay station that allows a motorist to pay via credit/debit card, cash or coin, for an amount of time specified by the user. Parking is limited to two-hour windows. A paper receipt is printed that is to be mounted on the motorist's windshield dashboard. Motorists may move their vehicles and re-park at any location with a Pay to Park station as long as it is within the purchased time limit. Motorists are required to pay meters Monday through Friday, 8:00 AM to 6:00 PM, except on holidays. The minimum purchase for parking is twenty-five cents for fifteen minutes. On-street parking in Hartford is free after 6:00 PM on weekdays and all day on weekends unless otherwise noted.

Two locations within the Study Area operate coin operated meters. One location is Jewell Street adjacent to Bushnell Park with 16 metered spaces. The second location is on Hadley Place/Foot Guard Place, bordered by High Street and Church Street. This location has 40 metered spaces. The cost to park at coin-operated meters is twenty-five cents for fifteen minutes and is limited to two-hour windows.

All on-street parking throughout the Study Area is parallel in configuration. In general, the HPA does not delineate individual on-street curbside parking spaces and is in the process of eliminating all previously delineated on-street parking spaces whenever possible. Instead, the City allows motorists to park their

[2] http://www.crcog.org/transportation/current_stud/northwest.html



LEGEND

- Arterial Road Parking
- Local Road Parking
- Local Road Metered Parking
- Arterial Road Metered Parking
- I-84
- Roads
- Parking, Bicycle and Pedestrian Accessibility Study Area
- Project Study Corridor

0 500 1,000 Feet

Sources of Data: ESRI, DeLorme, NAVTEQ

The I-84 Hartford Project

On-Street Curbside Parking Map

Date: 10/13/2014

Drawn By: Parsons Brinckerhoff

Figure 2-6

vehicles in designated parking areas. Some of the designated parking areas may be as long as the entire block. As individual spaces for on-street curbside parking are not delineated, it was necessary to estimate the number of parking spaces available throughout the Study Area.

On-street parking was first identified through field observations taken throughout the Study Area. Once on-street parking was identified, segments of allowable parking were digitized and measured utilizing aerial photographs in ArcGIS and in Google Earth Street View. Using the length of individual segments of allowable curbside parking and 23 feet of curb space per vehicle (per the ITE Manual of Traffic Engineering Studies), an estimated number of equivalent parking spaces was determined. The following State Statutes or assumptions about prohibited parking areas were incorporated:

- Ingress and egress access points of parking lots and driveways
- 10 feet from a fire hydrant (2005 CT Code - Sec.14-251. Parking vehicles)
- 25 feet from a marked intersection crosswalk (2005 CT Code - Sec. 14-251. Parking vehicles)
- 25 feet from a stop sign (2005 CT Code - Sec. 14-251. Parking vehicles)

There are an estimated 620 on-street parking spaces located on arterial roads and 599 on-street parking spaces on local roads within the Study Area. Hours and days of restricted parking are identified in the Appendix A.3.2**.**

Parking on Capitol Avenue within the Study Area is prohibited on weekdays between the hours of 7 AM and 9 AM and 3:30 PM and 6 PM. For the remainder of the day, Capitol Avenue uses the curbside travel lane for parking in both directions. When the parking prohibition is in effect, this travel lane is available for peak period travel demand. Additionally, several local streets have daily alternating one-side parking in effect. For a full illustration of on-street parking restrictions, see Appendix A.3.2.

On-Street Parking Utilization

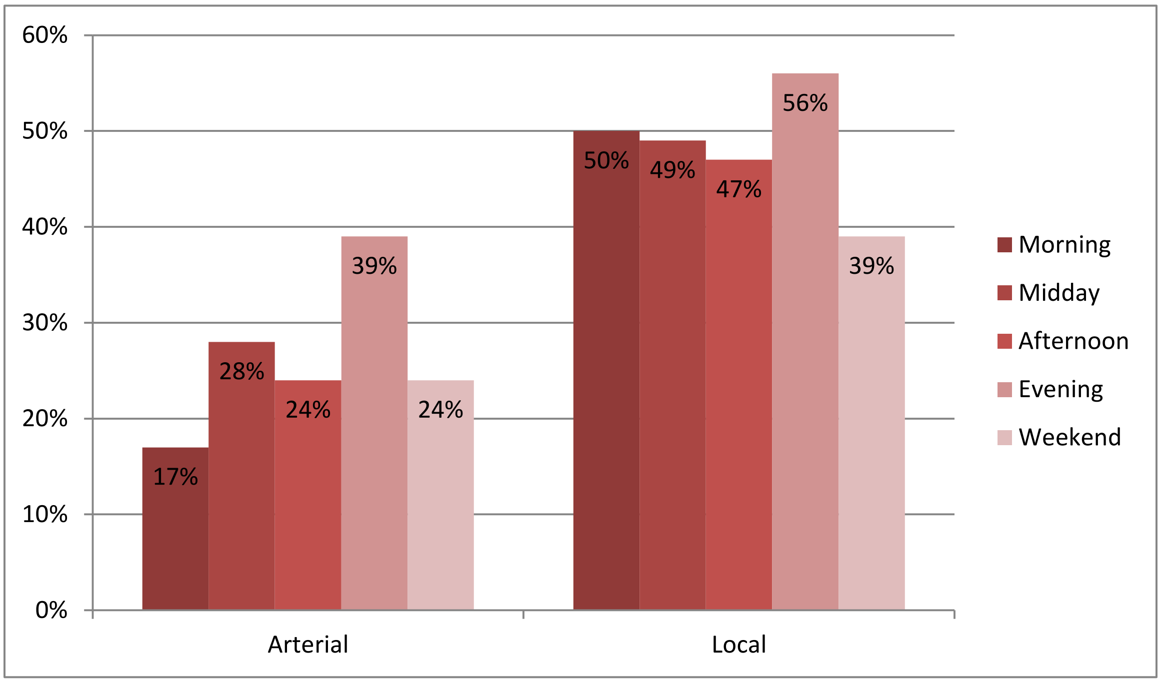
Field observations were taken on two weekdays and one weekend day during a non-holiday week to estimate on-street curbside parking utilization. Adjacent land use and parking restrictions were taken into consideration when determining the time of day for data collection. The results of the data collection are presented in full in Appendix A.3.2.

All parked vehicles were counted in two separate data collection periods: arterial road parking data was collected in October 2013 and local road parking data was collected in January 2014. In both periods, data was collected on two weekdays, one weeknight, and one weekend day. Utilization rates were calculated by dividing parking counts by the estimated parking capacities for each local and arterial road. Utilization rates are presented in Appendix A.3.2. As the capacity of each segment is calculated by dividing the overall segment length by 23 feet per ITE standards, some segments were calculated as over 100% utilized when the number of vehicles parked exceeded the theoretical capacity.

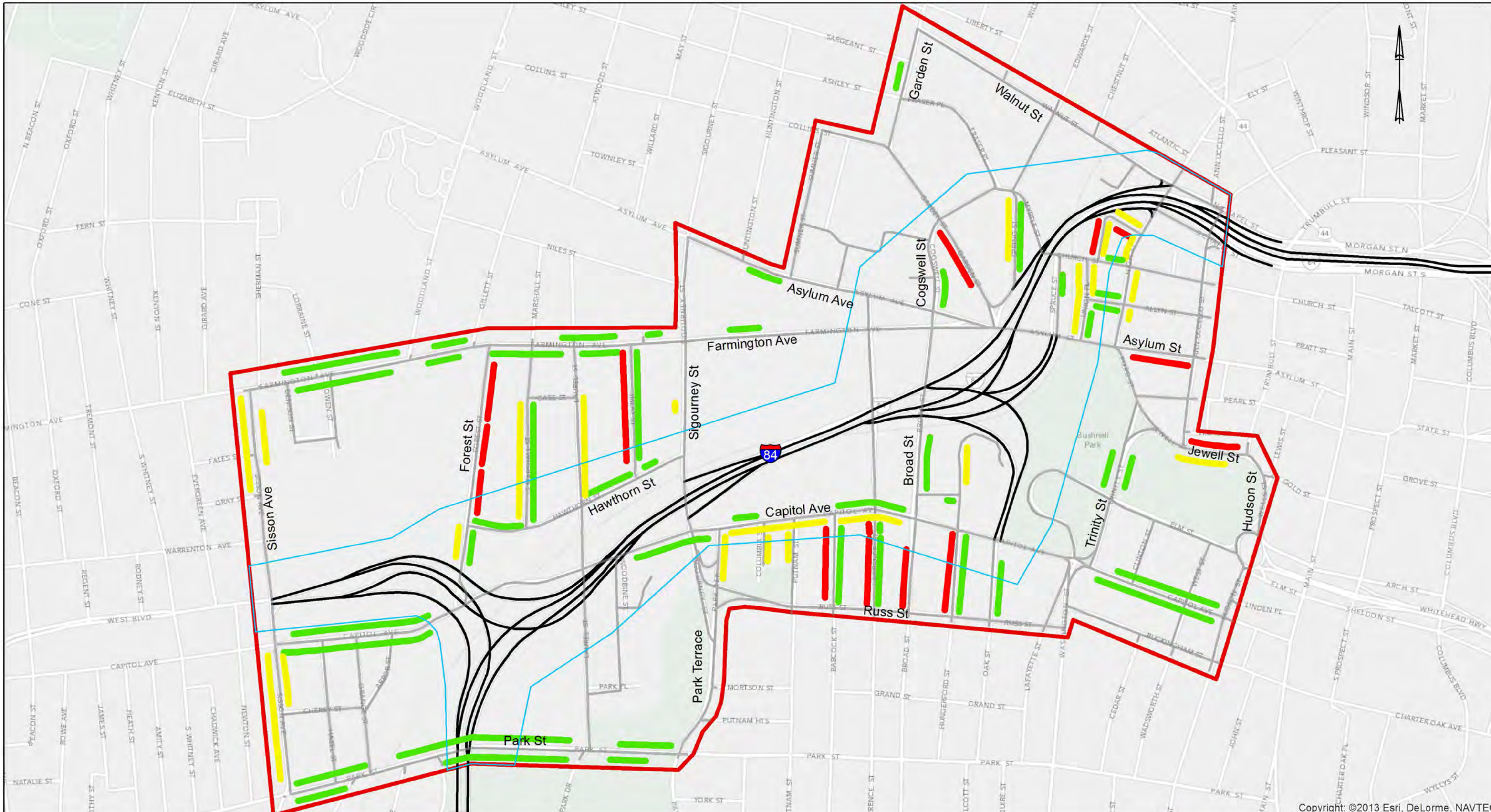
The average highest on-street parking utilization rates for arterial streets throughout the Study Area occurred during weekday evenings, between 7:00 PM and 8:00 PM, at thirty-eight percent. The average lowest on-street parking utilization rates for arterial streets throughout the Study Area occurred during weekday mornings, between 9:00 AM and 10:00 AM, at seventeen percent.

The average highest on-street parking utilization rates for local roads throughout the Study Area occurred weekday evenings, between 7:00 PM and 8:00 PM, at fifty-six percent. The average lowest on-street parking utilization rates for local roads throughout the Study Area occurred weekend afternoons, between 1:00 PM and 2:00 PM, at thirty-eight percent. Average utilization rates for on-street curbside parking are presented in Figure 2-7, below. Alternate side parking is not accounted for on the six local streets with alternate side parking schemes.

Figure 2-7: Average Utilization of On-Street Curbside Parking



On- street parking utilization is illustrated within the Parking, Bicycle, and Pedestrian Accessibility Study Area in Figure 2-8, following. Four locations within the study area were near capacity with higher than average parking utilizations at/near 90%, and six additional locations had high parking utilization rates at/near 66 %. See Table 2.1.3-1 and 2.1.3-3 in Appendix A.3.2 for parking utilization rates in the Study Area. The four locations near capacity are the southwest side of Garden Street (100% utilization), the west side of Babcock Street (100% utilization), the east side of Forest Street (99% utilization), and the west side of Hungerford Street (91% utilization). The six other locations with high parking utilization rates are: the west side of Lawrence Street (87% utilization), the west side of Broad Street (77 % utilization), the west side of Imlay Street (73% utilization), the north side of Jewell Street (73% utilization), the south side of Asylum Street (73% utilization), and the west side of Hoadley Place (69% utilization).



LEGEND

On-Street Parking Utilization

- Low (Under 33%)
- Medium (Between 33% and 66%)
- High (Over 66%)

- Road
- I-84
- Parking, Bicycle and Pedestrian Accessibility Study Area
- Project Study Corridor

0 750 1,500 Feet

Sources of Data: City of Hartford, ESRI

The I-84 Hartford Project

On-Street Parking Utilization Map

Date: 10/13/2014	Drawn By: Parsons Brinckerhoff	Figure 2-8

2.1.4 Bus Transportation

The Project Study Corridor is served by several different types of bus service. Local buses making frequent stops operate on city streets, crossing I-84 at several points. Commuter buses operate as express services to downtown from suburban park and ride locations. Some of the commuter routes operate on I-84 while others cross I-84 on city streets near Downtown. CT*fastrak* bus rapid transit service began operation on March 28, 2015 on a dedicated guideway into downtown which parallels I-84. Several private intercity carriers operate along I-84 through Hartford, stopping at Hartford Union Station. Paratransit service for people with disabilities operates throughout the Study Area.

Research included stakeholder interviews conducted during summer and fall 2013 supplemented by field visits and reviews of studies and initiatives up to the publication of this report.

Local Bus Service

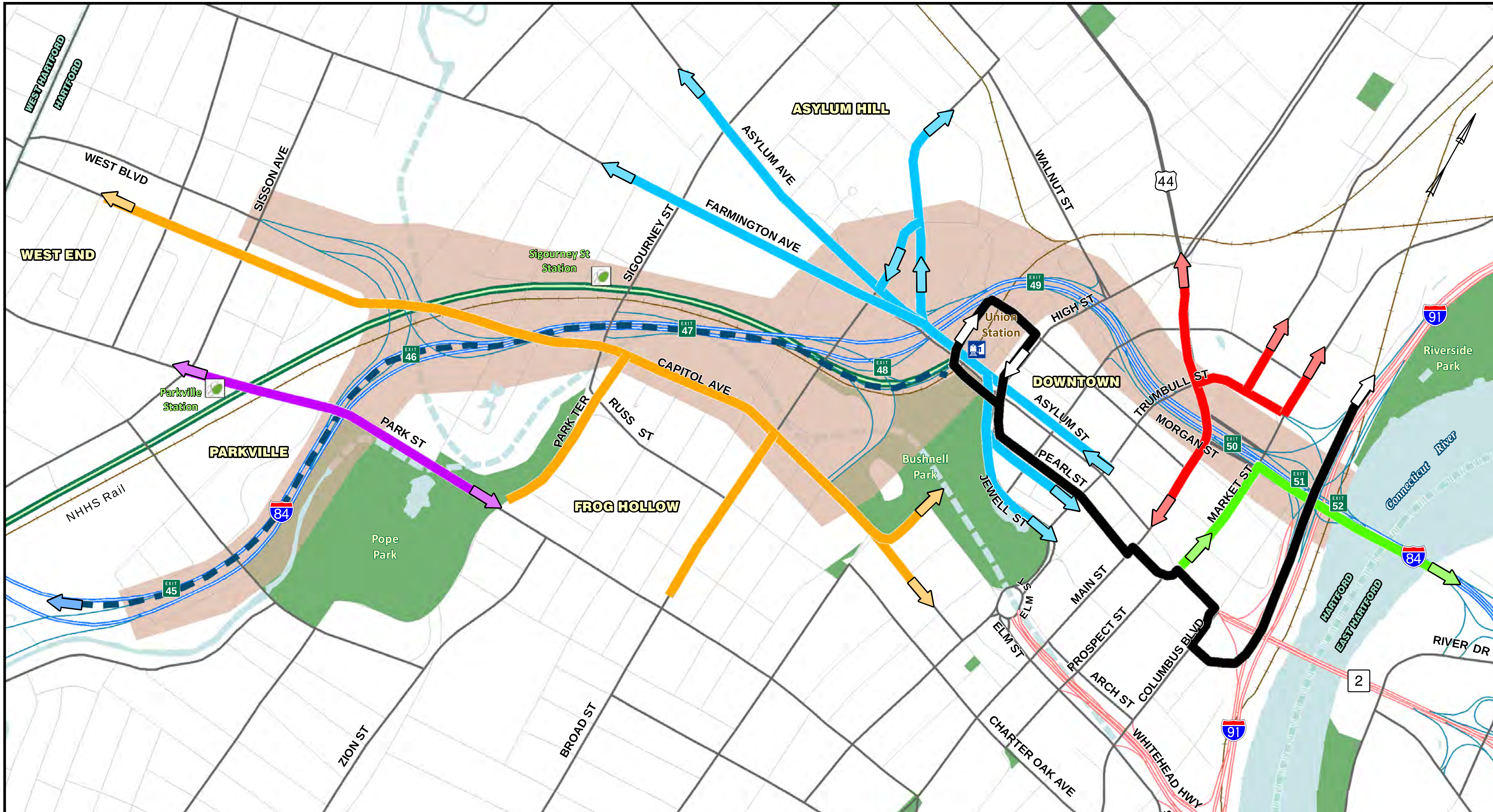
Connecticut Transit (CTTransit) is the CTDOT-owned bus service. CTTransit Hartford Division local bus service is provided through a contract operator and operates over 30 local bus routes in Hartford and in 25 other towns in the Capitol Region. The fleet of over 200 buses is garaged at CTTransit headquarters at 100 Leibert Road, less than two miles north of I-84 and Downtown Hartford.

Nearly all CTTransit Hartford Division routes serve Downtown Hartford. As a result, these routes intersect the Project Study Corridor at some point between I-91 and Hamilton Street. The routes can be grouped based on their alignment crossing I-84. These groups are illustrated on Figure 2-9: Local Bus Service Map, following. The groups (moving through the Project Study Corridor from west to east) are summarized below.

Park Street (Routes 31 and 33): These routes leave Downtown heading south on Main Street, then turn west onto Park Street into the Project Study Corridor. Both continue through the Project Study Corridor crossing I-84 on Park Street.

Capitol Avenue (Routes 61, 63 and 69): These routes leave Downtown heading south on Main Street, then turn west onto Capitol Avenue into the Project Study Corridor. Route 61 turns south onto Broad Street; Route 63 travels further west and turns south onto Park Terrace; Route 69 continues west through the Project Study Corridor and across I-84 along Capitol Avenue.

Asylum Street/Avenue (Routes 35, 60, 62, 64, 66, 72, 74, and 76): Outbound, these routes leave Downtown and cross I-84 along Asylum Street. Route 76 then turns north onto Garden Street. Routes 72 and 74 continue along Asylum Avenue, while Routes 60 through 64 continue along Farmington Avenue. These routes all return inbound via the same paths except that Route 76 enters the Project Study Corridor on Cogswell Street rather than Garden. Inbound, after crossing I-84 into Downtown, all of these routes turn right onto Ford Street and left onto Pearl Street. Route 35 is an express service between Downtown and Westfarms Mall via I-84 that enters and exits I-84 at Asylum Street.



LEGEND

- Asylum Street/Avenue (Routes 35, 60, 62, 64, 66, 72, 74, and 76)
- Bradley Flyer (Route 30)
- Capitol Avenue (Routes 61, 63 and 69)
- East of the River (Routes 80, 82, 83, 84, 85, 86, 87, 88, 94, 95 and 96)
- Main Street North (Routes 32, 34, 36, 38, 40, 42, 44, 46, 50, 52, 54, 56, and 58)
- Park Street (Routes 31 and 33)
- Route 35 (weekends only)
- Project Study Corridor
- Town/City Limit
- Park River Conduit
- I-84
- I-84 Ramp
- Other Highway
- U.S. Highway/State Road
- Major Road
- CTfastrak
- CTfastrak Station
- I-84 Exit #
- Union Station
- Park
- Water

0 500 1,000 Feet

Sources of Data: City of Hartford, CT Transit

The I-84 Hartford Project

Local Bus Service Map

Date: 1/12/2015	Drawn By: TranSystems	Figure No: 2-9

Bradley Flyer (Route 30): This route originates in the Project Study Corridor at Union Station making a clockwise loop on Asylum, Spruce, Church, and High streets. It then passes into Downtown along Asylum, Ford, and Pearl streets. It enters I-91 North traveling express to Bradley International Airport and other nearby destinations.

dash: The *dash* is a circulator route that operates in a clockwise loop in Downtown Hartford, shown in Figure 2-10, following. It serves stops in or near the Project Study Corridor just south of I-84 and makes one stop in the Project Study Corridor north of I-84. It also serves the Convention Center, Main Street area, and Bushnell Park.

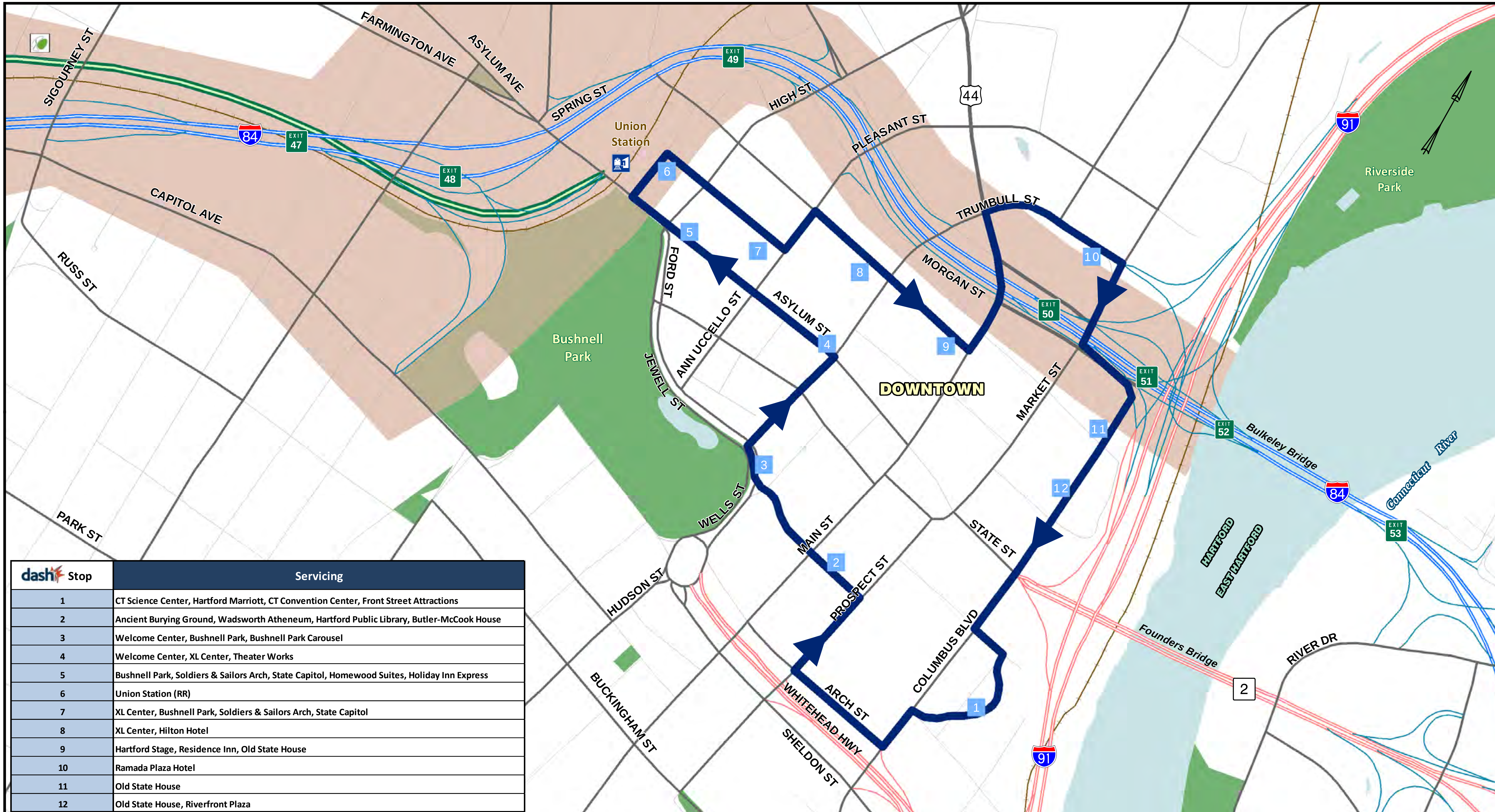
Main Street North (Routes 32, 34, 36, 38, 40, 42, 44, 46, 50, 52, 54, 56, and 58): These routes cross I-84 following Main Street, both inbound and outbound.

East of the River (Routes 80, 82, 83, 84, 85, 86, 87, 88, 94, 95 and 96): These routes touch only the eastern tip of the Project Study Corridor, and only in the outbound direction. From their Downtown terminus on Market Street, they travel north on Market Street and then east on Morgan Street entering I-84 on the ramp at the end of Morgan Street.

Other Routes: The only other routes serving Downtown all leave Downtown traveling south on Main Street and do not enter the Project Study Corridor. These include Routes 37, 39, 41, 43, 45, 47, 53, 55 and 59. Most of these routes, however, are through-routed with Main Street North Routes. Therefore, anything that impacts service on the Main Street North routes will also impact service on the Main Street South routes.

Most of the routes serving Downtown follow one of three circulation patterns in the core of Downtown Hartford. Main Street routes travel north-south along Main Street. Most routes to the north are through-routed with routes to the south. That is, the same bus will enter Downtown as a north route, keep going through Downtown and leave to the south as a south route. East of the river routes enter downtown via the Founders Bridge and make a loop along State, Market and Morgan streets before returning east on the Bulkeley Bridge (I-84). Routes from the west enter Downtown along Asylum, Ford, Jewell, and Gold streets before stopping on Main Street and returning to the west on Asylum Street.

The City of Hartford has received a U.S. Department of Transportation (USDOT) Transportation Investment Generating Economic Recovery (TIGER) grant for its Intermodal Triangle Project. The project will facilitate improvements in bus circulation for routes from the east and west by focusing on turning Pearl and Asylum streets into transit-priority streets allowing buses to be through-routed through downtown, much as the north and south routes are today. To identify specific routing changes, CRCOG recently completed the Downtown Hartford Transit Circulation and Through Routing Study. The study was a cooperative effort with the City, CRCOG, CTTransit, and CTDOT participating. The study identified east and west routes that could be through-routed and recommended that routes from the east that are not through-routed could be extended to a new local bus facility on the Union Place side of Union Station, increasing the number of local buses serving Union Station.



dash Stop	Servicing
1	CT Science Center, Hartford Marriott, CT Convention Center, Front Street Attractions
2	Ancient Burying Ground, Wadsworth Atheneum, Hartford Public Library, Butler-McCook House
3	Welcome Center, Bushnell Park, Bushnell Park Carousel
4	Welcome Center, XL Center, Theater Works
5	Bushnell Park, Soldiers & Sailors Arch, State Capitol, Homewood Suites, Holiday Inn Express
6	Union Station (RR)
7	XL Center, Bushnell Park, Soldiers & Sailors Arch, State Capitol
8	XL Center, Hilton Hotel
9	Hartford Stage, Residence Inn, Old State House
10	Ramada Plaza Hotel
11	Old State House
12	Old State House, Riverfront Plaza

LEGEND

- Dash Service Route
- Dash Stop
- I-84
- I-84 Ramp
- Other Highway
- U.S. Highway/State Road
- Major Road
- Railroad
- Project Corridor
- Town/City Limit
- I-84 Exit #
- Union Station
- Park River Conduit
- Park
- Water
- CTfastrak Station
- CTfastrak

dash — Free downtown shuttle departs CT Convention Center every 15 minutes Monday through Friday from 7:00am to 7:00pm. Extended hours during special large events—check www.cttransit.com for details.

0 400 800 Feet

Sources of Data: City of Hartford, CT Transit

The I-84 Hartford Project

Dash Service Map

Date: 1/12/2015	Drawn By: TranSystems	Figure No: 2-10

The base fare for local bus service, including free transfers, is $1.30. A 90-minute pass is available for the same price. Youth fares (age 5-18) are $1.05. Children under five ride for free. Seniors and persons with disabilities pay half fare at all times. Ten-ride tickets are available for the price of nine rides. 3-day, 5-day, 7-day and monthly passes are also available.

Service headways (the time interval between buses) on all Downtown Hartford local bus routes are shown in Table 2-3 below, presenting the grouping of routes described above.

Typical weekday ridership and performance measures on all Downtown Hartford local bus routes prior to the opening of CT*fastrak* are shown in Table 2-4, page 2-24. The three highest ridership routes all have very similar typical daily ridership (over 5,000 per day) and all cross I-84 in the Project Study Corridor. Route 60-66 travels across I-84 on Asylum Street; Route 50-54 passes over I-84 on Main Street; and Route 31-33 passes under I-84 on Park Street. Most routes operate with productivities (measured in terms of passengers per revenue-hour) of between 30 and 60, with only three routes below that range and two above. 22 of the 31 routes exceed 75% of the system average productivity, a level typically considered normal. Only one route falls below 50% of the system average, a level often considered in the industry to warrant an evaluation of options to improve performance.

The Capitol Region Council of Governments (CRCOG) is currently embarking on a Comprehensive Transit Service Analysis that will examine all local, commuter and *CTfastrak* bus service in the Capitol Region. The study will consider the performance of existing routes and identify options for service improvements. Study recommendations are not expected until late 2015 or 2016. Recommendations could include changes in bus routing and frequency, new crosstown routes and new connection points outside Downtown. Possible impacts on the Project Study Corridor could include additional routes crossing I-84 to provide service to Asylum Hill.

Table 2-3: CTTransit Hartford Division Local Routes and Headways

Route	AM	Midday	PM	Saturday	Sunday
Park Street					
31-33-Park Street	15	15	30-60	15	60
Capitol Avenue					
61-Broad Street	30	30	30	30	
63-Hillside Avenue	60	60	60	60	60
69-Capitol Avenue	60	60	60	60	
Asylum Street/Avenue					
35-Westfarms Flyer	60				60
60-66-Farmington Avenue	15	10	30-60	10	60
72-Asylum Avenue	20	30	30		
74-Granby Street	60	60	60	60	
76-Ashley Street	30	30	60	30	60

Table 2-3 (ctd.): CTTransit Hartford Division Local Routes and Headways

Route	AM	Midday	PM	Saturday	Sunday
Bradley Flyer					
30-Bradley Flyer	60	60	120	60	120
Main Street North					
32-36-Windsor Avenue	60	60	60	60	60
38-Weston Street	30	30	30	30	60
40-42-North Main Street	15-30	15	60	15	60
44-Garden Street	60	60	60	60	
46-Vine Street	20	20	30-60	20	
50-54-Blue Hills Avenue	30	15	60	15	60
56-58-Albany/Bloomfield Avenue	30	30	20-40	30	60
East of the River					
80-Buckland Flyer	60	60	60	60	
82-84-Tolland Street	60	60	60	60	60
83-Silver Lane	30	60	60	60	60
85-MCC Flyer	60	60	60		
86-Burnside Avenue-Sunset Hills	30	120	30		
87-Brewer Street	120	120	120	120	
88-Burnside Avenue-Manchester	30	30	30	30	60
94-96-Park Avenue/John Fitch Boulevard	120	40	60	40	
95-Glastonbury	60	60	60	60	
Other Downtown Routes					
37-39-New Britain Avenue	20	20	35-60	20	60
41-New Britain	30-40	35	30	35	
43-Campfield Avenue	60	60	60	60	
45-Berlin Turnpike Flyer	120	120	120	120	60
47-Franklin Avenue	30	15	60	15	60
53-55-Wethersfield Avenue/Middletown	20-40	30	25-35	30	
59-Locust Street	60	60	60	60	

Table 2-4: CTTransit Hartford Division Local Route Ridership and Performance

Route	Weekday Daily Passengers	Pass./ Hour	Pass./ Mile	Pass./ Trip
60-66	5,867	46.3	3.7	31.1
50-54	5,670	51.4	4.1	30.0
31-33	5,625	75.7	7.2	34.3
47	4,173	58.8	4.6	25.3
37-39	3,569	56.0	5.1	30.3
40-42	3,525	60.0	6.0	19.6
83	2,800	48.0	3.0	42.4
82-84	2,505	41.7	2.4	33.0
88	2,348	44.0	2.7	28.3
46	1,952	48.7	4.5	17.1
53-55	1,910	36.9	2.4	23.0
76	1,821	38.0	3.5	17.5
56-58	1,620	41.5	3.3	20.5
32-36	1,604	30.0	1.6	20.1
41	1,570	36.2	2.5	28.1
95	1,368	37.2	2.4	19.6
61	1,241	40.1	3.1	16.8
63	1,064	41.0	3.8	16.6
74	968	32.9	2.8	20.6
72	960	30.9	2.2	14.1
69	736	31.4	2.1	20.5
43	694	36.4	3.7	12.0
94-96	658	33.0	1.9	13.7
30	576	23.1	0.9	14.4
59	555	42.2	3.5	15.0
38	551	34.4	2.4	7.9
85	458	121.6	3.9	25.4
44	439	48.1	5.1	12.6
87	409	28.2	1.8	10.0
86	388	31.7	2.1	11.8
45	66	14.5	0.6	6.7

Commuter Bus Service

CTTransit commuter bus service in Hartford operates primarily in peak periods, with a few midday trips on some routes. The service is provided by a mix of operators. The CTTransit Hartford Division, operator of the local bus service, runs 12 of the 21 routes. A variety of private operators provide service on nine more routes. The 21 routes can be grouped based on their alignment crossing, entering or exiting I-84. The commuter bus routes are illustrated in Figure 2-11, following.

Asylum Street/ I-84 West Routes:

Routes 2, 9: These routes leave Downtown outbound on Asylum Street westbound and turn left onto I-84 westbound. Inbound, after exiting I-84 onto Asylum Street towards Downtown, these routes turn right onto Ford Street and left onto Pearl Street.

Routes 23 and 24: These routes operate on a loop through Downtown in the same direction morning and afternoon. Most trips pass through Asylum Hill to Downtown, exiting from I-84 eastbound to Capitol Avenue, then following Capitol Avenue westbound to Park Terrace, north on Sigourney across I-84 and east on Farmington Avenue to Asylum Avenue and across I-84 again. They then follow Ford Street and Pearl Street into Downtown turning north on Main Street and west on Morgan Street before entering I-84 westbound at Trumbull Street to begin the return trip. Some inbound trips exit I-84 directly onto Asylum Street and follow a shorter loop on Asylum, Ford, Pearl, Main and Morgan streets to I-84 westbound.

Asylum Street/Avenue West Routes:

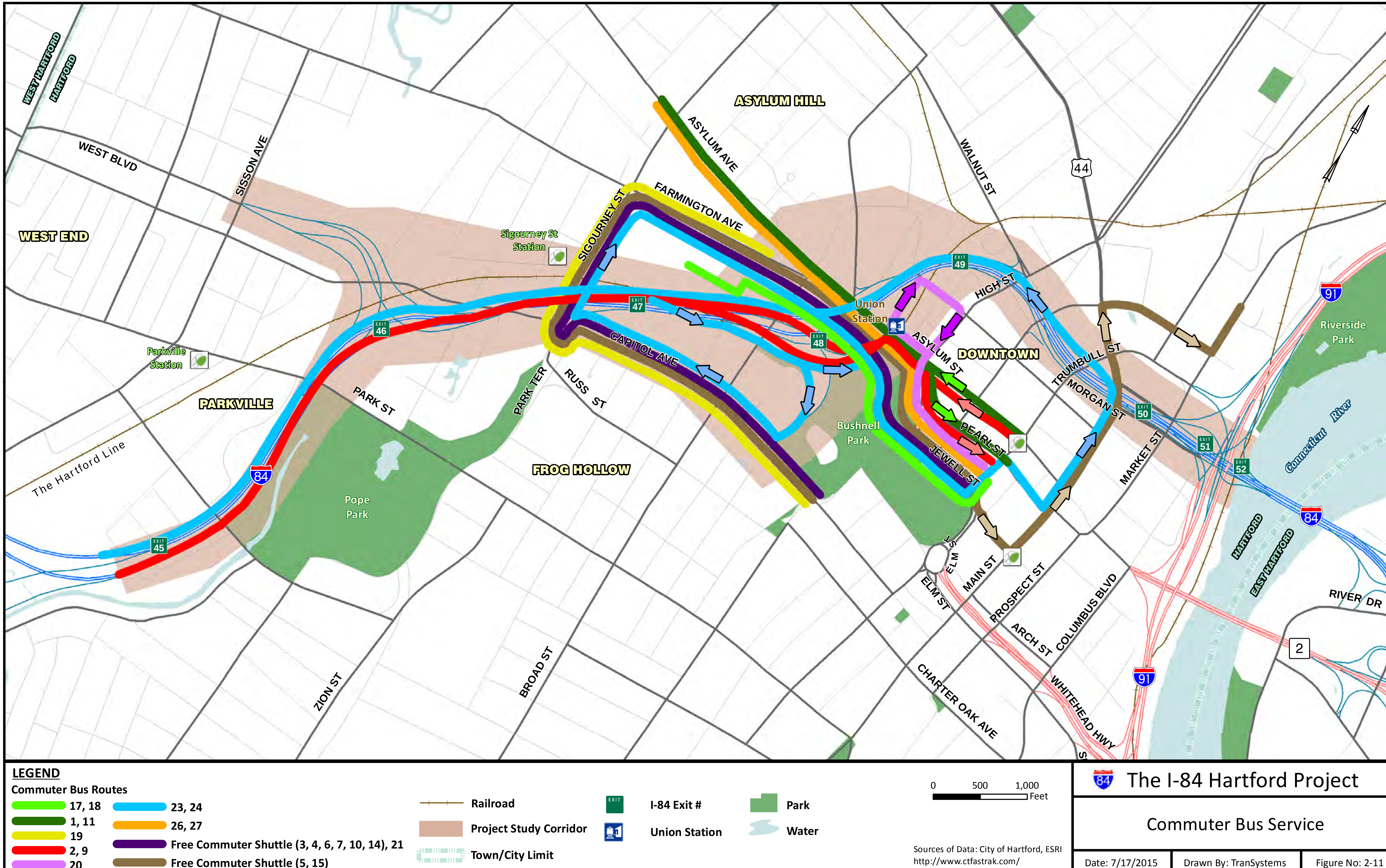
Routes 1, 11: These routes leave Downtown outbound on Asylum Street and cross I-84 continuing west along Asylum Avenue. Inbound, after crossing I-84 into Downtown, these routes turn right onto Ford Street and left onto Pearl Street.

Routes 26, 27: These routes begin outbound at the Capitol and circulate through Downtown. They then travel west on Pearl Street to Ford Street and Asylum Street crossing I-84 and continue west on Asylum Avenue. The reverse route is followed inbound.

Asylum Street/Avenue East and South Routes:

Routes 17 and 18: These routes travel east from Downtown across the Founders Bridge. Most trips do not cross the Project Study Corridor. Several trips, however, begin at Aetna in Asylum Hill and turn north onto Flower Street and east on Farmington Avenue and Asylum Avenue/Street through the Project Study Corridor, turning right onto Ford Street and left onto Pearl Street into downtown before heading east. Several morning trips also continue west through downtown on Asylum Street/Avenue to Aetna.

Route 20: This route begins in the Union Station intercity bus terminal, exiting to Church and High Streets and following Ford Street to Pearl Street to pass through downtown before heading south on I-91. Inbound it follows Pearl Street to Ford Street, then Asylum and Spruce streets into the station. It serves the Project Study Corridor at Union Station, but does not actually cross I-84.


ASYLUM HILL
WEST END
PARKVILLE
FROG HOLLOW
DOWNTOWN
WEST HARTFORD
HARTFORD
EAST HARTFORD
WEST BLVD
SISSON AVE
ASYLUM AVE
FARMINGTON AVE
SIGOURNEY ST
WALNUT ST
HIGH ST
ASYLUM ST
TRUMBULL ST
MORGAN ST
PEARL ST
JEWELL ST
MARKET ST
CAPITOL AVE
PARK ST
PARK TER
RUSS ST
ELM ST
MAIN ST
PROSPECT ST
COLUMBUS BLVD
ARCH ST
WHITEHEAD HWY
CHARTER OAK AVE
BROAD ST
ZION ST
RIVER DR
The Hartford Line
Sigourney St Station
Parkville Station
Union Station
Bushnell Park
Pope Park
Riverside Park
Connecticut River
44
84
91
2
45
46
47
48
49
50
51
52
LEGEND
Commuter Bus Routes
17, 18
1, 11
19
2, 9
20
23, 24
26, 27
Free Commuter Shuttle (3, 4, 6, 7, 10, 14), 21
Free Commuter Shuttle (5, 15)
Railroad
Project Study Corridor
Town/City Limit
I-84 Exit #
Union Station
Park
Water
0
500
1,000
Feet
Sources of Data: City of Hartford, ESRI
http://www.ctfastrak.com/
The I-84 Hartford Project
Commuter Bus Service
Date: 7/17/2015
Drawn By: TranSystems
Figure No: 2-11

Sigourney Street and Asylum Avenue/Street:

Routes 3, 4, 6, 7, 10, and 14: These routes travel east outbound from Downtown across the Founders Bridge or south from Downtown on I-91. Some outbound trips originate Downtown and do not cross the Project Study Corridor. Several trips, however, provide the service known as the “Free Commuter Shuttle”. These trips begin at the Capitol and follow Capitol Avenue westbound to Park Terrace, turning north on Sigourney Street across I-84, east on Farmington Avenue and Asylum Avenue, crossing I-84 again into Downtown, then turning right on Ford Street and left on Pearl Street. Inbound trips follow the exact same route in the opposite direction.

Routes 5 and 15: These routes cross I-84 following Main Street outbound and Market Street inbound. Several trips, however, provide service on the “Free Commuter Shuttle” following the route described above.

Route 21: This route begins outbound at the Capitol and follows Capitol Avenue westbound to Park Terrace, turning north on Sigourney Street across I-84, east on Farmington Avenue and Asylum Avenue, crossing I-84 again into Downtown, then turning right on Ford Street and left on Pearl Street before passing through downtown and heading south on I-91. Inbound trips follow the exact same route in the opposite direction.

Sigourney Street Only:

Route 19: This route begins outbound in Asylum Hill at Farmington Avenue and Flower Street and travels west on Farmington Avenue, turning right on Sigourney Street across I-84, left on Park Terrace, right on Capitol Avenue and left on Trinity Street before passing through Downtown and south on I-91. Inbound trips follow the exact same route in the opposite direction.

Table 2-5, following, shows the volume of commuter buses passing three key locations in the Project Study Corridor: Asylum Street at Hartford Union Station, Sigourney Street at I-84, and Main Street/Market Street at I-84. The volume on Asylum Street crossing I-84 would be slightly less than that at Hartford Union Station since Routes 2 and 9 and some trips on Route 23 turn onto or off the I-84 ramps between Hartford Union Station and the I-84 viaduct. The table shows bus volumes by time period. AM is generally 6-9 AM, midday is noon to 3 PM, and PM is 3-7 PM.

Table 2-5: Commuter Route Weekday Trips at Key Locations

Route	AM		Midday		PM	
Asylum at Union Station	**East**	**West**	**East**	**West**	**East**	**West**
Free Commuter Shuttle*		34	3		32	
1	6			1		5
2	6					6
9	2					2
11	7			1		9
17		4	1		6	
18		5	1		5	
20		3			3	
21		4	1		4	
23	7		1		7	
24	4				4	
26	2					2
27	2					2
Total	**36**	**50**	**7**	**2**	**61**	**26**
Sigourney Street at I-84	**North**	**South**	**North**	**South**	**North**	**South**
Free Commuter Shuttle*		34	3		32	
19	2					2
21		4	1		4	
23	3		1		5	
24	4				4	
Total	**9**	**38**	**5**	**0**	**45**	**2**
Main Northbound/Market Southbound at I-84	**North**	**South**	**North**	**South**	**North**	**South**
5		17	1		20	
15		3	1		4	
23	7		1		7	
24	4				4	
Total	**11**	**20**	**3**	**0**	**35**	**0**

* Includes some buses on Routes 3, 4, 5, 6, 7, 10, 14, and 15

As can be seen from the above descriptions, there are many different circulation patterns for the 21 commuter routes. In general most commuter routes travel east-west through Downtown. Outbound service either travels west through Downtown to I-84 or Asylum Avenue, or east through Downtown to Main Street north, the Founders Bridge east or I-91 south. Inbound service does the reverse. All routes use Pearl Street when traveling east through downtown, while service going west is split between Asylum Street and Pearl Street. Generally, CTTransit Hartford Division routes (Routes 1-15) use Asylum Street westbound while the other routes use Pearl Street.

As part of the planning for the City of Hartford's Intermodal Triangle Project, CRCOG's Downtown Hartford Transit Circulation and Through Routing Study recommended that all commuter service also be consolidated along the improved Pearl Street, along with the local buses, leaving CT*fastrak* and local service on Asylum Street.

Typical weekday ridership and performance measures on Hartford commuter bus routes operated by CTTransit Hartford Division prior to the opening of CT*fastrak* are shown in Table 2-6, below. The other private operators do not provide ridership data.

Commuter bus service operates on a zonal fare structure. Single ride fares range from $2.35 to $4.45. Children under the age of five ride for free but there are no discounted youth fares. Seniors and persons with disabilities pay just under half fare at all times. Ten ride tickets are available for the price of nine rides. Monthly passes are also available.

Table 2-6: CTTransit Hartford Division Commuter Route Ridership and Performance

Route	Passengers	Pass./ Hour	Pass./ Mile	Pass./ Trip
5	887	25.7	0.8	15.0
3	702	69.1	2.2	17.1
14	429	26.0	0.6	14.8
11	332	17.1	0.8	13.8
6	263	23.9	0.7	9.8
1	255	17.6	0.9	12.8
4	241	33.3	1.4	12.1
10	201	29.1	1.2	16.8
2	154	22.5	0.9	9.1
7	85	26.6	1.0	8.6
9	83	24.7	1.0	13.8
15	61	27.7	1.2	10.2

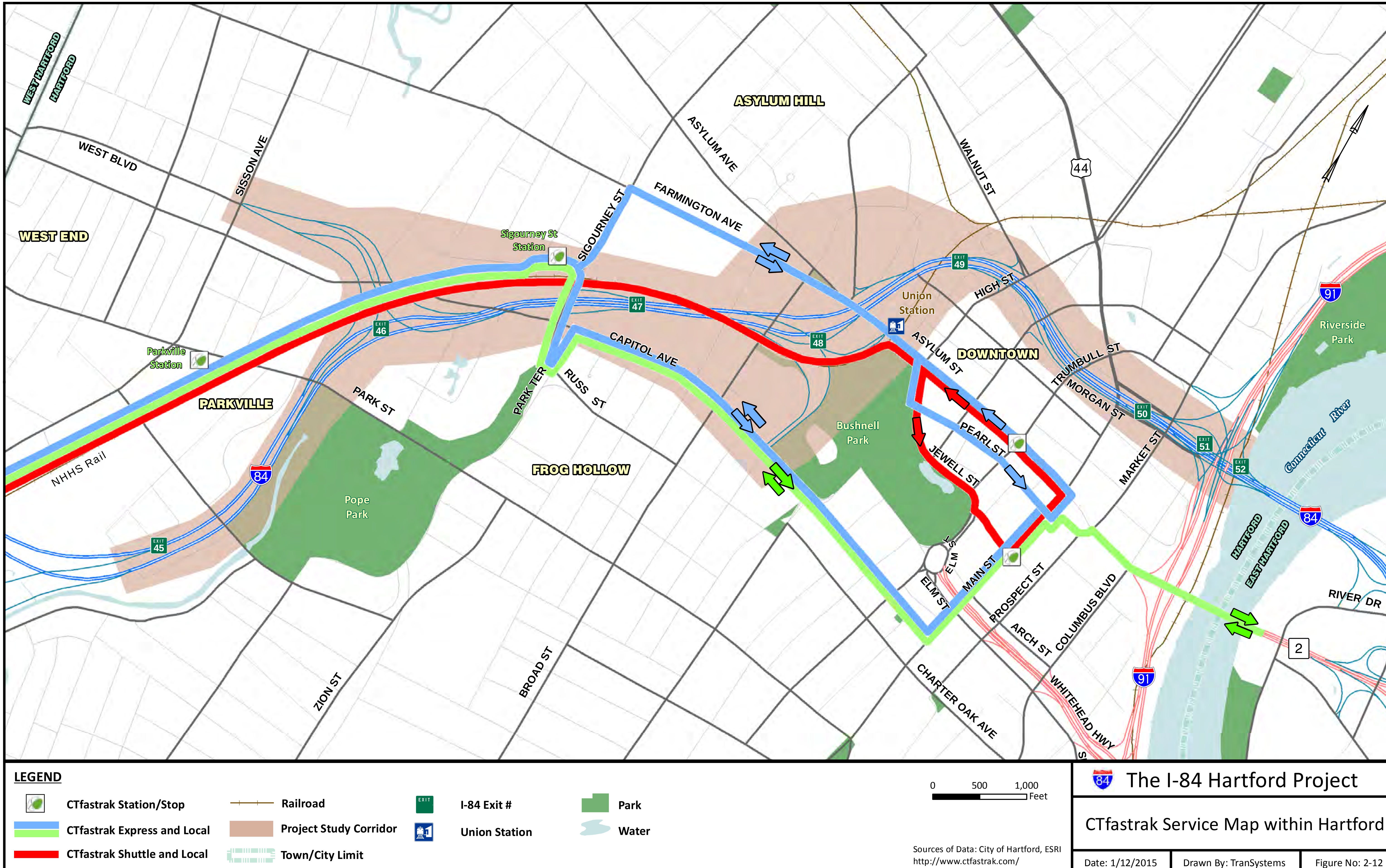
CT*fastrak*

CT*fastrak* is a new bus rapid transit (BRT) system that initiated service on March 28, 2015. The system utilizes a 9.4-mile dedicated guideway between New Britain and Hartford and also provides service beyond the guideway and across the river to East Hartford and Manchester. Several new routes have been created to provide a transfer-free, one-seat ride to popular destinations throughout the region. With connections to local and express bus routes as well as the interstate rail system, travelers are able to get to destinations throughout the central Connecticut region and beyond. CT*fastrak* has ten dedicated stations along the guideway and stops throughout downtown, including Union Station. The guideway is immediately adjacent to, and passes under, I-84 between Sigourney Street and the terminus of the guideway at Asylum Street. Three stations are within the Project Study Corridor: the downtown stop at Hartford Union Station (on Asylum Street) and the stations at Sigourney Street and Park Street. In addition to the stations, some *CTfastrak* routes to exit the guideway and provide service to stops in downtown, Asylum Hill, and south to Hartford Hospital in the South Green neighborhood.

CT*fastrak* provides frequent, daily service from approximately 4:00 AM to 1:00 AM, with beginning and end times varying by route. CT*fastrak* has twelve routes following different routing patterns through the Study Area. The routes are categorized by function: Local, Shuttle, and Express. These routes and patterns are illustrated on Figure 2-12, following.

CTfastrak Local Routes: The four local routes are 101-Hartford/New Britain, 102-Hartford/New Britain-Bristol, 121-Manchester Community College/Hartford/UConn Health Center, and 128-Hartford/Westfarms-New Britain via Stanley Street. Three (101, 102, and 128) of the four all-day local routes in the morning exit the guideway at Sigourney Street Station, travel east on Hawthorn Street, and turn left on Sigourney Street and right on Farmington Avenue before continuing across I-84 into downtown via Asylum Street. These routes loop through Downtown returning to the Project Study Corridor via Capitol Avenue before turning right onto Sigourney Street across I-84 and left on Hawthorn before re-entering the guideway. In the afternoon, this loop is reversed. The 121-Manchester Community College/Hartford/UConn Health Center route exits the guideway at Sigourney Street Station, travels east on Hawthorn Street, and turns right on Sigourney Street across I-84, turns left on Park Terrace, and right onto Capitol Avenue to head into Downtown. Once Downtown the 121 turns left on Main Street, then right onto Central Row and a left on Market Street, then a right onto Morgan Street and over the Bulkeley Bridge into East Hartford and on to Manchester. On the return trip, the 121 takes the Founders Bridge back into Hartford, following State Street to turn left onto Main Street and continues back to Capitol Avenue.

CTfastrak Shuttle Routes: There are four shuttle routes: 140-Central Connecticut State University (CCSU) Shuttle, 144-Wethersfield/Westfarms via Newington Center & Brittany Farms, 153-Flatbush/Copaco via West Hartford Center, and 161-St. Francis Hospital/Hartford Hospital via State Capitol. Both the 140 and the 161 are high frequency routes at 15 minute headways in the peak. The 140, 144, and 153 serve as feeder services to local *CTfastrak* stations outside of the Project Study Corridor. The 161 carries passengers between St. Francis Hospital, Downtown, and the Hartford



ASYLUM HILL
WEST END
PARKVILLE
FROG HOLLOW
DOWNTOWN
WEST HARTFORD
HARTFORD
EAST HARTFORD
WEST BLVD
SISSON AVE
SIGOURNEY ST
FARMINGTON AVE
ASYLUM AVE
WALNUT ST
HIGH ST
ASYLUM ST
TRUMBULL ST
MORGAN ST
PEARL ST
JEWELL ST
MARKET ST
CAPITOL AVE
PARK TER
RUSS ST
PARK ST
ELM ST
MAIN ST
PROSPECT ST
COLUMBUS BLVD
ARCH ST
WHITEHEAD HWY
CHARTER OAK AVE
BROAD ST
ZION ST
RIVER DR
NHHS Rail
Sigourney St Station
Parkville Station
Union Station
Bushnell Park
Pope Park
Riverside Park
Connecticut River
44
84
91
2
45
46
47
48
49
50
51
52
LEGEND
CTfastrak Station/Stop
CTfastrak Express and Local
CTfastrak Shuttle and Local
Railroad
Project Study Corridor
Town/City Limit
I-84 Exit #
Union Station
Park
Water
0 500 1,000 Feet
Sources of Data: City of Hartford, ESRI
http://www.ctfastrak.com/
The I-84 Hartford Project
CTfastrak Service Map within Hartford
Date: 1/12/2015
Drawn By: TranSystems
Figure No: 2-12

Hospital. Beginning at St. Francis Hospital, the 161 travels down Ashley Street, taking a right onto Sigourney Street, and then left from Park Terrace onto Capitol Avenue, a right onto Washington Street and turns right on Jefferson Street and circles around Hartford Hospital to come back up Washington Street. On the return trip from Sigourney Street, the 161 turns left onto Asylum Avenue and a right onto Woodland Avenue to reach St. Francis Hospital.

CTfastrak Express Routes: The four express routes are 923-Bristol Express, 924-Southington-Cheshire Express, 925-Waterbury Express, and 928-Southington-Cheshire-Waterbury Express. These four routes follow the same loop as the local routes after Sigourney Street Station.

Weekday headways for each route are shown in Table 2-7, below. Saturday daytime headways are the same as the weekday midday headways, while Sunday headways are the same as evening headways (except where noted).

Table 2-7: CT*fastrak* Routes and Weekday Headways

CT*fastrak* Routes	Peak Headway	Midday Headway	Evening Headway
Local Routes			
101-Hartford/New Britain*	7-8	12	20
102-Hartford/New Britain-Bristol	30	60	60
121-Manchester Community College/Hartford/UConn Health Center	20	30	60
128-Hartford/Westfarms-New Britain via Stanley Street	20	30	60
Shuttle Routes			
140-Central Connecticut State University (CCSU) Shuttle,	15	20	30
144-Wethersfield/Westfarms via Newington Center & Brittany Farms	60	60	60
153-Flatbush/Copaco via West Hartford Center	60	60	60
161-St. Francis Hospital/Hartford Hospital via State Capitol	15	20	30
Express Routes			
923-Bristol Express	20	120	N/A
924-Southington-Cheshire Express	30	N/A	N/A
925-Waterbury Express	30	N/A	N/A
928-Southington-Cheshire-Waterbury Express	60	60	60

*Saturday peak headway is 15 minutes.

CT*fastrak* follows the same zonal fare structure as the existing local and commuter buses. In the month of May 2015, there were over 13,500 CT*fastrak* boardings on an average weekday. Previous projections anticipated 11,200 boardings. In 2030, CT*fastrak* is estimated to serve 16,300 boardings for an average weekday.

Intercity Bus Service

Hartford Union Station lies adjacent to I-84 between Asylum Street and Church Street. The Spruce Street side of the station serves as an intercity bus terminal. The station is served by Greyhound, Peter Pan Bus Lines, and Bonanza (a subsidiary of Peter Pan). All intercity bus service west of Hartford begins or ends in New York City. A few northbound trips end in Hartford but most continue to the north (via I-91) or east (via I-84) ending in either Boston or Springfield.

Intercity buses from the west generally exit I-84 using the Asylum Street exit (Interchange 48B) and continue straight across Asylum Street onto Spruce Street where they enter the station. The exit from the station is onto Church Street. Eastbound exiting buses generally continue east on Church Street and use one of the north-south streets to cross over to Morgan Street where they can enter I-84 eastbound just before the Bulkeley Bridge.

Intercity buses from the east generally exit I-84 at the Asylum Street exit (Interchange 48), turn left on Asylum Street and left onto Spruce Street where they enter the station. Westbound buses must exit onto Church Street and turn right on High Street, right on Asylum Street and then left onto I-84.

Intercity bus service operates from Union Station from 5:00 AM until 1:15 AM There are approximately 26 daily departures to New York, 13 to Boston and 11 to Springfield. Four trips operate to the University of Connecticut main campus in Storrs. One trip daily travels to White River Junction, VT.

Paratransit Service

ADA complementary paratransit service in the Hartford region is provided by the Greater Hartford Transit District. They operate a fleet of 117 vehicles that provides pre-scheduled demand responsive service for people with disabilities that prevent them from using fixed route bus service. Service is provided within ¾ mile of each fixed route during the hours that each route operates. Accordingly, service hours vary from place to place within the region. The fare is $3.00 per one-way trip.

2.1.5 Rail Transportation

I-84 closely parallels Amtrak's Hartford Line railroad through the Project Study Corridor. The line currently operates a single track through the Corridor used for both passenger and freight operations. The existing and proposed rail transportation conditions on The Hartford Line through the Project Study Corridor are documented in this report. Research into both passenger and freight service was conducted in late 2013 and reviewed for accuracy up to the publishing of this report.

Amtrak "Shuttle" Train North of Union Station

Amtrak Passenger Rail Service

Hartford Union Station, located immediately east of I-84 between Church Street and Asylum Street, is the hub of passenger rail activity in the region. Amtrak ridership has been increasing steadily, both nationally as well as in Hartford. Recently released Amtrak ridership figures indicate that Hartford Union Station ranks #57 nationally among Amtrak stations with 179,186 riders (boardings and alightings) in FY 2014.

Three Amtrak operated intercity rail passenger services operate seven days per week at Hartford Union Station. Several short two-car “shuttle” trains operate between Springfield, MA and New Haven, CT. These trains provide cross platform connections at New Haven Union Station to and from Amtrak Northeast Corridor (NEC) Regional trains operating to New York and Washington, DC. A longer distance service serves Hartford as well; Amtrak’s Vermonter provides a daily roundtrip between St. Albans, VT and Washington, DC via Hartford.

Additionally, one NEC Regional train operates roundtrip from Springfield, MA to New York, NY and Washington, DC via Hartford each weekday. A second northbound train operates through Hartford on Friday nights, while a second southbound train operates on Sunday. Two NEC roundtrips serve Hartford on Saturdays. Select weekend NEC Regional trains continues as far south as Lynchburg, VA (southbound direction only).

In total, 11 arrivals and departures serve Union Station Monday-Friday with one additional northbound service occurring only on Friday. These services operate between 6:35 AM and 11:47 PM. On Saturday, Amtrak service increases to 14 arrivals and departures beginning at 7:08 AM and ending with the last train at (northbound) 10:42 PM. Service peaks on Sunday, with 15 arrivals and departures beginning at 7:08 AM and ending with the last train at (northbound) 10:10 PM. Table 2-8, below, summarizes the passenger rail service provided at Union Station in Hartford.

Table 2-8: Passenger Rail Service Schedule

Hartford, CT Trains Departing South (towards New Haven)														
141	143	495	405	147	493	401	463	57	55	475	465	467	479	497
M-F	Sa/Su	M-F	Sa/Su	Sa/Su	M-F	Sa/Su	Sa/Su	Sa/Su	M-F	M-F	Sun.	Sat.	M-F	Sun.
6:35 AM	7:08 AM	7:45 AM	8:05 AM	8:37 AM	11:03 AM	11:14 AM	1:16 PM	3:26 PM	3:32 PM	4:42 PM	4:47 PM	6:04 PM	8:01 PM	8:15 PM

Hartford, CT Trains Departing North (towards Springfield)													
450	490	470	460	54	56	464	488	476	140	148	432	146	136
Sa/Su	M-F	M-F	Sa/Su	Sa/Su	M-F	Sa/Su	Sa/Su	M-F	Sa/Su	M-F	Sun.	Sat.	Fri.
9:23 AM	9:29 AM	11:14 AM	11:28 AM	2:11 PM	2:13 PM	3:41 PM	5:36 PM	6:10 PM	7:19 PM	9:31 PM	10:10 PM	10:42 PM	11:47 PM

Future Plans: The Hartford Line Rail Program

The Hartford Line rail program will result in substantial increases to rail passenger service at Hartford Union Station when it begins in late 2016. Monday through Friday, intercity passenger rail service will increase to 34 arrivals and departures, tripling the current service frequency. On Saturday and Sunday, 22 arrivals and departures are planned. According to previously conducted ridership estimates by CTDOT, Hartford ridership is projected to grow to approximately 375,000 annual riders by 2030. This doubling of rail ridership at Hartford Union Station will make it a much busier station than today.

The Hartford Line Program Planned Station Improvements

As part of The Hartford Line Rail Program, the Connecticut Department of Transportation is proposing limited improvements to Hartford Union Station, focused primarily on the center platform boarding area. The center platform is approximately 750 feet long by approximately 24 feet wide. It serves one track and sits 8 inches above the top of rail height. The existing station-side platform is not used.

Existing Center Platform at Hartford Union Station

Planned improvements will rebuild approximately 260 feet of the north end of the center platform to create an ADA compliant high-level platform. The rebuilt high-level platform will be approximately 16 feet wide and have a fold-up edge to enable extra-wide freight cars to pass through the station. Other customer amenity improvements will include new passenger information systems, expanded video monitoring system, and new ticket vending machines. This new high-level platform will substantially improve the overall boarding process for passengers at Hartford Union Station and reduce dwell time for trains at the station. In addition, a new stairway is being installed at the south end of the existing platform to facilitate pedestrian access directly from the north sidewalk of Asylum Street.

Freight Rail Operations

There are two primary rail freight carriers that operate on The Hartford Line through the Project Study Corridor: Connecticut Southern Railroad (CSO) and Pan Am Southern Railway. The CSO operating hub is the Hartford Yard, located one mile north of the station. CSO operates two scheduled daily freight trains during weekdays, though schedules are flexible and can change due to customer demands and scheduling considerations for connecting railroads.

Pan Am Southern Railway operates freight trains from East Deerfield, MA to Plainville, CT via Hartford. They operate extra trains as needed and do not follow a set schedule. Currently this service can range from one to three round trips per week. Since these freight trains are unscheduled, Amtrak dispatchers will route freight trains from Springfield, MA to Berlin, CT when track time and space is available. See Table 2-9, below, for a listing of freight train services.

Table 2-9: Freight Train Services

Days Operated	Train	Schedule	Service Plan	Size
Monday-Friday	CSO-1	1700-0500	Hartford to Cedar Hill New Haven	Up to 90 cars
Monday-Friday	CSO-5	1830-0630	Hartford to Cedar Hill New Haven	Local switching
As Needed	EDPL	Varies	East Deerfield to Plainville	Varies
As Needed	PLED	Varies	Plainville to East Deerfield	Varies

Hartford Union Station Condition and Amenities

The Hartford Union Station is a historic building, listed on the National Register of Historic Places. The existing level of customer amenities at Hartford Union Station is typical for a station of this size. The lower lobby level is the main location for most transportation services, and has the following features:

- Subway
- Dunkin Donuts
- Union Station News and Gifts
- Men's Restrooms
- Women's Restrooms
- Vending Machines
- Rental Car Phone
- Bank of America ATM
- Information Kiosk
- Amtrak Ticket Window
- Greyhound Ticket Window
- Peter Pan Bus Line Ticket Window
- Electronic Information Kiosk
- Brochure Racks
- Security Booth

West Entrance of Hartford Union Station

Lower Lobby of Hartford Union Station

Access/Egress

The primary access point into the lower lobby is located on the west side of the station. This ADA accessible access point serves as the main drop off/pick up site, taxi stand, intercity motor coach, and primary parking facilities. There are two elevators in the lower lobby level. One elevator provides access to the Amtrak boarding platform directly above the lower lobby level. The second elevator provides access to the historic station building for patrons using mobility aid devices or unable to use the stairs.

The historic main waiting room area is located just to the east of the lower lobby and has two main stairway entrances: one via the lower lobby level and the other on the east side of the building on Union Place. These are not ADA accessible pathways as the waiting room is approximately eight feet higher than the lower lobby. Mobility challenged individuals must use the elevator to access the main waiting room. There is secondary access to Union Place on the southeast and northeast corners of the waiting room. The west side of the waiting room also has two staircases which lead up to the unused station side platform. Since the platform is not used and fenced off, the stairs are not used to access passenger rail services. In addition, the historic main waiting room area has limited seating available.

Leased office spaces are located on the north and south sides of the main waiting room. On the north end of the Union Station building are the offices of the Greater Hartford Transit District (GHTD), owner of the station. These offices are on an ADA pathway, providing access to individuals using mobility aid devices. The *Hot Tomatoes* restaurant is also located on the main station level, but it is not accessible from inside the station. Customers must access the restaurant from a separate entrance on the southeast side of the building off of Union Place.

GHTD Planned improvements for Union Station

The Greater Hartford Transit District (GHTD) is currently undertaking a major project to improve connectivity at Hartford Union Station. This project will add a new CTTransit Center to the northeast side of Union Station on Union Place. The enhancements will include a new bus customer waiting area, 3 new bus bays, streetscaping, ADA accessibility improvements, and a reconfiguration of GHTD offices. This project, funded by a USDOT TIGER Grant, will significantly enhance the facilities' capabilities as an intermodal transfer location. In addition, GHTD is reviewing proposals to install a new passenger information display system in the station. This will include new electronic outdoor information displays at all 14 intercity motor coach bays, as well as new transportation information displays for passengers inside the station.

Future Capabilities of Hartford Union Station and Rail Corridor

Hartford Union Station has historically handled much larger numbers of rail passengers and train service than it does today. The key issue with the facility is not the building capacity, but the limitations of the track and platform at the station. As currently configured, the station can only accommodate one train at a time due to the single track arrangement through the station. In the past, Hartford Union Station had three tracks and was able to accommodate up to three trains at a time. However, two of these tracks were removed

Location of Planned CTTransit Center at Harford Union Station

in the late 1980s, leaving only one for all trains to use.

In the future, this limitation will begin to cause delays and congestion to the overall rail system, as trains must be precisely scheduled to arrive when the single track is available. Any delays in the system could impact the overall rail services reliability. To improve rail service, the Hartford Line's 2030 Full Build scenario proposes adding a second track through Hartford. Additionally, the viaduct carrying the railroad through and adjacent to Union Station is in need of structural repair or replacement. A study is underway which will evaluate potential rehabilitation or replacement strategies. The study will be coordinated with the I-84 Hartford Project, which could relocate the railroad north of I-84. The I-84 Hartford Project will not include any improvements to the rail corridor unless the railroad is relocated. FRA has no current program funding identified for a second track or the railroad viaduct replacement.

The historic main waiting room has the potential to be recaptured and utilized in the future if needed with the addition of passenger information systems and new seating. However, a set of doors and stairs separates this area from the lower lobby currently in use.

Intermodal Connectivity

Hartford Union Station is an important intermodal connector today. In addition to the Amtrak rail services described previously, taxi cabs, intercity motor coach services, local transit buses, rental cars, parking, and bicycle facilities are available at Hartford Union Station. Intercity and local bus service is discussed in Section 2.1.4: Bus Transportation, parking at Union Station is discussed in Section 2.1.3, and bicycle accessibility is discussed in Section 2.1.6: Bicyclist Accessibility.

Taxi Cabs at Hartford Union Station

Taxi Cabs

The taxi cab drop off and pick up location is on the west side of Hartford Union Station near the intercity bus parking area. There is room for approximately seven cabs at this location.

Rental and Shared Cars

Hertz is listed as a rental car service at Hartford Union Station, though no staff or rental vehicles are stationed onsite. Instead, a phone for Hertz rental car services is located in the lower lobby of Hartford Union Station near the Subway. Renters must arrange a pick-up and drop-off with Hertz. However, the hours are limited to Monday through Friday, 8:00 AM to 5:30 PM and 9:00 AM to 11:30 AM on Saturdays. Enterprise Rent-A-Car has several locations near downtown Hartford. They offer free pick up service for renters and will meet renters at the station if requested. Hours are limited to 7:30 AM to 6:00 PM Monday through Friday and 9:00 AM to noon on Saturdays.

There are two active car sharing services in the Hartford area. Neither has a site at Union Station. Hertz 24/7 car sharing service is located at Central Connecticut State University, which is approximately 9.5 miles from Union Station. Zipcar car sharing service has two nearby sites: University of Hartford (approximately 3 miles) and Trinity College (approximately 1.75 miles).

2.1.6 Bicyclist Accessibility

Bicyclist Accessibility has been assessed for the Parking, Bicycle, and Pedestrian Accessibility Study Area (the Study Area, for the duration of this section). Existing and proposed on-street and off-street bicycle networks were analyzed for gaps and improvements. Research included stakeholder interviews conducted during summer and fall 2013 supplemented by field visits and reviews of studies and initiatives. Figure 2-13, following, illustrates the on- and off-street bicycle facilities within the Study Area. On June 5, 2015, SB 502, "An Act Concerning Bicycle Safety," was signed into law, which now allows left-handed bike lanes, contraflow bike lanes, and two-way cycle tracks.

On-Street Facilities

On-street bicycle facilities typically take the form of bicycle routes and bicycle lanes. With the exception of signed prohibitions, bicyclists are permitted on any street within the City of Hartford. However, certain roadways in the Study Area can be considered more applicable for bicycle use.

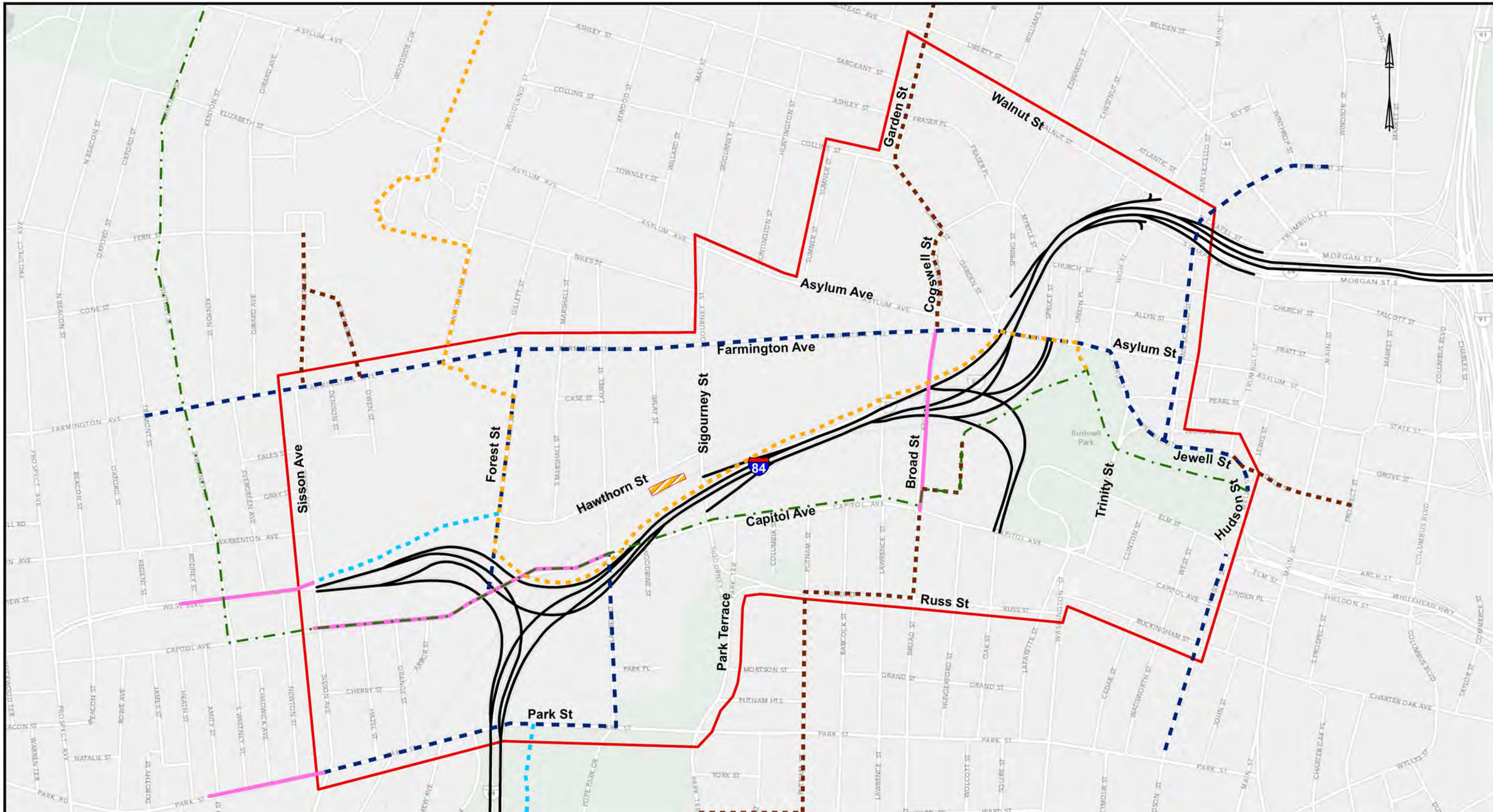
There are two existing bike lanes within the Study Area. One, located on Capitol Avenue between Laurel Street and Sisson Avenue, is part of the current East Coast Greenway route, and has fading or missing lane markings. The other bike lane is on Broad Street between Farmington Avenue and Capitol Avenue and was initially installed in October 2013.

Fading Bike Lane Markings on Capitol Avenue

Recent and Ongoing Initiatives and Studies

The City of Hartford and CRCOG have been involved in many initatives and studies aimed to improve upon the existing bicyclist safety and connectivity throughout the Study Area and the City. The *Regional Pedestrian and Bicycle Plan,* completed for CRCOG in April 2008, identified existing conditions and proposed recommendations to improve pedestrian and bicycle conditions throughout the region, which included the Study Area. Specific recommendations included:

- Complete the East Coast Greenway (discussed further in off-street bicyclist facilities)
- Address the deficient on-road bicycle network in the City of Hartford
- Provide bicycle parking facilities, such as racks
- Develop bike stations that will provide storage and shower amenities
- Develop a bicycle rental program
- Implement targeted crosswalk enforcement



LEGEND

- Existing East Coast Greenway
- Proposed East Coast Greenway
- Existing Bike Lane
- Proposed Bike Lane
- Proposed Multi Use Path
- Proposed Sharrow
- Sigourney CTfastrak Station
- I-84
- Parking, Bicycle and Pedestrian Accessibility Study Area

0 750 1,500 Feet

Sources of Data: ESRI, DeLorme, NAVTEQ

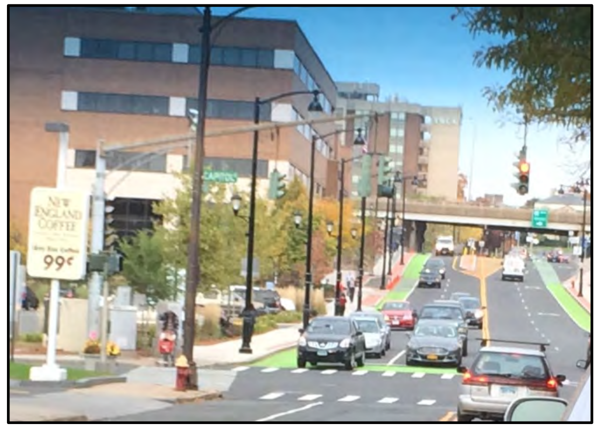
The I-84 Hartford Project

Bicycle Facility Map

Date: 01/29/2015	Drawn By: Parsons Brinckerhoff	Figure 2-13

According to The City of Hartford's 2010 *Downtown Circulation Study*, the general bicycle environment in Hartford is uninviting for casual bicyclists. This is caused by lack of bike lanes, one-way streets, and wide street cross-sections. As a result, bicyclists sometimes use sidewalks in conflict with pedestrians, an action not prohibited by City Ordinances.

The Capitol Region Council of Governments (CRCOG) published a *Pedestrian/Bicycle Crash Study* in 2012 after completing an analysis of crashes in the region between 1995 and 2010. It was determined that the region had a higher percentage of pedestrian fatalities than both the state and the nation. Hartford ranked highest in the region for per capita crash totals of both pedestrians and bicyclists with 15.8 crashes per 1,000 population for the fifteen year period. East Hartford ranked second with 5.4 crashes per 1,000 population.



Existing Bike Lane on Broad Street

Of bicycle crashes, sixty-four percent were attributed to the bicyclist and thirty-four percent to motorists. Of the bicyclist at fault incidents, over one-third is attributed to bicyclist behavior such as violation of traffic control and another third occurred when the bicyclist failed to grant the right of way. At twenty percent of bicyclist at fault incidents, the next largest category of crashes is attributed to wrong way riding.

The City of Hartford's Capitol City Connectivity Plan, published in the August 2014 Capital City Parks Guide: Plans for Hartford's Regional Community, and Neighborhood Parks recommends the expansion of bicycle paths, sharrows, and multi-use paths with the goal of enhancing pedestrian and bicycle connections between and within City parks.

According to the Plan, the City is proposing a number of new bike lanes. A proposed new bike lane along Farmington Avenue to Asylum Avenue would provide access to Union Station and the new CT*fastrak* stop at Union Station. The new lane would continue along Bushnell Park to Wells Street and into Downtown. A new bike lane is also proposed for Ann Uccello Street between Bushnell Park and North Chapel Street. The City is also proposing a new bike lane on Forest Street to provide access to Hartford Public High School and connect the existing bike lane on Capitol Avenue to the proposed path on Farmington Avenue. The proposed Forest Street bike lane would also connect to a proposed multi-use path that would route behind the high school towards Sisson Avenue and connect to the existing bike lane on West Boulevard. This route is currently used by bicyclists and pedestrians as an off-road alternative instead of the Capitol Avenue bike lane. Additionally, the City is proposing a sharrow, or a marked path indicating the road is to be shared with bikes and cars, on Cogswell/Broad Street to connect to the existing bike lane on Broad Street.

Bicyclist Stakeholder Interview Summary

I-84 Project Team members conducted an informal interview and two walking tours with Bike Walk Connecticut to discuss the organization's views and issues regarding bicyclist accessibility within portions of the Study Area. The following paragraphs represent a summary of the opinions of Bike Walk Connecticut members who participated in the interview and walking tours. See Appendix A.3.1, Stakeholder Interview Summaries for further information.

Capitol Avenue is considered the safest cycling route, as there are bike lanes present in some portions. However, the lanes abruptly end in places and share space with on-street parking, forcing bicyclists into traffic lanes. Specifically, the Capitol Avenue bike lanes end suddenly before Sisson Avenue where the parking lane and bike lane turn into a right-turn only lane for the Capitol Avenue and Sisson Avenue intersection. Farmington Avenue is considered the worst route for bicyclists, as there are no bike lanes, a lot of on-street parking, and the roadway is often congested.

Asylum Avenue lacks an eastbound shoulder and bicycling westbound on Asylum Avenue is difficult with both the uphill grade and vehicles preparing to turn right at Garden Street. It was also noted that it is difficult for bicyclists to turn left from Asylum Avenue to Farmington Avenue due to the non-traditional four square intersection geometry and vehicular free flow conditions.

There is a lack of north/south connections for bicyclists and pedestrians, and that those that do exist are poorly lit and difficult to navigate. The closure of Flower Street has exacerbated this issue. Homestead Avenue has become a popular bike route to Downtown from the West Hartford/Bloomfield area.

Other difficult to navigate sections include Capitol Avenue into Bushnell Park, as the pedestrian bridge behind the Armory, part of the East Coast Greenway, is unattractive. The City streets that pass under the Sisson Avenue ramps are poorly lit and are unattractive. Park Street would be a viable option for bicyclists but is narrow and has on-street parking.

The group agreed that improvements to city streets should include more continuous and protected bike lanes, better enforcement of traffic rules regarding bikes, clearer markings, and enforcement of no parking in bike lanes.

The Project Team has identified a deficiency in the City's existing and proposed bicycle network in the vicinity of the Sigourney Street CT*fastrak* station. Plans are in place to improve bicycle facilities around the station, located near the corner of Sigourney and Hawthorn Streets, opposite Imlay Street. The construction contract for this project is scheduled to be awarded in late August 2015.

As a separate project, CTDOT has discussed potentially installing bike paths on both sides of Sigourney Street between Capitol Avenue and Farmington Avenue. The I-84 Hartford Project Team will track the progress of these plans.

Off-Street Facilities

Bicycle or multi-use paths are exclusive vehicle-free facilities that are typically located outside the roadway cross-section. Off-street paths are generally located within or adjacent to flood control channels, transit corridors, utility corridors, greenways, and/or parks. These paths are popular for utilitarian and recreational riding, are typically preferred by less experienced riders and bicycle commuters whose trips are longer than a couple of miles.

Interim Route of the East Coast Greenway behind the State Armory

The East Coast Greenway is a project to create a linked network of multi-use paths stretching from Maine to Florida. The Greenway traverses east to west through Bolton and Manchester prior to crossing the Connecticut River via the Founders Bridge. The Greenway currently exits Hartford to the northwest via Whitney Street. The route continues northwest to meet the Farmington Canal Trail in Simsbury.

The interim route and the proposed final route of the East Coast Greenway through Hartford were provided by CRCOG. The proposed final route, illustrated in Figure 2-13, page 2-40, is not defined at its crossing of I-84. According to CRCOG, the task force committee that was looking at routes wanted to keep options open as changes to I-84 would potentially open new opportunities for the Greenway. The initial concept had been laid out to use the parking lots behind the buildings on Capitol Avenue for the Greenway alignment.

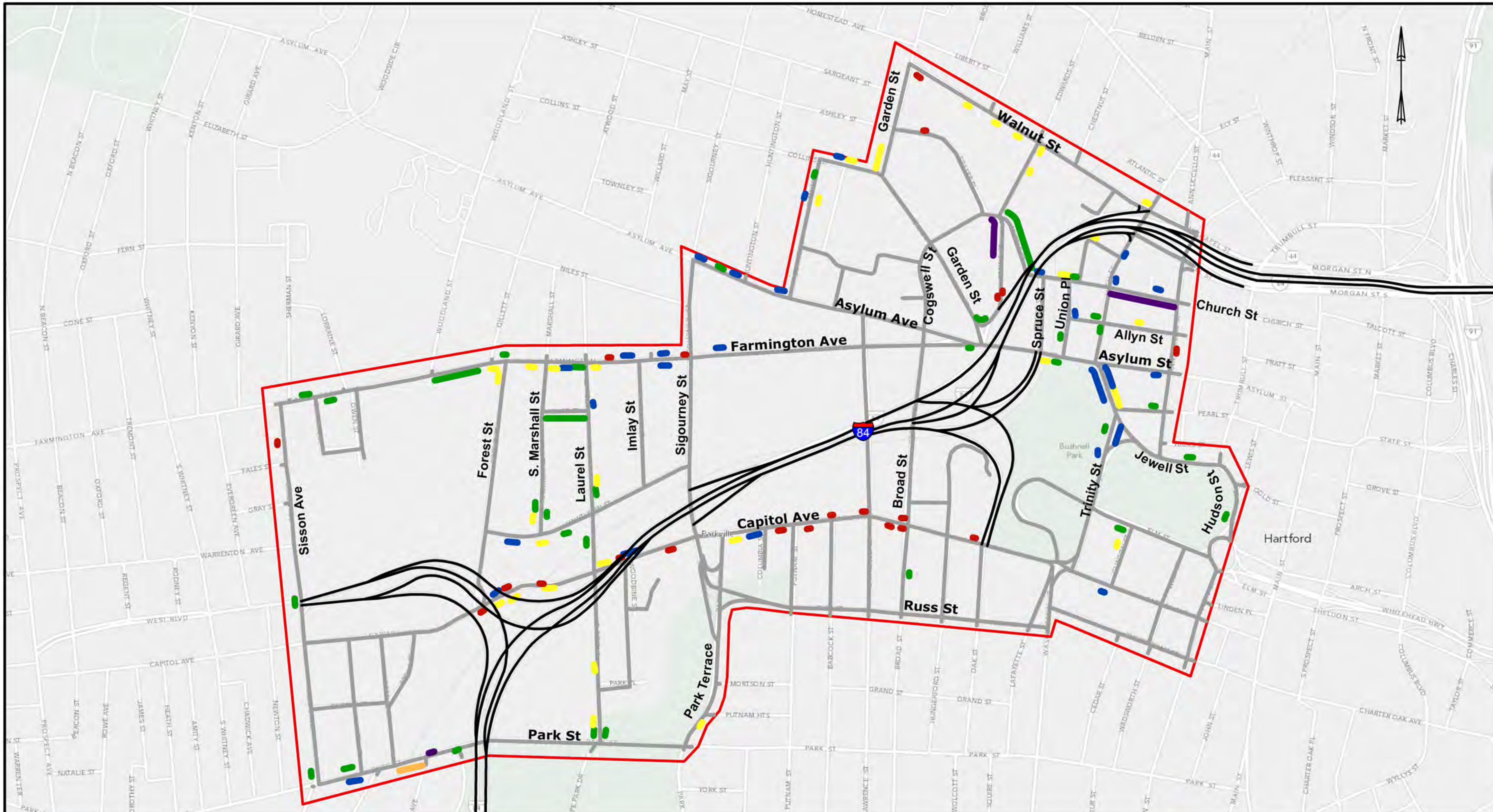
An unofficial multi-use path is utilized by pedestrians and bicyclists between Sisson Avenue and Forest Street. The path begins by the Fire Station on Sisson Avenue, routes through a basketball court and through the Hartford Public High School grounds where it ends on Forest Street.

2.1.7 Pedestrian Accessibility

Pedestrian Accessibility has been assessed for the Parking, Bicycle, and Pedestrian Accessibility Study Area (the Study Area, for the duration of this Section). Research included stakeholder interviews conducted during summer and fall 2013 supplemented by field visits and reviews of studies and initiatives up to the publication of this report.

Sidewalks and Pedestrian Routes

Sidewalks were evaluated along arterial roads, local roads, and transit routes to document their condition and assist in determining pedestrian accessibility within the Study Area. These conditions, as well as the Study Area, are illustrated in Figure 2-14, following. Within the Study Area, the majority of



LEGEND

Sidewalk Deficiencies
- Uneven
- Large Cracks and Holes
- Missing Section
- Abrupt Edge
- Non-Accessible
- Obstruction

- I-84
- Roads
- Parking, Bicycle and Pedestrian Accessibility Study Area

0 500 1,000 Feet

Sources of Data: ESRI, DeLorme, NAVTEQ

The I-84 Hartford Project

Pedestrian Accessibility Map

Date: 5/7/2014	Drawn By: Parsons Brinckerhoff	Figure 2-14

sidewalks were deemed to be in acceptable condition, with the exception of a few locations. Sections of Capitol Avenue, Park Street, and the intersection of Elm Street and West Street were missing portions of the sidewalk.

In several locations, substandard sidewalk widths restrict or obstruct access where structures have been built into in the sidewalk, including bridge columns and utility/signal poles. Capitol Avenue, between Sigourney Street and Forest Street, has bridge columns in the middle of the sidewalk that reduce the effective width to inadequate levels. The corner of High Street and Chapel Street North has a portion of the sidewalk missing as well as having three utility poles in the sidewalk.

Sigourney Street has a stairway at the Capitol Avenue overpass to provide pedestrian connectivity at this grade separated crossing. There is no bicycle, stroller, or handicap access at this location, violating the Americans with Disabilities Act (ADA) provisions for pedestrian amenities. During field visits, pedestrians were observed bypassing the stairway and instead cutting up a grassy hill to Sigourney Street.

There are several tunnels and underpasses conveying pedestrians beneath the railroad within the Study Area, including on Capitol Avenue, Park Street, and Asylum Street. The Capitol Avenue and Park Street underpasses were observed to be poorly lit, unkempt, and narrow. Although the Asylum Street tunnel is illuminated, the sidewalk is in poor condition.

Flower Street has been permanently closed to traffic and to pedestrians. A pedestrian walkway has been constructed underneath I-84 between Broad Street and Flower Street to provide a pedestrian and bicyclist bypass.

Intersections

Crosswalk conditions, pedestrian signal operations, and ADA compliance were assessed at Study Area intersections. A detailed intersection by intersection breakdown is provided in Appendix A.3.3. According the Connecticut Department of Transportation's *2009 Connecticut Statewide Bicycle and Pedestrian Plan*, specific guidelines for pedestrian intersection accessibility include:

- Tactile warning strips are required at all ramps
- Separate curbs ramps should be installed at each crosswalk, instead of one ramp at the corner
- Consider use of Accessible Pedestrian Signals (APS) which provide non-visual information to pedestrians such as audible tones, verbal messages, and/or vibrating surfaces

Pedestrian accessibility conditions at intersections were mostly acceptable with some recurring non-conformities, including sidewalk ramps not aligned with the crosswalk and deteriorated crosswalk pavement markings. Vibrant crosswalk pavement markings increase motorists' awareness of the potential presence of pedestrians and guide pedestrians at appropriate crossing locations. Sidewalk ramps that are not in line with the crosswalk make crossing the street difficult for disabled or blind pedestrians. An ADA-compliant sidewalk ramp should be placed at each crossing location.

Unobstructed signals and pedestrian walkways are important to provide clear sight lines for both motorists and pedestrians. Blocking a motorist's view of pedestrians is a safety concern, especially on right turns. One such obstruction is at the intersection of Broad Street and the I-84 eastbound on-ramp where the pedestrian signal and ramp are behind an I-84 bridge pier.

There are locations where tactile warning strips and audio signals are missing. The intersections of the I-84 eastbound on- and westbound off-ramps with Sigourney Street have pedestrian push buttons and pedestrian signals. However, there are missing ramps and crosswalks.

Pedestrian push buttons at many intersections are not easily accessible. For example, at the intersection at Broad Street and Capitol Avenue, the pedestrian button in located on the back side of the pole and the traffic signal controller cabinet blocks access to the push button and to the ramp.

The location of greatest concern is the Sisson Avenue intersection with the I-84 Interchange 46 ramps. The eastern approach (the I-84 ramps) is very wide and takes two pedestrian phases to cross. The median is narrow and not protected from traffic. The pedestrian push button and pole on the median may have been damaged by traffic.

Recent and Ongoing Initiatives and Studies

The City of Hartford, CRCOG, and other local agencies have numerous ongoing initiatives focused on creating a more walkable city. Central to these initiatives is the iQuilt Plan, a culture-based urban design plan for Downtown Hartford, focused on signage, wayfinding, and placemaking. The Intermodal Triangle is a localized implementation of the iQuilt Plan; funded by a TIGER Grant from USDOT and the City of Hartford, it seeks to enhance walkability through connectivity of Union Station and Main Street using complete streets infrastructure.

Key elements of the Hartford Intermodal Triangle project include:

- partial renovation of Union Station,
- special signal and lane treatment for the CT*fastrak* terminus,
- major bus stop enhancements around Union Station,
- sidewalk and pedestrian crossing enhancements, and
- wayfinding signage for pedestrians and vehicles.

Also as part of this project Jewell Street will be transformed into Bushnell Park North, a pedestrian- and bicycle-friendly "green boulevard" featuring a narrower roadway, wider sidewalks, and bicycle lanes. These improvements will encourage pedestrian movement and improve pedestrian accessibility between Bushnell Park and Union Station. The Intermodal Triangle is currently in the design phase with construction anticipated to begin in summer 2014 and project completion scheduled for fall 2015.

The Greater Hartford Transit District (GHTD) *Bus Livability Project* is also planned. This project includes the *Union Station Pedestrian Neighborhood Connectivity Project* and the *GHTD Streetscape Project* that includes streetscape improvements to portions of Asylum Avenue, Sigourney Street, and Farmington Avenue. The *Union Station Pedestrian Neighborhood Connectivity Project* will improve pedestrian connectivity in the Asylum Avenue/Farmington Avenue Trident, linking it with Union Station and extending it to the High Street/Ford Street intersection. Included as part of this project are improvements to streetscaping, sidewalks, landscaping and lighting. Also proposed is a new pedestrian crossing on Spruce Street between the parking lot and Union Station and new traffic signals that will be more responsive to pedestrians.

The City of Hartford's 2010 *Downtown Circulation Study* identified opportunities to enhance the connectivity of the transportation network and the accessibility of walking, transit, and driving. Included as part of this project are the following pedestrian objectives:

- Strengthen connections between areas of the city
- Create a walkable environment and strengthen pedestrian connections
- Improve wayfinding for pedestrians and motorists

The City of Hartford is also undertaking a Sidewalk Accessibility Study that will provide detailed sidewalk condition and accessibility information throughout Hartford.

According to the Capitol Region Council of Governments (CRCOG) 2012 *Pedestrian/Bicycle Crash Study*, fifty percent of pedestrian crashes were attributed to unsafe practices in the road by a pedestrian. Of these crashes, the majority (60%) occurred between intersections. The remaining pedestrian at fault crashes are evenly split between signalized and unsignalized intersections.

In addition to these studies, the development of the Hartford Yard Goats minor league baseball field, which is scheduled to open in Spring 2016, will also provide pedestrian improvements in the vicinity of the ballpark.

Stakeholder Interview Summaries

Informal interviews were held with The Hartford, Council of Churches, ArtSpace Residents Association, and the Asylum Hill Neighborhood Association to discuss their concerns and issues regarding pedestrian facilities within the Study Area. The following are brief summaries of these interviews, presented as stated by the Stakeholders to the Project Team. The full Stakeholder Interviews are provided in Appendix A.3.1.1

ArtSpace Residents Association

Pedestrian access in the Asylum Avenue and Farmington Avenue Trident area is poor. ArtSpace, located at 555 Asylum Avenue, across the street from Union Station, has an art gallery and hosts many events. However, visitors must park across the street in the Union Station parking lot on Spruce Street and cross Asylum Avenue. As there is no pedestrian access across Asylum Avenue at Spruce Street, pedestrians are required to use crosswalks at Union Place or Garden Street. The Trident area is a large, busy intersection without illumination, which is an unappealing and undesirable pedestrian environment.

Asylum Hill Neighborhood Association

According to one interviewee of the Asylum Hill Neighborhood Association, the Asylum Hill Neighborhood is not considered part of Downtown. The representative opined that the closing of Flower Street was a “disaster” and I-84 cut-off the neighborhood. If Asylum Hill were considered part of the Downtown, the interviewee felt that developers would be showing more interest. Currently, pedestrian connections to Downtown are poorly maintained, dangerous, and make the area feel ‘cut-off’.

Bike Walk CT

The Project Team conducted one informal interview and two walking tours with Bike Walk CT. At these events, members of Bike Walk CT identified safety concerns for bicyclists and pedestrians within the study area, including dim lighting, poor road maintenance, and competition with automobile traffic. They noted dim lighting and poor bike path conditions on Capitol Avenue between Sisson Avenue and Laurel Street and on the pedestrian bridge over I-84 to Bushnell Park behind the Armory. There are also cars frequently blocking bike lanes at the intersections of Sisson Avenue and Capitol Avenue, and Farmington Avenue and Asylum Street.

The group recommended to improve safety and to expand bike lanes in the Study Area. Continuous and protected bike lanes, better enforcement of traffic rules regarding bikes, clearer marking and enforcement of no parking in bike lanes were suggested remedies. The group also called for more north/south bike and pedestrian connections, observing that existing north/south routes were poorly lit and difficult to navigate.

The Hartford

The Hartford discussed the potential to connect the Asylum Hill neighborhood to Downtown. Currently, The Hartford feels that very few of its employees travel to Downtown, as it seems to be an unappealing and difficult trip as a pedestrian.

Council of Churches

The churches which make up the Council attract a large amount of visitors from outside Hartford. Emmanuel Church estimates that eighty percent of its parishioners are from the suburbs (mainly West Hartford, Farmington, and Glastonbury) and travel in for services. The Frog Hollow neighborhood where the church is located has had concerns regarding the CT*fastrak* and street closures such as Flower Street. The church is working in coordination with Billings Forge Neighborhood Works to continue to improve the neighborhood.

The Cathedral of Saint Joseph hosts over 100,000 visitors each year, including 1,500 each week at mass. The cathedral also hosts concerts, community events, graduations, and weddings. Farmington Avenue in the area of the cathedral can become very congested during large events. Trinity Episcopal has a more local congregation, with a large percentage of the Burmese community living in the Laurel Street/South Marshall Street neighborhood that walk to the church. A large Indian community attends the church from the Union Station area. A safe and accessible pedestrian environment is important to these churches and their communities.

2.2 Existing Traffic Data

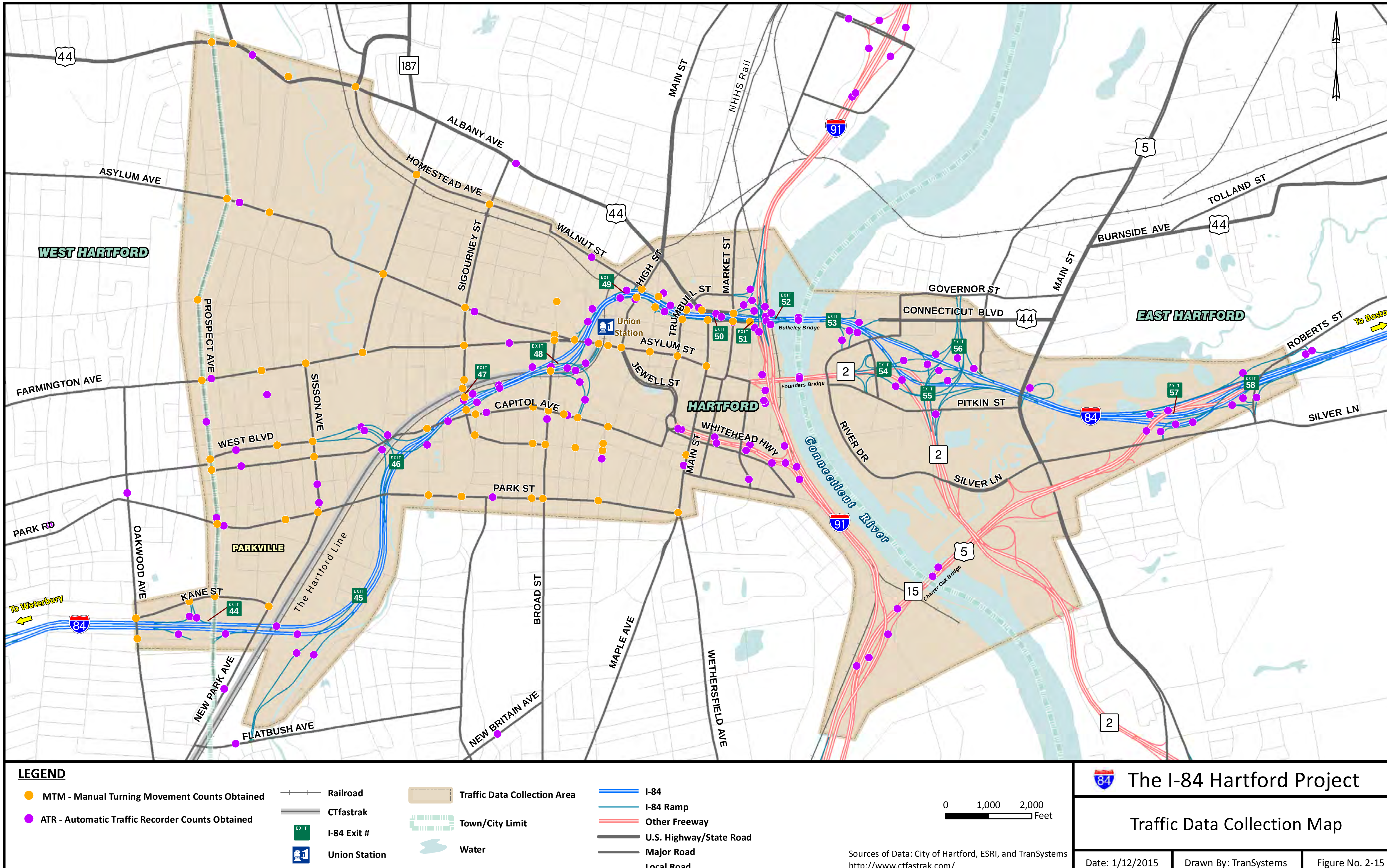
Existing traffic data was collected to use as the basis for assessing existing traffic operations and to determine a baseline for future conditions. The existing traffic conditions are assessed in Section 2.4: Existing Traffic Operations.

In order to get a full picture of traffic patterns throughout the Project Study Corridor, data was gathered for adjacent segments of I-84, as well as intersecting freeways and local streets. The Traffic Data Collection Area (the Study Area, for the duration of this Section), illustrated on Figure 2-15, following, was selected to encompass the roads deemed most critical to travel in and around Hartford. Most of these routes experience recurring congestion during peak hours. Others operate below capacity currently but may be impacted (temporarily or permanently) by the Project. The traffic analysis is concerned primarily with the Project Study Corridor. The Project Team notes that at the time of traffic data collection and analysis in preparation of this report, the minor league baseball park had not yet been announced. Traffic analysis in future studies will include traffic patterns altered as a result of the new ballpark, which is scheduled to open in 2016.

2.2.1 Traffic Volumes

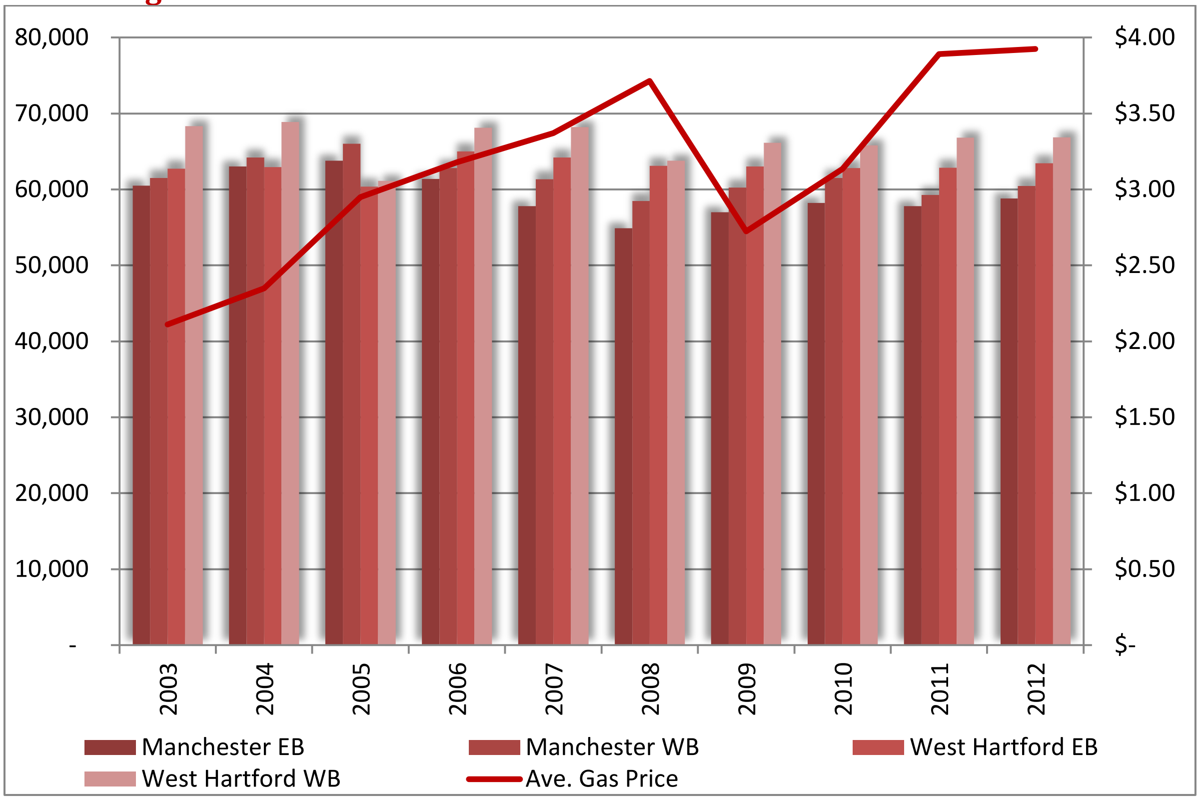
Traffic volumes were obtained for I-84, other freeways, and the secondary roadway network (local streets). For calibration, all counts were factored to 2012 average weekday equivalents using two CTDOT continuous count stations: Continuous Count Station 49, located at the west end of the Study Area in West Hartford, and Continuous Count Station 26 in Manchester, located west of Interchange 63. Combined with 24-hour ramp counts taken every three years, these count stations provide a reliable overview of weekday traffic patterns along the freeway.

Figure 2-16, page 2-51, illustrates the historical average daily traffic (ADT) at Continuous Count Stations 26 and 49 on I-84 for the ten year period from 2003 to 2012 relative to national average gas price. In the last four years, the traffic has remained fairly constant with a unidirectional ADT of 58,000 to 60,000 in Manchester and 63,000 to 66,000 in West Harford. 2008 brought the lowest volumes for Manchester counts but also marked the beginning of an 18-month recession that led to declining economic growth rates on a global level. The gas prices in the graph have been adjusted for inflation based on the Consumer Price Index (CPI) at the time of the gasoline purchase. Thus from 2009 onwards the graph illustrates slow recovery in traffic volumes and a gradual increase in gasoline price. Prior to 2008, the traffic volumes ranged from 58,000 to 66,000 in Manchester with a peak ADT of 69,000 in 2005. West Harford volumes have shown little or no variation in the westbound direction; the traffic remained constant at 68,000 between 2003 and 2007. In the eastbound direction, traffic volumes varied between 62,000 to 64,000 prior to the recession.



LEGEND
MTM - Manual Turning Movement Counts Obtained
ATR - Automatic Traffic Recorder Counts Obtained
Railroad
CTfastrak
I-84 Exit #
Union Station
Traffic Data Collection Area
Town/City Limit
Water
I-84
I-84 Ramp
Other Freeway
U.S. Highway/State Road
Major Road
Local Road
0 1,000 2,000 Feet
Sources of Data: City of Hartford, ESRI, and TranSystems
http://www.ctfastrak.com/
The I-84 Hartford Project
Traffic Data Collection Map
Date: 1/12/2015
Drawn By: TranSystems
Figure No. 2-15
WEST HARTFORD
HARTFORD
EAST HARTFORD
PARKVILLE
Union Station
Connecticut River
To Waterbury
To Boston
ASYLUM AVE
ALBANY AVE
HOMESTEAD AVE
WALNUT ST
SIGOURNEY ST
FARMINGTON AVE
PROSPECT AVE
SISSON AVE
WEST BLVD
CAPITOL AVE
PARK ST
PARK RD
OAKWOOD AVE
KANE ST
NEW PARK AVE
FLATBUSH AVE
NEW BRITAIN AVE
BROAD ST
MAPLE AVE
WETHERSFIELD AVE
MAIN ST
HIGH ST
TRUMBULL ST
MARKET ST
ASYLUM ST
JEWELL ST
WHITEHEAD HWY
NHHS Rail
The Hartford Line
Bulkeley Bridge
Founders Bridge
Charter Oak Bridge
RIVER DR
GOVERNOR ST
CONNECTICUT BLVD
PITKIN ST
SILVER LN
BURNSIDE AVE
TOLLAND ST
ROBERTS ST

Figure 2-16: Continuous Count Station Historical Traffic Variations



In addition to the two continuous count stations (CCS), the historical average daily traffic (ADT) for I-84 and I-91 was collected from CTDOT's Traffic Monitoring Volume Information Traffic Count Data. Table 2-10, following, displays 19 years of historical ADT data, from 1992 to 2010. Daily traffic volumes on I-84 over the Connecticut River have remained fairly constant over the last 19 years and particularly over the last 10 years with ADTs near 141,000 vehicles per day. This is likely due to the recurring congestion throughout Hartford; most of the city's freeways have operated at or near capacity for decades, leaving little room for growth. While the peak periods have spread into traditionally off-peak hours, the overall daily volumes have not increased substantially, reflecting the time-sensitive nature of commuter traffic. In addition to these two mainline locations, a High Occupancy Vehicle (HOV) connector location and five ramps connecting I-91 and I-84 are shown. Most of these ramps have seen little or no growth in the last 19 years. The largest growth, about one percent per year, has been experienced on the I-84 eastbound off-ramp to I-91 northbound (Exit 51).

Table 2-10: Historical Average Daily Traffic Volumes

Year	I-84 on the Bulkeley Bridge	I-84 WB Off-Ramp to I-91 NB (Exit 51)	I-84 EB Off-Ramp to I-91 SB (Exit 52)	I-84 EB On-Ramp from I-91 SB	I-84 EB Off-Ramp to I-91 NB (Exit 51)	I-84 WB On-Ramp from I-91 NB
1992	138,900	10,000	18,500	-	9,800	22,200
1993	144,700	-	-	-	-	-
1994	140,800	-	15,100	21,100	-	-
1995	134,600	10,700	15,100	22,300	10,500	23,600
1996	132,900	-	-	-	-	-
1997	135,500	-	-	-	-	-
1998	139,000	10,200	14,400	22,600	10,200	23,200
1999	143,500	-	-	-	-	-
2000		-	-	-	-	-
2001	141,800	10,200	14,500	21,900	11,200	23,300
2002	-	-	-	-	-	-
2003	-	-	-	-	-	-
2004	141,400	11,300	15,500	23,600	12,400	23,100
2005	-	-	-	-	-	-
2006	-	-	-	-	-	-
2007	141,400	9,400	13,100	20,500	11,900	21,300
2008	-	15,200	14,500	-	12,500	21,900
2009	-	-	15,900	-	12,500	23,000
2010	141,100	10,900	14,500	22,000	11,800	23,100
Average Annual Percent Change (AAPC)						
92-10	0.09%	0.48%	-1.34%	-	1.04%	0.22%
95-10	0.31%	0.12%	-0.27%	-0.09%	0.78%	-0.14%
98-10	0.13%	0.55%	0.06%	-0.22%	1.22%	-0.04%

Source: Existing Conditions Technical Memorandum, CDM Smith
Summary of CT DOT Counts using Traffic Count Locator Program (TCLP)

The two mainline continuous count stations (CCS) provide day-of-week, monthly, and yearly variations in traffic volumes. For ease of comparison, traffic volumes at all locations are extrapolated to a year 2012 baseline. Figure 2-17, following, summarizes the traffic on I-84 by month as a ratio compared to the year-round average daily traffic.

Volumes during the summer months are approximately five to ten percent higher than average weekday traffic. Winter months show volumes five to ten percent lower than the year-round average daily traffic.

Figure 2-17: I-84 Monthly Traffic Variation

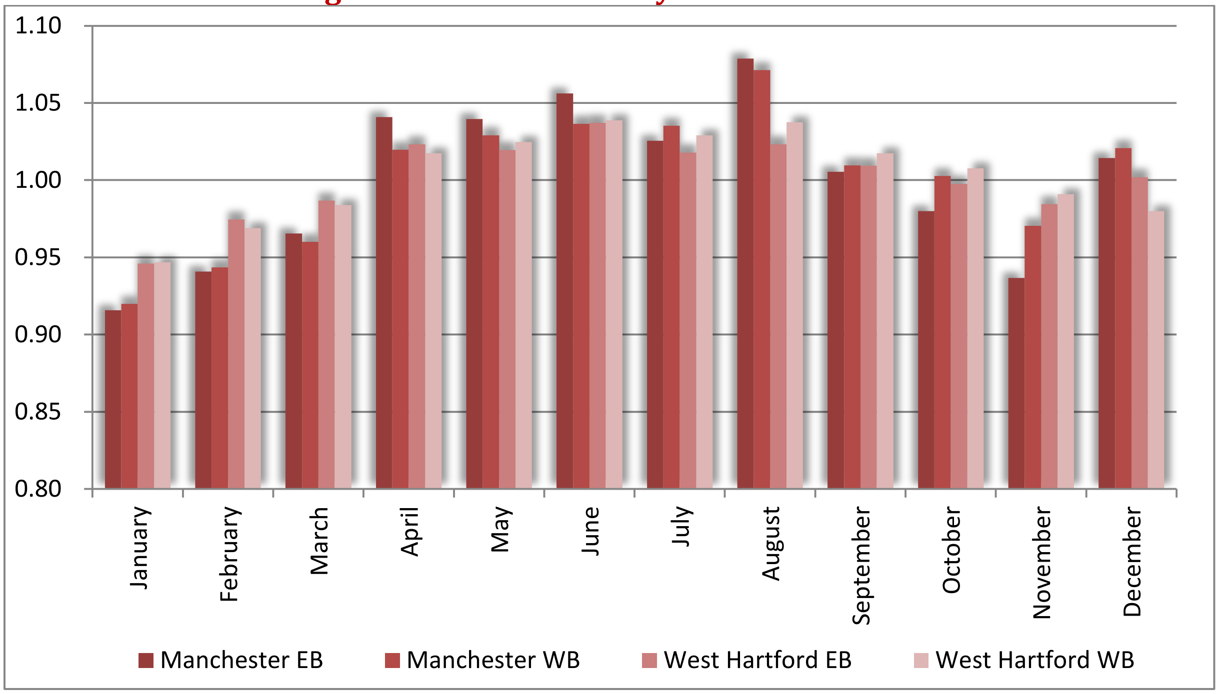
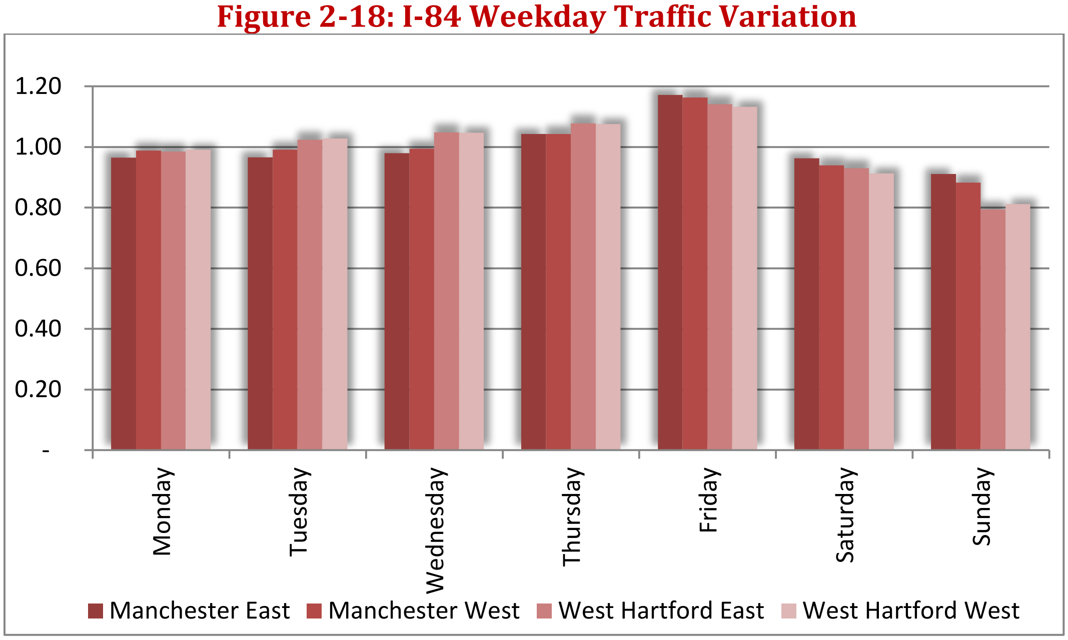


Figure 2-18, below, illustrates the daily variations as a ratio compared to the year-round average daily traffic at the same locations as presented in the monthly variations. Traffic increases throughout the week to the highest level on Friday, which is roughly twelve to twenty percent higher than the average daily traffic. Weekend traffic is roughly eighty to ninety percent of average weekday traffic. The lowest volumes are typically experienced on Sundays.

Figure 2-18: I-84 Weekday Traffic Variation



In the course of its I-84 Viaduct Value Pricing Study, CDM Smith developed a balanced count profile, a 24-hour normalized set of volumes for each ramp and freeway segment on I-84 from Farmington to Vernon and on I-91 from Hartford to Windsor Locks. The balanced count profile provides traffic volumes for a typical day for both I-84 and I-91 within and beyond the Study Area. It is also critical for calibrating the existing conditions microsimulation model (discussed in further detail in Section 2.4: Existing Traffic Operations) and the Study Area time of day travel demand model. The balanced count profile is included as Appendix A.2.1.

Daily Traffic Volumes

I-84 in Hartford carries more vehicles per day than any other route in Connecticut: nearly 175,000 at its busiest point. Eastbound, 61,000 vehicles enter Hartford from West Hartford, building up to a peak of 84,000 just after the Broad Street on-ramp. At the East Hartford town line, 70,000 vehicles travel east across the Connecticut River on an average day. Westbound, 69,000 vehicles cross the Bulkeley Bridge, increasing to 91,000 just before the ramp to Asylum Street, Exit 48. 64,000 of these continue to the West Hartford town line.

The busiest interchange in the Study Area is the three-level interchange of I-84 and I-91: 270,000 vehicles pass through this interchange every day. In particular, the busiest ramps in the corridor are from I-84 eastbound to I-91 northbound (22,800 vehicles per day) and from I-91 southbound to I-84 westbound (24,100 vehicles per day). Eight other ramps on I-84 carry more than 10,000 vehicles per day. Average daily traffic on I-84 through the Project Study Corridor is listed in Table 2-11, following. Appendix A.2.2 includes all supplemental counts obtained in December 2013 and April 2014 and utilized in the study.

Peak Hour Traffic Volumes

Like any road with recurring congestion, I-84 in Hartford exhibits flattened peak hours. That is, rather than distinct peaks in the morning and in the afternoon, traffic volumes plateau near a maximum value for multiple consecutive hours. The morning peak lasts from 7:30 to 9:00 AM, and in the afternoon, the peak period stretches from 3:30 to 6:00 PM. Peak hour volumes presented in Table 2-12, page 2-56, and discussed below are hourly volumes taken from the highest single hour within these peak periods.

West of Broad Street traffic primarily flows eastbound in the morning and westbound in the afternoon. East of Broad Street this pattern is reversed. This reflects Hartford’s status as the main regional attractor of volume: in the morning, commuters pour into the city and the evening sees them head back out. Of particular relevance are Hartford’s insurance and government offices, which attract thousands of trips from the surrounding suburbs each day. Overall, volumes are slightly higher in the afternoon peak than in the morning.

In the morning peak period, mainline traffic is heaviest eastbound just after the Sigourney Street on-ramp at 6,955 vehicles per hour. 1,580 vehicles take Exits 48A and 48B off-ramps to Asylum Street and Capitol Avenue and 1,560 leave I-84 for I-91 northbound. Westbound the mainline volume is highest with 7,170 vehicles just before Asylum Street (Exit 48). Other than the I-91 ramps, the Asylum Street off-ramp is the busiest I-84 off-ramp within the Project Study Corridor carrying 1,770 vehicles from I-84 to Garden Street, Asylum Street, and Farmington Avenue.

In the afternoon, eastbound mainline traffic peaks at 6,985 just after the Broad Street on-ramp. 1,585 vehicles enter I-84 eastbound from Broad Street and 1,685 take Exit 51 to I-91 northbound. Westbound the highest traffic volume is 7,050 vehicles just before the off-ramp to Sigourney Street (Exit 47). The westbound on-ramp with the greatest contributing volume is the turning roadway from I-91 southbound carrying 1,685 vehicles.

Table 2-11: I-84 Average Daily Traffic Summary

Westbound	ADT	Eastbound	ADT
Mainline – West of Flatbush	64,405	Mainline – West of Flatbush	60,880
Flatbush Ave. Off-Ramp	9,275	Flatbush Ave. On-Ramp	8,555
Sisson Ave. On	5,335	Sisson Ave. Off-Ramp	4,780
Sisson Ave. Off-Ramp	8,695	Sisson Ave. On-Ramp	10,675
Sigourney St. Off-Ramp	8,565	Sigourney St. On-Ramp	8,265
Mainline	85,600	Mainline	83,595
Capitol Ave. On-Ramp	5,410	Capitol Ave. Off-Ramp	6,295
Asylum St. On-Ramp	4,245	Asylum St. Off-Ramp	5,865
Asylum Ave. Off-Ramp	14,715	Broad St. On-Ramp	12,505
Mainline	90,665	Mainline	83,935
High St. On-Ramp	5,225	High St. Off-Ramp	1,740
Trumbull St. On-Ramp	3,130	Trumbull St. Off-Ramp	3,080
Mainline	82,310	Mainline	79,115
I-91 Northbound On-Ramp	12,225	I-91 Northbound Off-Ramp	22,760
I-91 Southbound On-Ramp	24,110	I-91 Southbound Off-Ramp	11,220
Morgan St. Off-Ramp	8,275	Morgan St. On-Ramp	10,440
I-91 Northbound Off-Ramp	15,220	I-91 Southbound On-Ramp	14,030
Bulkeley Bridge	69,470	Bulkeley Bridge	69,605

Table 2-12: Existing (2012) I-84 Peak Hour Volumes and Directional Distributions

Description	Westbound							Description	Eastbound						
	AM Peak Hour (7:30 – 9 AM)			PM Peak Hour (3:30 – 6 PM)			ADT		AM Peak Hour (7:30 – 9 AM)			PM Peak Hour (3:30 – 6 PM)			ADT
	Volume (Vehicles per Hour)	% of Daily Traffic	Directional Distribution	Volume (Vehicles per Hour)	% of Daily Traffic	Directional Distribution			Volume (Vehicles per Hour)	% of Daily Traffic	Directional Distribution	Volume (Vehicles per Hour)	% of Daily Traffic	Directional Distribution	
Mainline	3,730	6%	42%	5,450	8%	59%	64,405	Mainline	5,070	8%	58%	3,865	6%	41%	60,880
Flatbush Ave. Off	690	7%	50%	860	9%	54%	9,275	Flatbush Ave. On	680	8%	50%	745	9%	46%	8,555
Sisson Ave. On	245	5%	37%	495	9%	63%	5,335	Sisson Ave. Off	410	9%	63%	285	6%	37%	4,780
Sisson Ave. Off	760	9%	39%	965	11%	53%	8,695	Sisson Ave. On	1,200	11%	61%	860	8%	47%	10,675
Sigourney St. Off	1,160	14%	71%	630	7%	34%	8,565	Sigourney St. On	470	6%	29%	1,235	15%	66%	8,265
Mainline	5,855	7%	46%	7,050	8%	53%	85,600	Mainline	6,955	8%	54%	6,265	7%	47%	83,595
Capitol Ave. On	195	4%	19%	685	13%	70%	5,410	Capitol Ave. Off	840	13%	81%	290	5%	30%	6,295
Asylum St. On	130	3%	15%	680	16%	69%	4,245	Asylum St. Off	740	13%	85%	310	5%	31%	5,865
Asylum Ave. Off	1,770	12%	76%	770	5%	33%	14,715	Broad St. On	550	4%	24%	1,585	13%	67%	12,505
Mainline	7,170	8%	54%	6,775	7%	49%	90,665	Mainline	6,050	7%	46%	6,985	8%	51%	83,935
High St. On	280	5%	52%	565	11%	84%	5,225	High St. Off	260	15%	48%	110	6%	16%	1,740
Trumbull St. On	130	4%	21%	470	15%	80%	3,130	Trumbull St. Off	490	16%	79%	120	4%	20%	3,080
Mainline	6,765	8%	56%	6,110	7%	47%	82,310	Mainline	5,300	7%	44%	6,755	9%	53%	79,115
I-91 NB On	1,095	9%	41%	860	7%	34%	12,225	I-91 NB Off	1,560	7%	59%	1,685	7%	66%	22,760
I-91 SB On	1,565	6%	66%	1,685	7%	64%	24,110	I-91 SB Off	810	7%	34%	940	8%	36%	11,220
Morgan St. Off	945	11%	64%	500	6%	28%	8,275	Morgan St. On	530	5%	36%	1,285	12%	72%	10,440
I-91 NB Off	1,315	9%	57%	1,175	8%	48%	15,220	I-91 SB On	990	7%	43%	1,290	9%	52%	14,030
Bulkeley Bridge	6,490	9%	60%	5,135	7%	44%	69,470	Bulkeley Bridge	4,350	6%	40%	6,515	9%	56%	69,605

Turning Count Volumes

In addition to mainline and ramp traffic counts, turning movement (TM) counts were performed at 78 intersections within the Study Area. Manual turning counts and automated traffic recorder volumes were collected along Hartford's major secondary roads. These count locations are illustrated on Figure 2-15, page 2-50. The count data is included in Appendix A.2.2. Supplemental counts were obtained in December 2013 and April 2014. These TM Counts were used for intersection analyses and calibration of existing conditions microsimulation models (see Section 2.4: Existing Traffic Operations for further detail). In special cases, where TM counts and traffic counts were not comparable, engineering judgment was used to account for any discrepancy between the two sources. A roadway segment can have multiple access points (e.g., mid-block driveways, minor streets, parking garages) and thus, the number of cars departing an upstream intersection may not match the number arriving at the next intersection downstream.

Origin and Destination Data

On freeways, weaving traffic tends to degrade the level of service and reduce capacity. Closely spaced interchanges, left-hand ramps, lane drops, and high numbers of lanes tend to increase the severity of weaving; all of these features are present on I-84 within the Project Study Corridor. Origin-destination data is critical to understanding and modeling traffic flow, especially when evaluating weave conditions.

Using multiple helicopter-mounted cameras hovering in place over Hartford for ninety minutes at a time, as well as two cameras on the ground to record the 'tunnel' downtown, Skycomp recorded 5,400 sets of high-resolution photos for each peak period. A computer algorithm then tracked individual vehicles through the network to produce the required data. Skycomp summarized the origin-destination data into a matrix format for the AM and PM periods in the westbound and eastbound directions. The adjusted origin-destination matrix is included in Appendix A.2.3. The procedure and results are summarized in the Aerial Photo Survey Data Collection Summary Report, included in Appendix A.2.4.

For the majority of off-ramps, knowing the associated origin-destination data and the turning counts at the adjacent intersection is sufficient to develop a microsimulation model. The sole exception within the Study Area is Exit 46, the off-ramps to Sisson Avenue. The two I-84 off-ramps converge 580 feet before the intersection, which results in a significant weave during peak hours. To determine the proportion of turning traffic coming from each ramp, vehicles were manually tracked during both peak hours.

Using the origin-destination matrices from Skycomp and the balanced count profile from CDM Smith, the number of vehicles on each route was calculated. Where mismatches existed between the two data sources, the volumes were held constant and the routes modified as little as possible. The results are summarized in Figure 2-19 through Figure 2-22, pages 2-59 through 2-62. Each figure represents one direction of I-84 trips for one of the two peak periods. All vehicle trips are broken down into six categories: trips that cross Hartford on I-84 (through), trips entering Hartford on I-84 and exiting somewhere in the City (inbound), trips between I-84 and I-91, trips entering the freeway within the City and leaving Hartford on I-84 (outbound), trips between I-91 and other exits within Hartford, and trips that both enter and leave I-84 within Hartford (local). Each category has been assigned a fixed color band with a width proportional to traffic volume. These color bands are identified and described below.

For the morning peak, the Skycomp data extends from 7:30 AM to 9:00 AM, similar to the observed peak from 7:00 AM to 9:00 AM. Some adjustments and interpolation were necessary. Figure 2-19 and Figure 2-20 illustrate how traffic flows primarily into Hartford during the AM peak period. Out of 22,500 trips in the 120-minute interval, 5,700 (25%) are through trips (yellow band), 3,000 (13%) go between I-84 and I-91 (orange band), 5,700 (25%) are inbound trips exiting I-84 within Hartford (blue band), 2,400 (10%) originate in Hartford and exit the city on I-84 (magenta band), 4,300 (19%) go between I-91 and local roads via I-84 (green band), and 1,500 (7%) are purely local trips (black band).

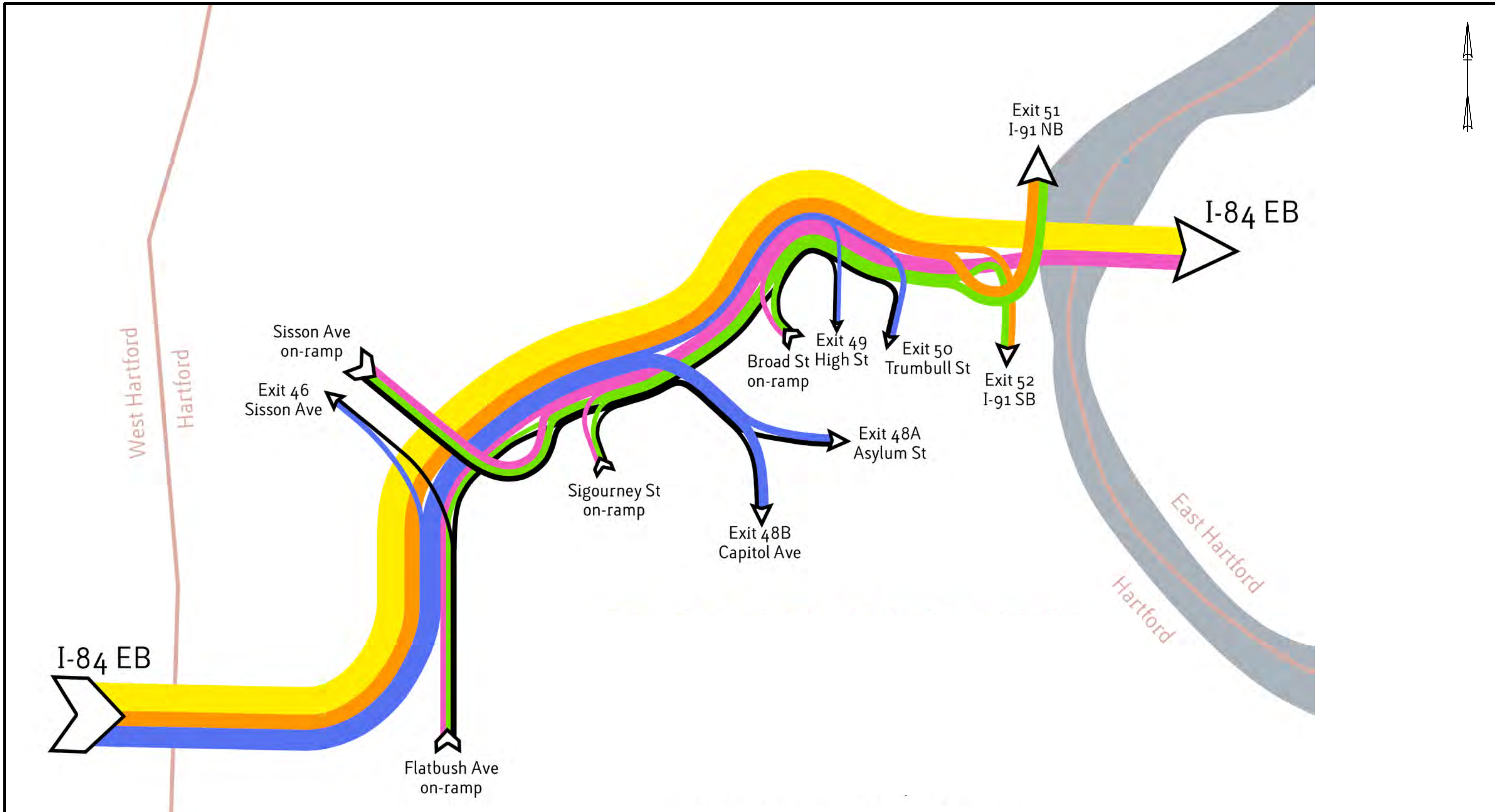
In the afternoon, the trend reverses, and traffic flows primarily out of Hartford, as illustrated in Figure 2-21 and Figure 2-22. For the analysis, Skycomp data was collected between 3:00 PM and 4:30 PM, and was adjusted and interpolated to reflect the afternoon peak period from 3:00 PM to 6:00 PM. Out of 37,700 total trips in the 180-minute interval, 9,800 (26%) are through trips (yellow band), 5,000 (13%) go between I-84 and I-91 (orange band), 4,500 (12%) are inbound trips exiting I-84 within Hartford (blue band), 9,700 (26%) originate in Hartford and exit the city on I-84 (magenta band), 6,300 (17%) go between I-91 and local roads via I-84 (green band), and 2,300 (6%) are purely local trips (black band).

Many of these routes require significant weaving maneuvers due to the presence of left-hand ramps and the lack of lane balance. Even where crossing the freeway is legally prohibited, such as between the Capitol Avenue on-ramp and Exits 47 (Sigourney Street) and 46 (Sisson Avenue), hundreds of motorists make these maneuvers every day. Microsimulation modeling of this weaving behavior is essential to understanding traffic operations on I-84 in Hartford.

2.2.2 Travel Speeds

In order to develop a comprehensive understanding of recurring congestion and to calibrate various models, travel speed data was acquired from INRIX from the year 2012. INRIX operates the largest crowd-sourced data network in the world, tapping into 30 million anonymous GPS and smartphone devices worldwide. This real-time traffic source, including everyday users such as trucks, delivery vans, and other fleet vehicles equipped with GPS locator devices, and everyday smart phone GPS application users, provides reference travel speeds data along the Connecticut roadway network. For analysis, only Tuesdays through Thursdays were used as inputs, and outliers (e.g., holidays, traffic incidents) were removed.

INRIX averages speeds across all lanes, and removes outliers considered excessively high or low. Because of this, if one lane is moving at 50 mph and the adjacent lane is only going 10 mph, INRIX will report a speed of 30 mph, which does not provide a full picture of traffic conditions.



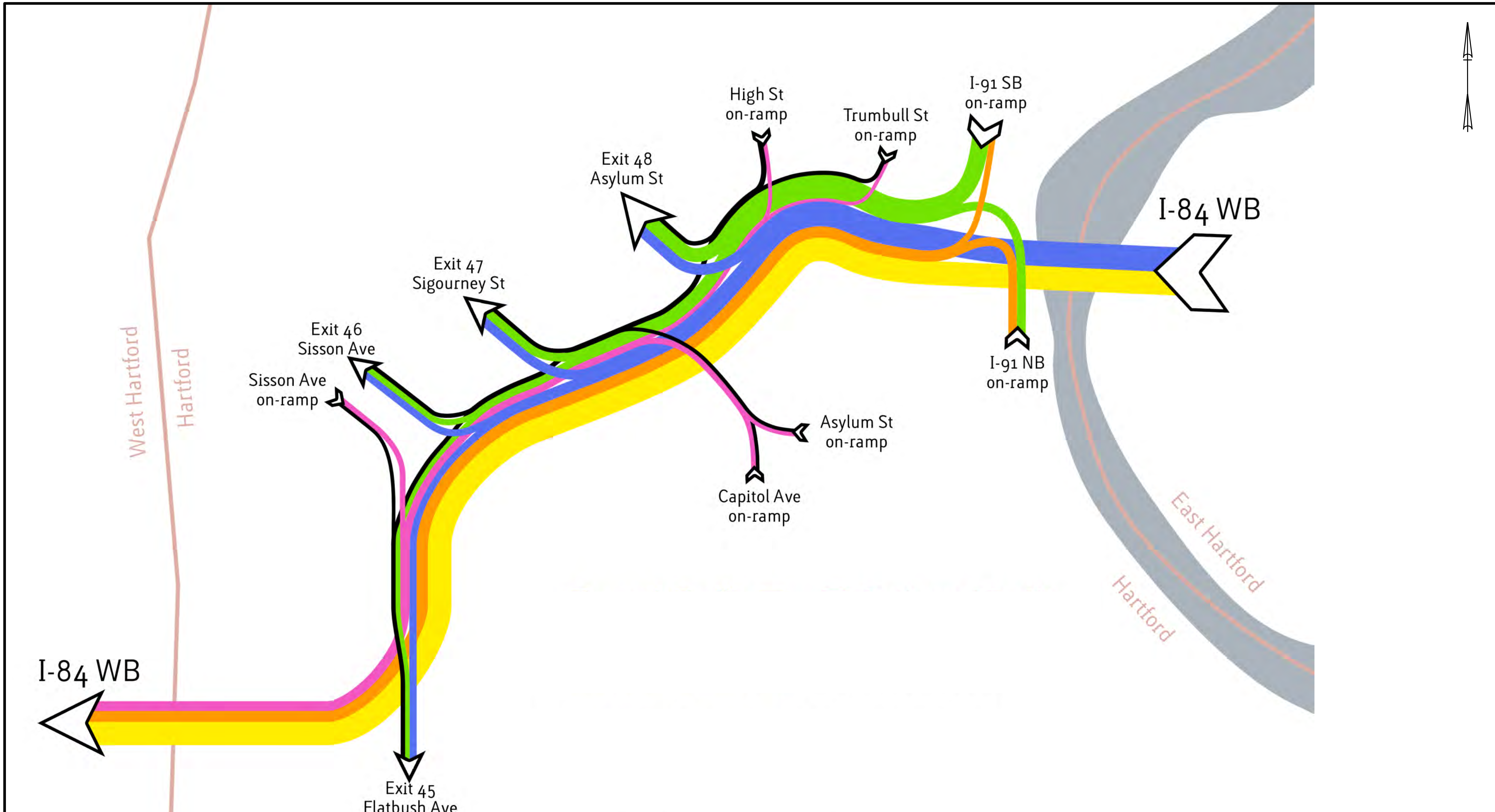
LEGEND

Through Traffic	Outbound Traffic
I-84 to I-91	Local to I-91
Inbound Traffic	Local Traffic

The I-84 Hartford Project

I-84 Origin Destination Map - Eastbound, AM Peak

Date: 5/19/2014	Drawn By: TranSystems	Figure No: 2-19



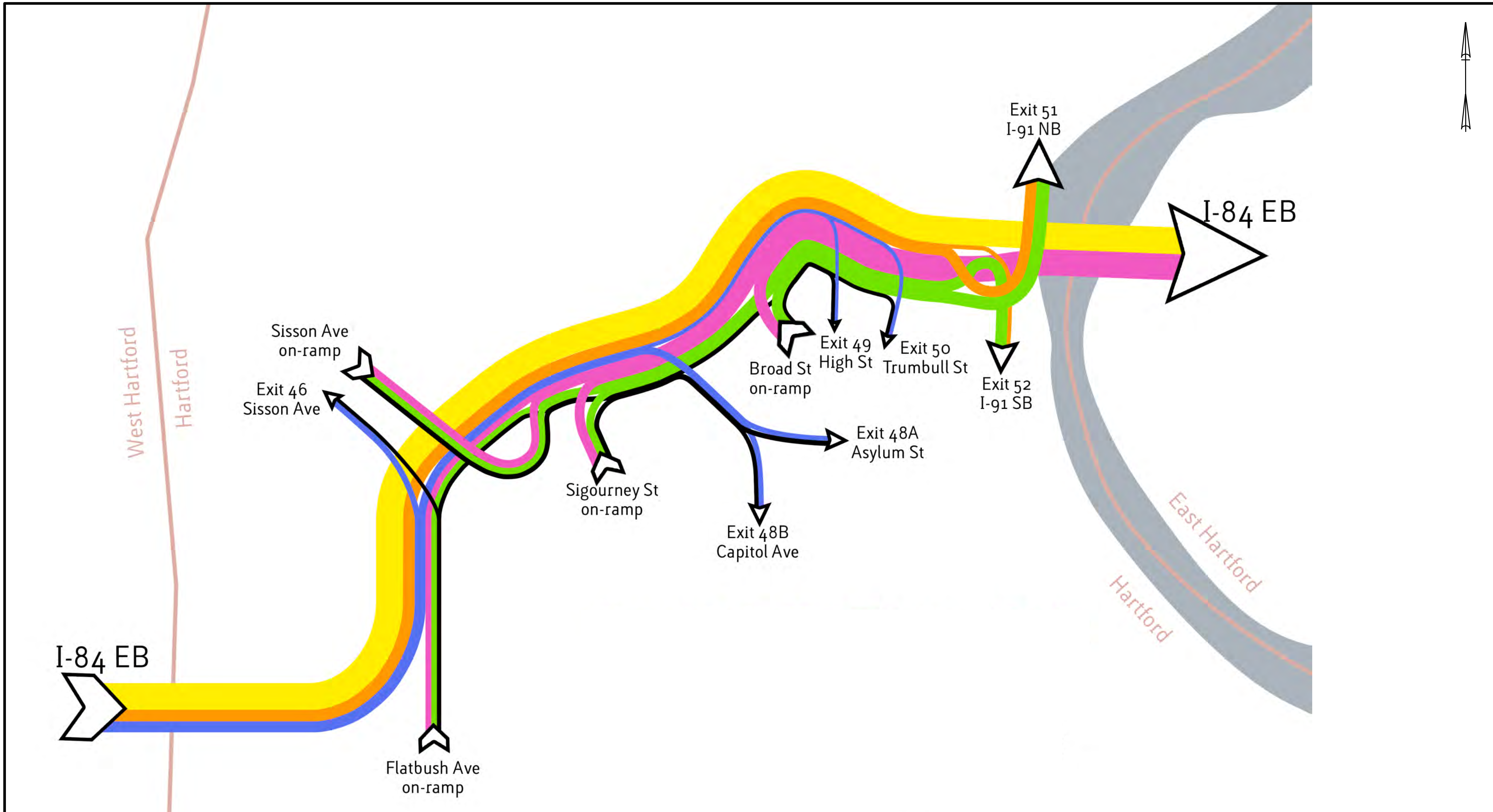
LEGEND

Through Traffic
I-84 to I-91
Inbound Traffic
Outbound Traffic
Local to I-91
Local Traffic

The I-84 Hartford Project

I-84 Origin Destination Map - Westbound, AM Peak

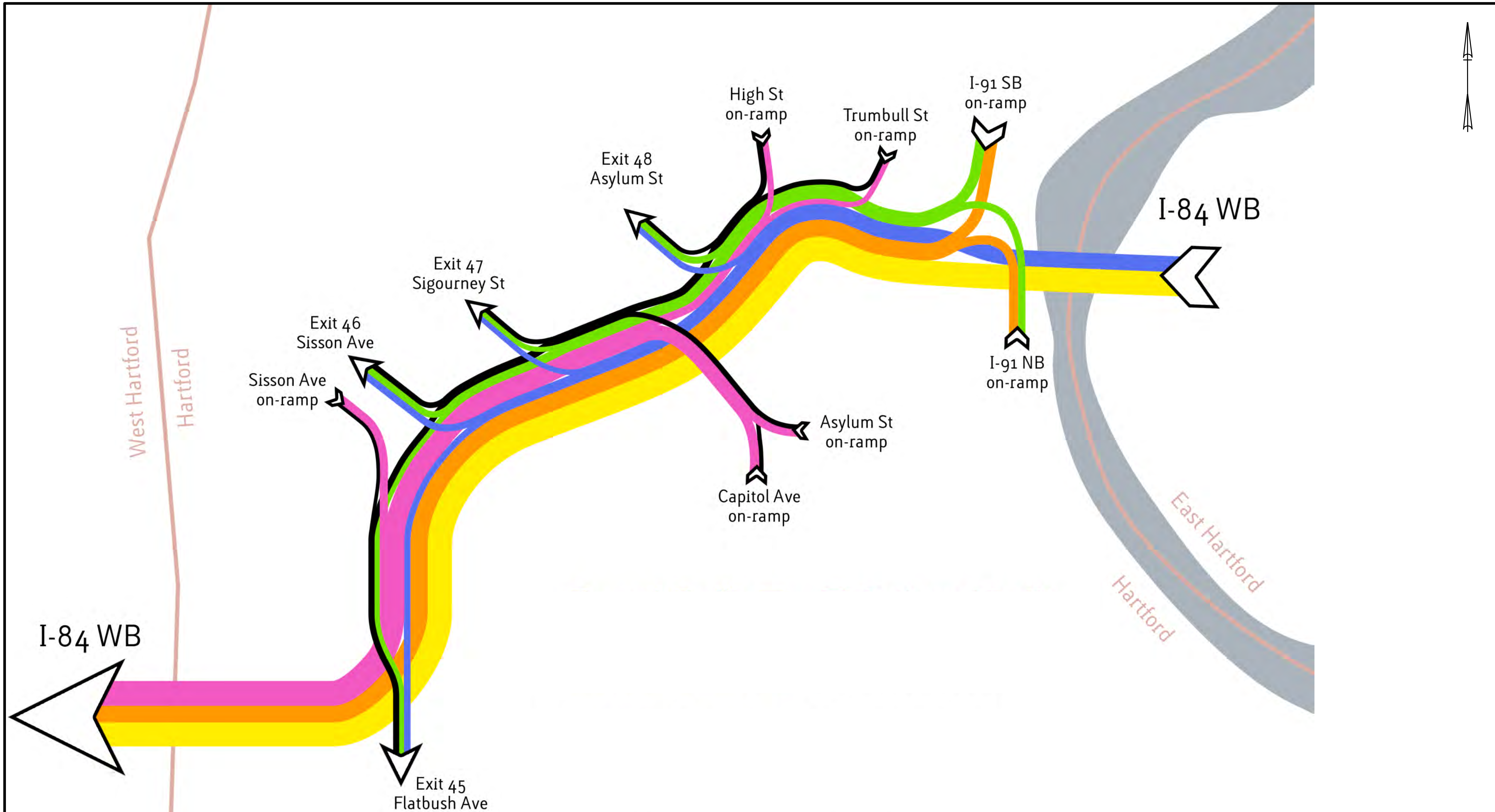
Date: 5/19/2014	Drawn By: TranSystems	Figure No: 2-20



LEGEND

Through Traffic
I-84 to I-91
Inbound Traffic
Outbound Traffic
Local to I-91
Local Traffic

The I-84 Hartford Project		
I-84 Origin Destination Map - Eastbound, PM Peak		
Date: 5/19/2014	Drawn By: TranSystems	Figure No: 2-21



LEGEND

Through Traffic
I-84 to I-91
Inbound Traffic
Outbound Traffic
Local to I-91
Local Traffic

The I-84 Hartford Project

I-84 Origin Destination Map - Westbound, PM Peak

Date: 5/19/2014	Drawn By: TranSystems	Figure No: 2-22

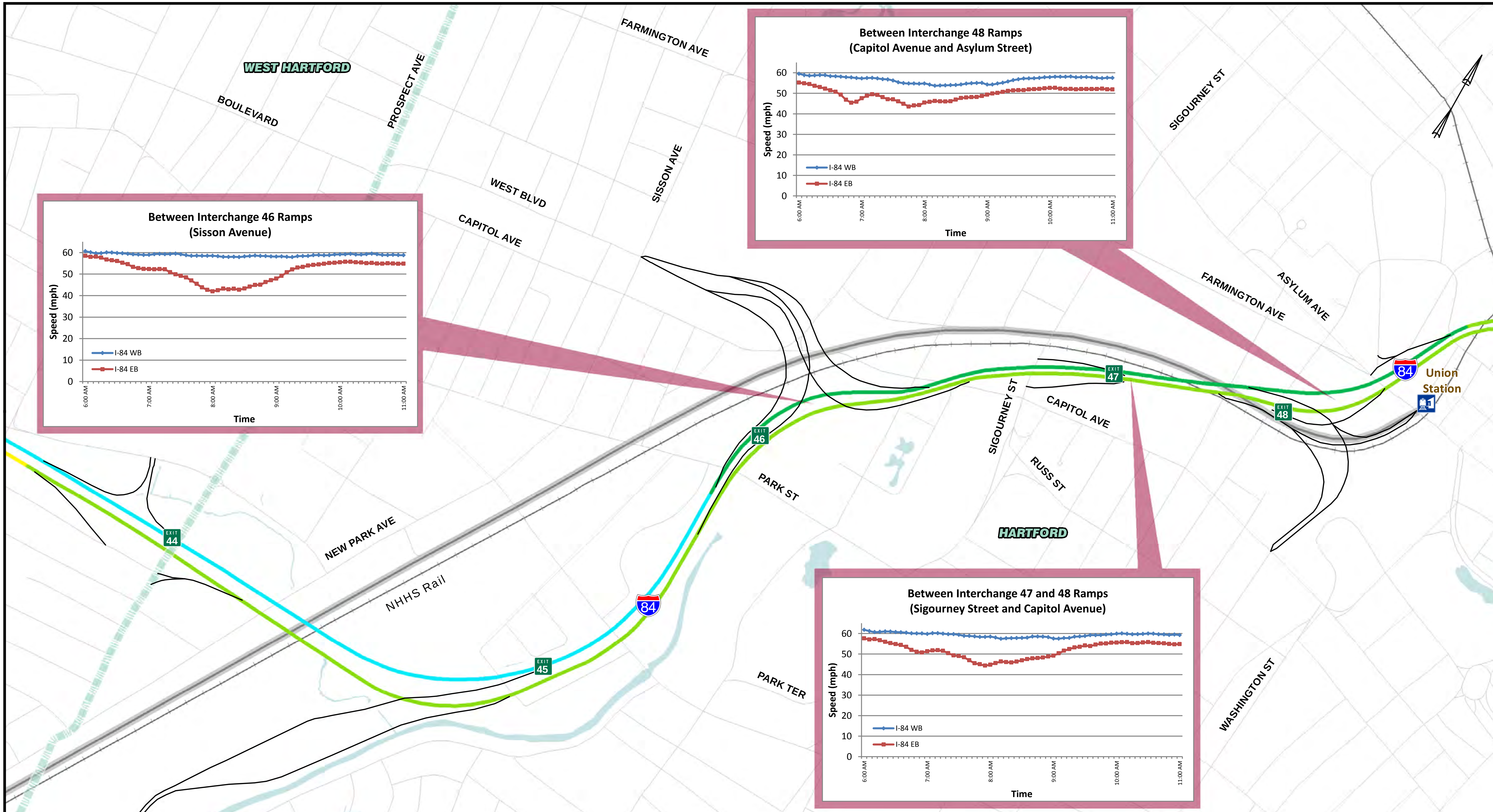
Figure 2-23 through Figure 2-26, pages 2-64 through 2-67, illustrate the average travel speeds during AM and PM peak periods. Average vehicle speeds throughout a typical weekday are presented in graphical heat maps in Appendix A.2.5. The time-of-day variations in travel speed are displayed in graphs in Figure 2-23 through Figure 2-26. The substantial dips in travel speeds and consequential increases in delay are readily visible. It is important to remember that INRIX averages speeds across all lanes. For example, on I-84 westbound just before Exit 47 (Sigourney Street), the right lane is typically congested in the AM peak but adjacent lanes move at normal speed. INRIX reports an average speed of 54 mph here at 8:10 AM; the speed differential across the lanes, though, is significant. The speed limit on I-84 throughout the Project Study Corridor is 50 mph.

Travel speeds on I-84 in Hartford are heavily time-dependent. Speeds tend to stay between 55 and 65 mph during off-peak time periods, generally constrained by the roadway geometry. Segments of I-84 with full acceleration and deceleration lanes and wide shoulders generally have average speeds above 60 mph. On the viaduct itself, where shoulders are very narrow and intense weaving is present, average speeds dip below 60 mph. At the curve just north of Union Station, where the geometry is most constraining, eastbound traffic does not exceed 55 mph on average. Westbound traffic flows at an average speed of 55 mph from the Bulkeley Bridge through the depressed section downtown.

Traffic speeds vary far more during the peak hours than in off-peak hours, due to traffic congestion. Because of the fine gradations afforded by the data, it is possible to track how congestion affects different roadway segments over time. On I-84 eastbound in the morning peak, average speeds around the Union Station curve hover around 45 mph from 6:45 AM to 8:00 AM. Speeds in West Hartford are even slower. Half a mile before Exit 44 (Prospect Avenue), traffic moves slower than 40 mph between 7:30 AM and 8:50 AM, to as slow as 24 mph at 8:00 AM. Farther downstream, along the weaving section between the Flatbush Avenue on-ramp and the Exit 46 (Sisson Avenue) off-ramp, average speeds stay below 50 mph between 7:30 AM and 9:10 AM with a minimum of 36 mph at 8:00 AM.

Westbound commuters see even worse traffic in the morning. Average speeds first dip below 50 mph in the short weaving section between the High Street on-ramp and Exit 48 (Asylum Street) at 6:55 AM and remain below 50 mph until 9:40 AM. The majority of congestion occurs east of the Connecticut River. At 8:00 AM, travel speeds are below 45 mph between Exit 57 (CT 15) and Exit 48 (Asylum Street), a distance of 2.8 miles. Traffic moves slowest between Exit 56 (Governor Street) and the Bulkeley Bridge: below 20 mph between 7:45 AM and 8:30 AM.

In contrast to the morning peak, Hartford itself bears the brunt of afternoon congestion. In the eastbound direction, speeds first drop below 45 mph at 3:10 PM between the Sisson Avenue on-ramp and Exit 48A-B (Capitol Avenue and Asylum Street). This heavy weave segment remains congested for over three hours, until 6:30 PM. The worst congestion occurs at 5:30 PM with sub-45 mph average speeds spanning the entirety of Hartford's city limits. In the most congested segment of the freeway, eastbound between the Sigourney Street on-ramp and the Capitol Avenue/Asylum Street off-ramp, average speeds drop as low as 13 mph at 5:30 PM.



LEGEND

AM Peak Average Speeds

- <10 mph
- 10-20 mph
- 20-30 mph
- 30-40 mph
- 40-50 mph
- 50-60 mph
- >60 mph

- Railroad
- CTfastrak
- Town/City Limit
- I-84 Exit #
- Union Station
- Park
- Water
- Ramp

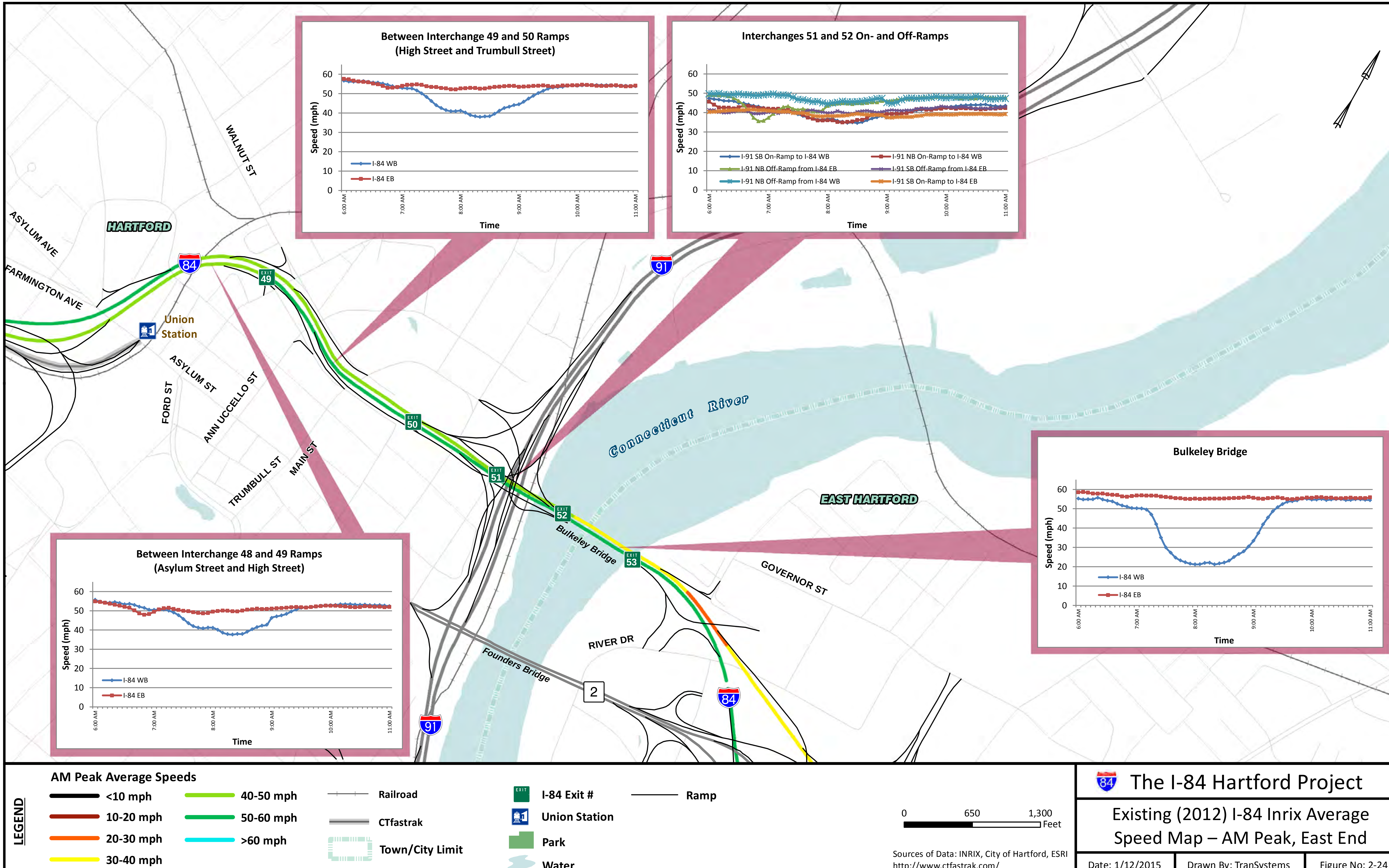
0 650 1,300 Feet

Sources of Data: INRIX, City of Hartford, ESRI
http://www.ctfastrak.com/

The I-84 Hartford Project

Existing (2012) I-84 Inrix Average Speed Map – AM Peak, West End

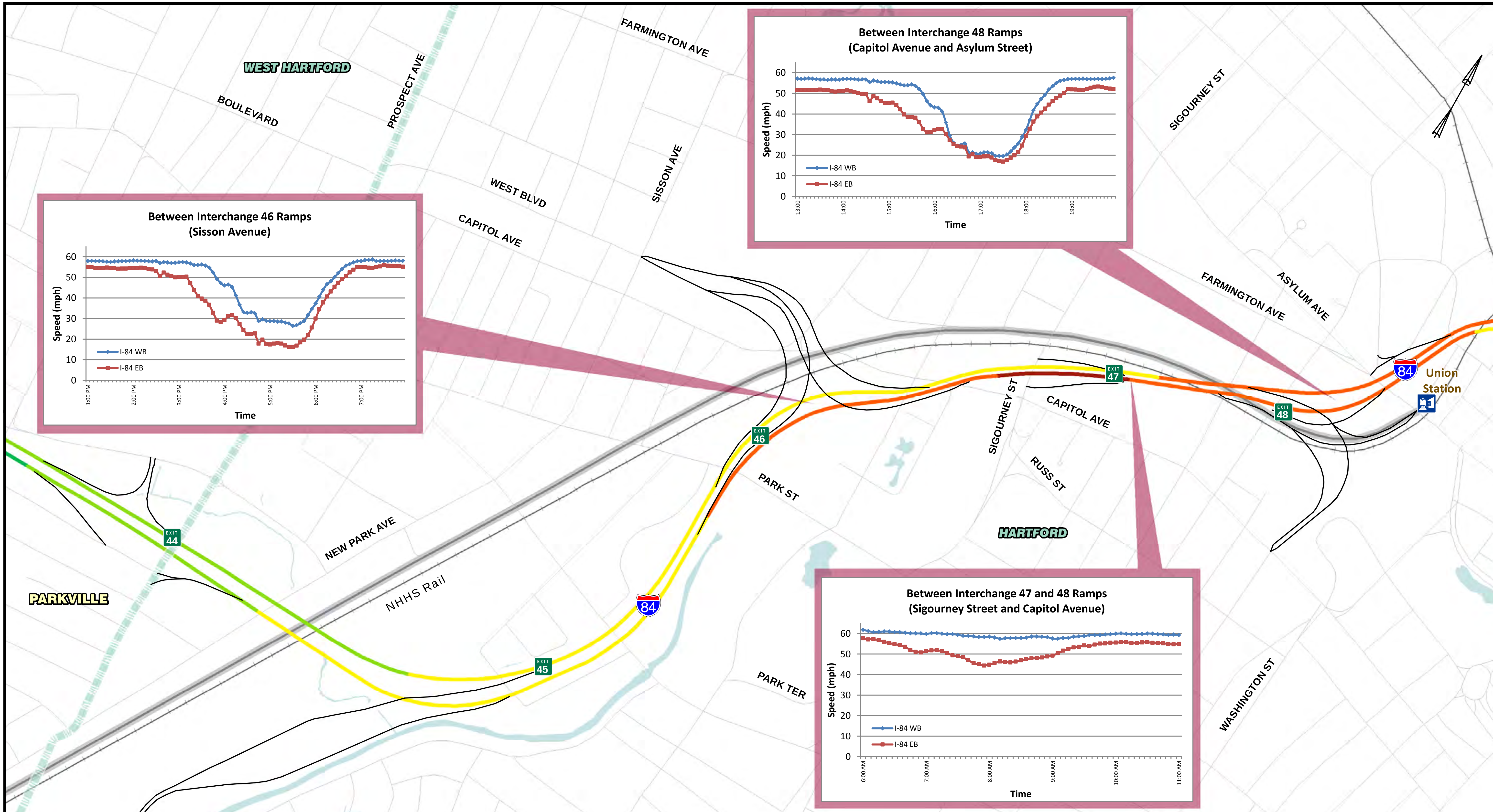
Date: 1/12/2015	Drawn By: TranSystems	Figure No: 2-23



The I-84 Hartford Project

Existing (2012) I-84 Inrix Average Speed Map – AM Peak, East End

Date: 1/12/2015 | Drawn By: TranSystems | Figure No: 2-24



LEGEND

PM Peak Average Speeds

- <10 mph
- 10-20 mph
- 20-30 mph
- 30-40 mph
- 40-50 mph
- 50-60 mph
- >60 mph
- Railroad
- CTfastrak
- Town/City Limit
- I-84 Exit #
- Union Station
- Park
- Water
- Ramp

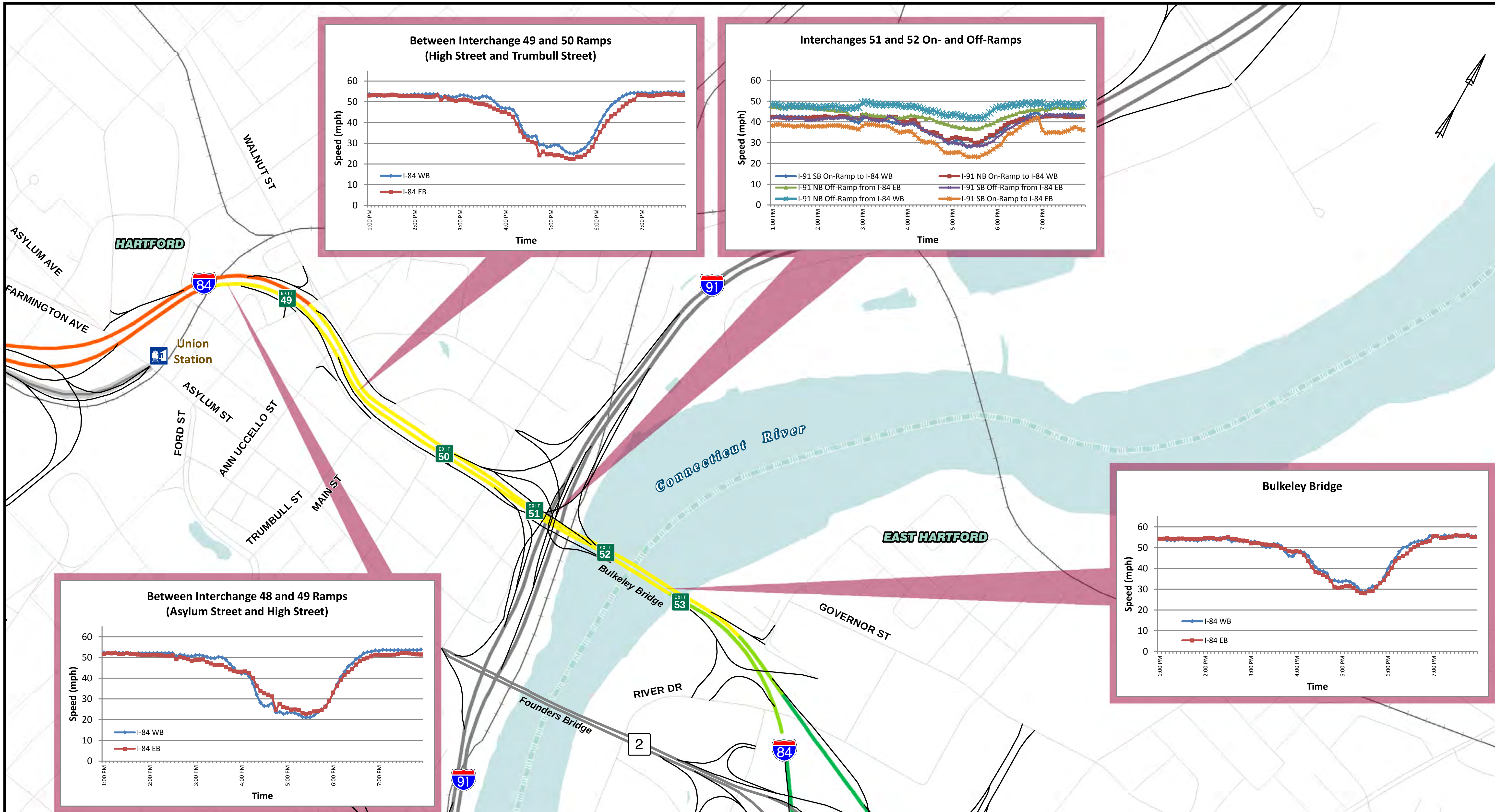
0 650 1,300 Feet

Sources of Data: INRIX, City of Hartford, ESRI
http://www.ctfastrak.com/

The I-84 Hartford Project

Existing (2012) I-84 Inrix Average Speed Map – PM Peak, West End

Date: 1/12/2015	Drawn By: TranSystems	Figure No: 2-25



LEGEND

PM Peak Average Speeds

- <10 mph
- 10-20 mph
- 20-30 mph
- 30-40 mph
- 40-50 mph
- 50-60 mph
- >60 mph
- Railroad
- CTfastrak
- Town/City Limit
- I-84 Exit #
- Union Station
- Park
- Water
- Ramp

0 650 1,300 Feet

Sources of Data: INRIX, City of Hartford, ESRI
http://www.ctfastrak.com/

The I-84 Hartford Project

Existing (2012) I-84 Inrix Average Speed Map – PM Peak, East End

Date: 1/12/2015	Drawn By: TranSystems	Figure No: 2-26

On I-84 westbound, the epicenter of congestion is the segment between the High Street on-ramp and the off-ramp to Exit 48 (Asylum Street). Speeds here hover around 50 mph at midday, then drop below 45 mph at 3:50 PM and stay there until 6:20 PM. From 5:20 PM to 5:30 PM, traffic flows through downtown Hartford at 20 – 25 mph with sub-45 mph average speeds extending out from the Exit 56 (Governor Street) off-ramp to the on-ramp from CT 173 (South Main Street) in West Hartford.

2.2.3 Supplemental Data Collection

The City of Hartford's Department of Public Works provided signal plans and timings for most of their signalized intersections within the Study Area. Each intersection to be modeled was observed in the field during both peak periods including signal phasing, lane use, and turn restrictions, as well as counting queue lengths on each approach for model calibration.

Traffic-relevant road geometry was collected using online mapping services, i.e., Google Maps, Bing Maps, and Pictometry Online. This includes lane use, storage length, stop bar location, elevation, on-street parking, and pedestrian and bicycle facilities. Street-level imagery from Google and Bing was used to gather information on speed limits, turn restrictions, guide signs, and bus stop locations. On I-84, construction plans contained detailed elevations and grades for use in the microsimulation model.

2.2.4 Heavy Vehicles

Heavy vehicle volumes were measured at six locations along I-84: in Farmington, between CT 4 and CT 9; at the West Hartford-Hartford town line; in Hartford, between Sigourney Street and Flower Street; on the Bulkeley Bridge; in East Hartford, between CT 15 and I-384; and in Vernon, between CT 30 and Tunnel Road. These one-day counts classified vehicles as cars, medium heavy vehicles, and large heavy vehicles. Additional counts were taken on many local roads throughout the Study Area, with more detailed classifications. The full results are available in Appendix A.2.16.

In the Project Study Corridor, heavy vehicle volumes tend to peak in the middle of the day, between the morning and evening rush hours. The percentage of heavy vehicles during the peak hours drops as low as 3%. The overall heavy vehicle volumes fall at night, but since car volumes drop off by a much greater amount, the heavy vehicle percentage is universally highest between 2:00 am and 4:00 am. The magnitude of this early morning peak varies significantly throughout the region. In downtown Hartford, the proportion of heavy vehicles reaches 30% at 3:00 am. For comparison, in Vernon, the heavy vehicle fraction reaches 66% during the same time. While total volumes are significantly higher in Hartford than in Vernon, the truck volumes are almost identical. This suggests that heavy vehicle traffic is much more likely to take longer trips and also more likely to be through traffic. Heavy vehicle volumes are split approximately evenly between eastbound and westbound throughout the day. This is consistent with Hartford being a major destination for commuter traffic but not for heavy vehicles, which enter and leave the city at roughly the same rate throughout the day.

Breaking heavy vehicles down into medium heavy and large heavy vehicle classifications offers additional insights. In Hartford, during the daytime, heavy vehicle volumes are split evenly between the two. At night, large heavy vehicles comprise the vast majority of heavy vehicles. The proportion of large heavy vehicles increases outside the city: in Vernon, during the daytime, 70% of heavy vehicle traffic is large heavy. This leads to the conclusion that medium heavy trucks are used for short trips in and around Hartford, primarily during the daytime, while large heavy trucks are used for long-haul, primarily through, trips.

2.2.5 I-84 Spot Speed Analysis

A spot speed analysis was conducted within the study area to determine the 85th percentile free-flow vehicular speeds on I-84. Data was collected from four locations: I-84 at Park Street, I-84 at Broad Street, I-84 between Asylum Street and High Street, and I-84 over the Connecticut River (Bulkeley Bridge). Data collection locations are illustrated in Figure 2-27, page 2-71. The outer locations were selected to establish an understanding of vehicular speeds entering and exiting the Project Study Corridor. Data was collected on dry pavement conditions from 10 AM to 2 PM on March 11th and March 12th, 2015. The time period was selected after review of travel speed data from INRIX to best approximate free-flow conditions. The data was collected using mast-mounted microwave detectors.

Data

Speed and volume data was collected in one minute intervals for each travel lane. The speed data included average speeds and 85th percentile speeds. There were some locations where the raw data contained outlier results and were, therefore, removed from the data set. These anomalies included one minute intervals where speeds were uncharacteristically low, had duplicate time entries, or were repeated for consecutive intervals. In some cases the filtered data results were not significantly different from the unfiltered data. However, there were some locations where the filtered data was 6-8 mph higher than the unfiltered data. In all cases, the filtered data sets consisted of over 200 time intervals, which is a sufficient sample size for representative results.

Due to the nature of the corridor, using data from travel lanes influenced by ramp traffic would not yield true free-flow vehicular speeds. This is due to the friction created between the vehicles entering and exiting the highway. Therefore, the inside (median) lanes were used to determine the overall 85th percentile speeds at each location.

Results

The speed data indicates there is a moderate speed differential between the outer limits of the study area and the anticipated project construction limits. On the west end of the study area, eastbound traffic entering the anticipated project construction limits has an 85th percentile speed of 70.9 mph. On the east end of the study area, westbound traffic entering the anticipated project construction limits has an 85th percentile speed of 66.0 mph. Whereas, eastbound and westbound traffic at the horizontal curve between Asylum Street and High Street have 85th percentile speeds of 57.3 mph and 59.5 mph, respectively. The average 85th percentile speed within the anticipated construction limits is approximately 60 mph. The posted speed limit throughout the study area is 50 mph. The results of the spot speed study are presented in Table 2-13, below.

Table 2-13: I-84 Spot Speed Study Results

I-84 Location	Posted Speed Limit	Calculated Speed[1]	85th Percentile Speed
Park Street	50 mph	Eastbound: 44 mph[2] Westbound: 44 mph[2]	Eastbound: 70.9 mph Westbound: 69.5 mph
Broad Street	50 mph	Eastbound: 35 mph[2] Westbound: 37 mph[3]	Eastbound: 60.8 mph Westbound: 63.4 mph
Curve between Asylum St./Broad St.	50 mph	Eastbound: 35 mph[2] Westbound: 39 mph[2]	Eastbound: 57.3 mph Westbound: 59.5 mph
Bulkeley Bridge	50 mph	Eastbound: 50+ mph[4] Westbound: 50+ mph[4]	Eastbound: 63.6 mph Westbound: 66.0 mph

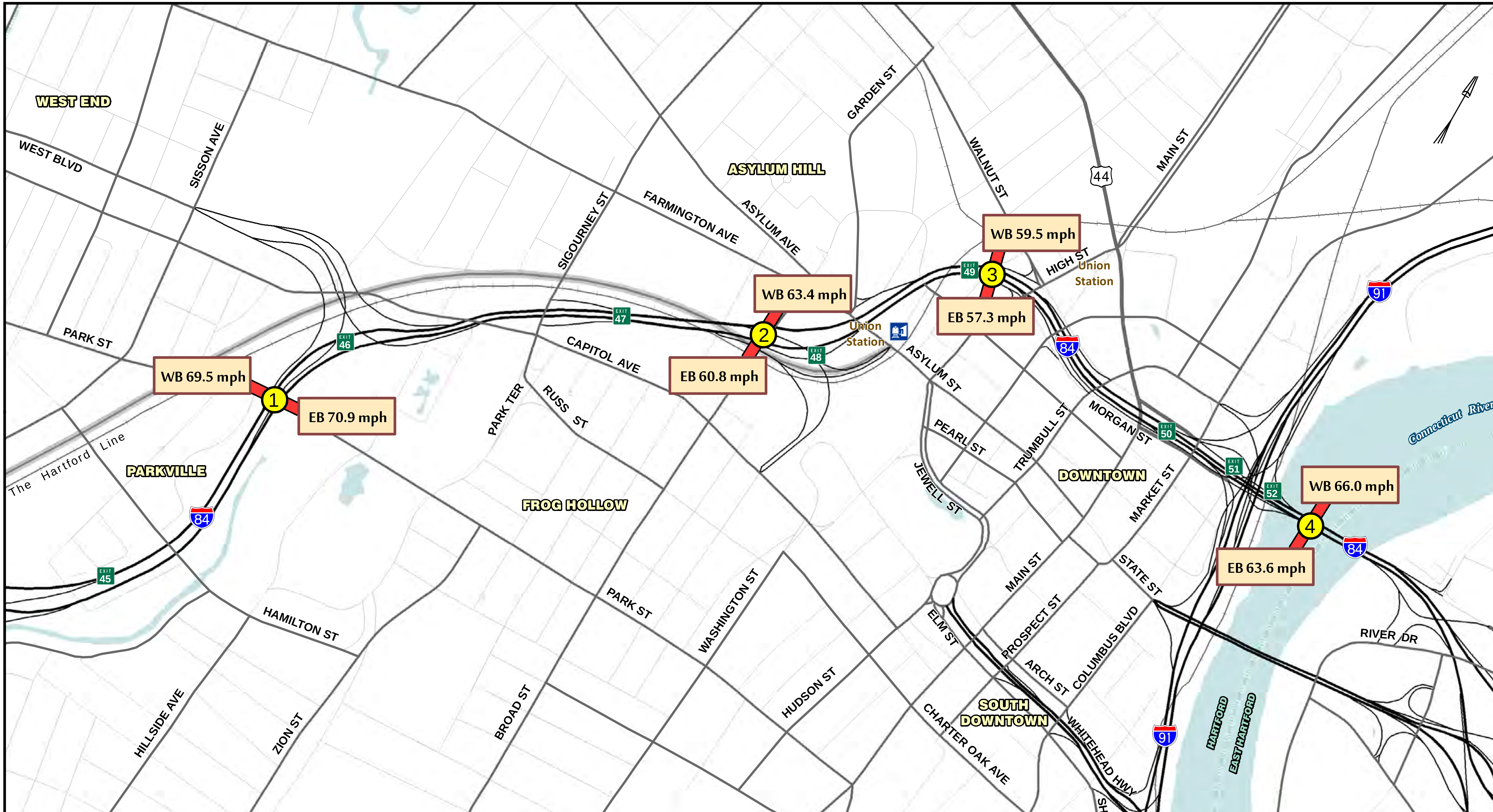
1) Based on design criteria (see Section 2.5, Roadway Geometry Review)
2) Speed limited by stopping sight distance (horizontal sightline)
3) Speed limited by stopping sight distance (vertical sag curve)
4) Horizontal tangent section not limited by stopping sight distance or vertical geometry

Analysis

Observed 85th percentile speeds are significantly higher than the calculated speeds for the existing highway geometry. Since the majority of freeways within the region are posted for 65 mph, drivers typically expect to travel safely at speeds in that range. However, due to the geometry and substandard shoulder widths within the corridor, driver expectations for safe traveling speed may be higher than the corridor provides and could, therefore, lead to higher crash rates.

Recommended I-84 Design Speed for Alternatives Development

The CTDOT Highway Design Manual recommends a range of design speeds between 50 and 55 mph for an Urban Freeway (Built Up) roadway classification (Chapter 5, Figure 5A). There is also guidance on selecting a design speed based on 85th percentile speed data (Chapter 2-4.01 Design Speed, Figure 2-4A). For an 85th percentile speed of 60 mph, the recommended design speed is between 55 and 60 mph.



LEGEND

I-84 85th Percentile Speeds - Study Locations

1 Location No. 1 (Park Street)
2 Location No. 2 (Broad Street)
3 Location No. 3 (Curve)
4 Location No. 4 (Bulkeley Bridge)

Railroad
CTfastrak
Town/City Limit

I-84 Exit #
Union Station
Water

0 500 1,000 Feet

Sources of Data: City of Hartford, ESRI
http://www.ctfastrak.com/

The I-84 Hartford Project

I-84 85th Percentile Speeds

Date: 7/23/2015	Drawn By: TranSystems	Figure No: 2-27

2.3 Crash Data and Safety Analysis

Crash data was obtained from the Connecticut Department of Transportation (CTDOT) for the approximately 2.88 mile section of I-84 in Hartford from the West Hartford town line (Milepost 59.30) to the downtown Hartford platform (Trumbull Street and Main Street over I-84, Milepost 62.18). The data covers the 35 month period from January 31, 2009 to December 31, 2011 and includes all crashes that resulted in a death, injury or where the damage to the property of one individual was $1,000 or more. Crashes occurring on the I-84 mainline, I-84 interchange ramps, and I-84 interchange ramp terminal intersections are analyzed separately within this section. Having not yet defined the preferred alternative, the impacts of the I-84 Hartford Project on the local street network cannot be determined.

2.3.1 I-84 Mainline

During this period, a total of 1,832 crashes were reported on this segment of I-84, including 2 fatalities and 423 crashes that resulted in 611 injuries. This translates to an average rate of 1.72 crashes per day. A review of the overall corridor crash data shows that approximately 77 percent of reported crashes resulted in property damage alone, while the remaining 23 percent involved an injury or a fatality. It is clear that the frequency of crashes on the corridor contributes to significant non-recurring traffic delays within the Project Study Corridor. The lack of proper shoulders and substandard roadway geometry, as identified in Section 2.5: Roadway Geometry Review, further add to the delay as vehicles involved in crashes are unable to pulloff the travel lanes and instead effectively close the travel lane until the crash-site is cleared.

The rate at which crashes occur is measured relative to the length and amount of traffic carried by the segment in question. An analysis was conducted to determine the number of crashes per 100 million vehicle miles traveled on each section of the corridor, as well as for the corridor overall. In total, the overall crash rate was 452 crashes per 100 million vehicle miles traveled (HMVMT). Directionally, crashes occur at a higher rate in the eastbound direction (553 crashes per HMVMT) than in the westbound direction (359 crashes per HMVMT). These rates are comparably higher than the 2009 average crash rate of 314.2 crashes per HMVMT for all State roads in Connecticut. Table 2-14, following, summarizes the crashes and crash rates by section of highway for I-84 in the eastbound direction while Table 2-15, following, summarizes the crashes in the westbound direction. Crash rates by segment are illustrated Figure 2-28, page 2-75.

Table 2-14: I-84 Eastbound Mainline Crash Summary

Segment From	Segment To	Crashes	Crash Rate per 100 Million Veh. Miles	Fatalities	Injuries	Percent Crashes w/ Injuries
Interchange 44 on-ramp	Interchange 45 on-ramp	34	122	0	15	32.4%
Interchange 45 on-ramp	Interchange 46 off-ramp	157	396	0	46	21.7%
Interchange 46 off-ramp	Interchange 46 on-ramp	113	364	0	50	29.2%
Interchange 46 on-ramp	Interchange 47 on-ramp	31	205	0	12	12.9%
Interchange 47 on-ramp	Interchange 48 off-ramp	241	1,149	0	74	23.7%
Interchange 48 off-ramp	Interchange 48 on-ramp	104	578	0	38	23.1%
Interchange 48 on-ramp	Interchange 49 off-ramp	157	739	0	33	18.5%
Interchange 49 off-ramp	Interchange 50 off-ramp	149	1,119	0	42	22.8%
Interchange 50 off-ramp	Interchange 51 off-ramp	90	1,247	1	30	30.0%
I-84 Eastbound Total		**1,076**	**553**	**1**	**340**	**23.5%**

Table 2-15: I-84 Westbound Mainline Crash Summary

Segment From	Segment To	Crashes	Crash Rate per 100 Million Veh. Miles	Fatalities	Injuries	Percent Crashes w/ Injuries
Interchange 51/52 on-ramps	Interchange 50 on-ramp	15	167	0	7	33.3%
Interchange 50 on-ramp	Interchange 49 on-ramp	95	589	0	39	16.8%
Interchange 49 on-ramp	Interchange 48 off-ramp	127	1,280	0	45	26.0%
Interchange 48 off-ramp	Interchange 48 on-ramp	102	409	0	32	22.5%
Interchange 48 on-ramp	Interchange 47 off-ramp	130	476	0	57	27.7%
Interchange 47 off-ramp	Interchange 46 off-ramp	103	409	0	26	20.4%
Interchange 46 off-ramp	Interchange 46 on-ramp	68	301.1	1	38	26.5%

Table 2-15 (ctd.): I-84 Westbound Mainline Crash Summary

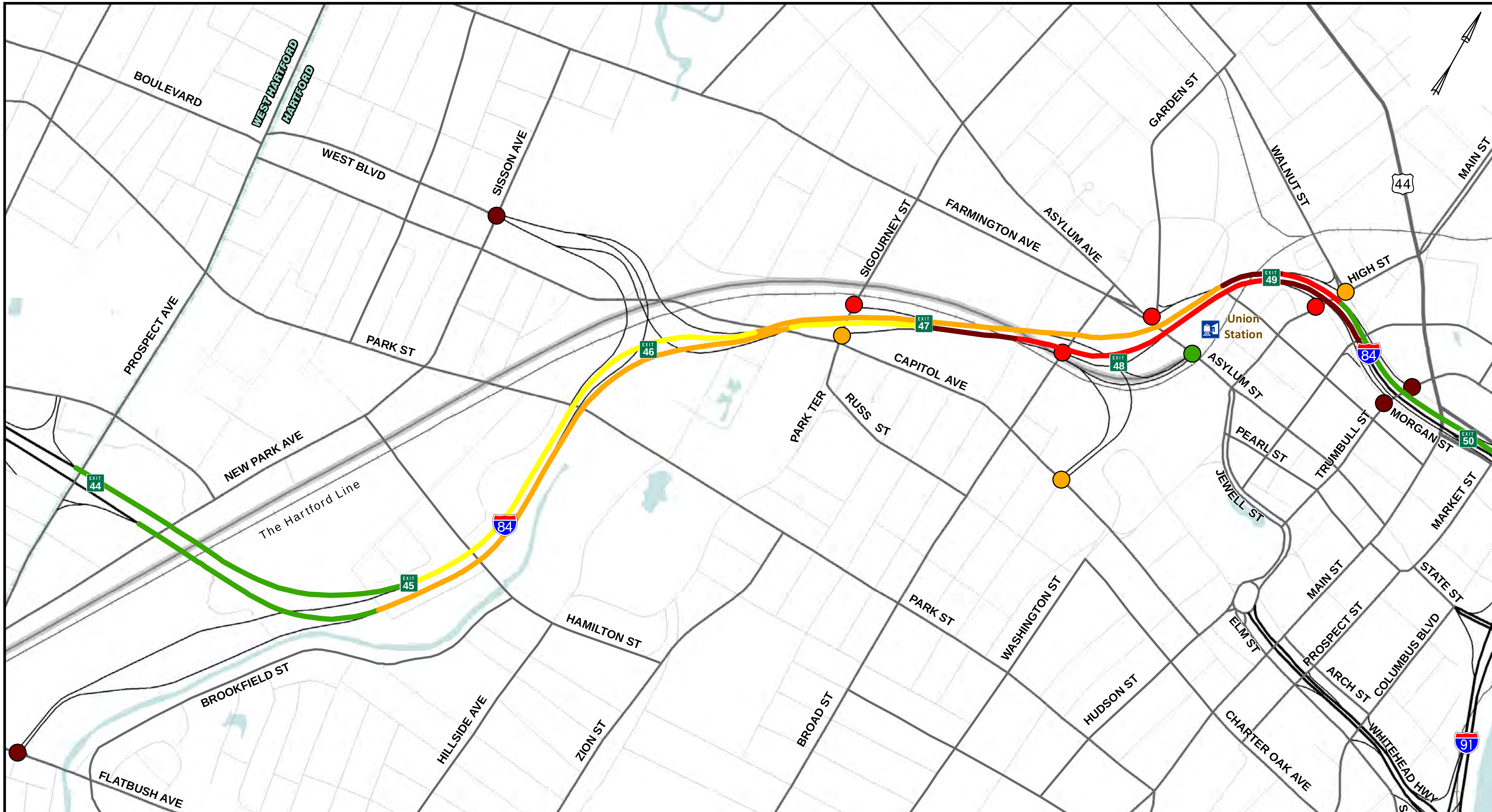
Segment From	Segment To	Crashes	Crash Rate per 100 Million Veh. Miles	Fatalities	Injuries	Percent Crashes w/ Injuries
Interchange 46 on-ramp	Interchange 45 off-ramp	71	206.8	0	20	16.9%
Interchange 45 off-ramp	West Hartford Town Line	45	109.7	0	7	13.3%
I-84 Westbound Average		**756**	**359**	**1**	**271**	**22.5%**
I-84 Total Both Directions		**1,832**	**452**	**2**	**611**	**23.1%**

Four sections of I-84 in Hartford have been identified as having exceptionally high crash rates:

- The I-84 westbound segment between the Interchange 49 on-ramp (High Street) and the Interchange 48 off-ramp. 1,280 crashes per HMVMT occurred on this 0.11 mile segment.
- The I-84 eastbound segment between the Interchange 50 off-ramp (Trumbull Street) and the Interchange 51 off-ramp (I-91 Northbound). 1,247 crashes per HMVMT occurred on this 0.09 mile segment.
- The I-84 eastbound segment between the Interchange 47 on-ramp (Sigourney Street) and the Interchange 48 off-ramp (Capitol Avenue/Asylum Street). 1,149 crashes per HMVMT occurred on this 0.25 mile segment.
- The I-84 eastbound segment between the Interchange 49 off-ramp (High Street) and the Interchange 50 off-ramp (Trumbull Street). 1,119 crashes per HMVMT occurred on this 0.16 mile segment.

The crash data provided by CTDOT also includes information regarding the severity and type of crashes that occurred along this segment of I-84. The data indicates that approximately 0.6 percent of the crashes resulted in an incapacitating injury; approximately 6 percent resulted in a non-incapacitating but evident injury and approximately 17 percent with possible injuries. Approximately 50 percent of the crashes on the corridor were identified as rear-end collisions; 26 percent were sideswipe – same direction collisions; and 17 percent were fixed object collisions. The high rate of rear-end crashes suggests that congestion may adversely influence safety on the corridor. Crashes on mainline I-84 are illustrated by type in Figure 2-29, page 2-76.

A review of the contributing factors for crashes within the segment indicates that approximately 44 percent of the crashes were caused by vehicles following too close. 21 percent were caused by an improper lane change, 12 percent were due to driver losing control, and 8 percent were due to speeds too fast for conditions. In addition, it was found that 3 percent of the crashes were caused by failure to grant the right of way, 1.8 percent were due to violation of traffic control, 1.6 percent were caused by driving under the influence, 1.4 percent were caused by an animal or foreign object in the road, and 1.0 percent were caused by slippery surface conditions. The remaining contributing factors were either unknown or for a variety of other reasons. The contributing factors for I-84 mainline crashes



LEGEND

Ramp Intersection Crash Rate (per 1,000,000 Entering Vehicles)
- 0.10
- 0.11 - 0.25
- 0.26 - 0.50
- 0.51 - 0.75
- 0.76 - 1.00+

I-84 Mainline Crash Rate (per 100,000,000 VMT)
- 109.7 - 200.0
- 200.1 - 315.0
- 315.1 - 500.0
- 500.1 - 750.0
- 750.1 - 1000+

- Railroad
- CTfastrak
- Town/City Limit
- I-84 Exit #
- Union Station
- Water

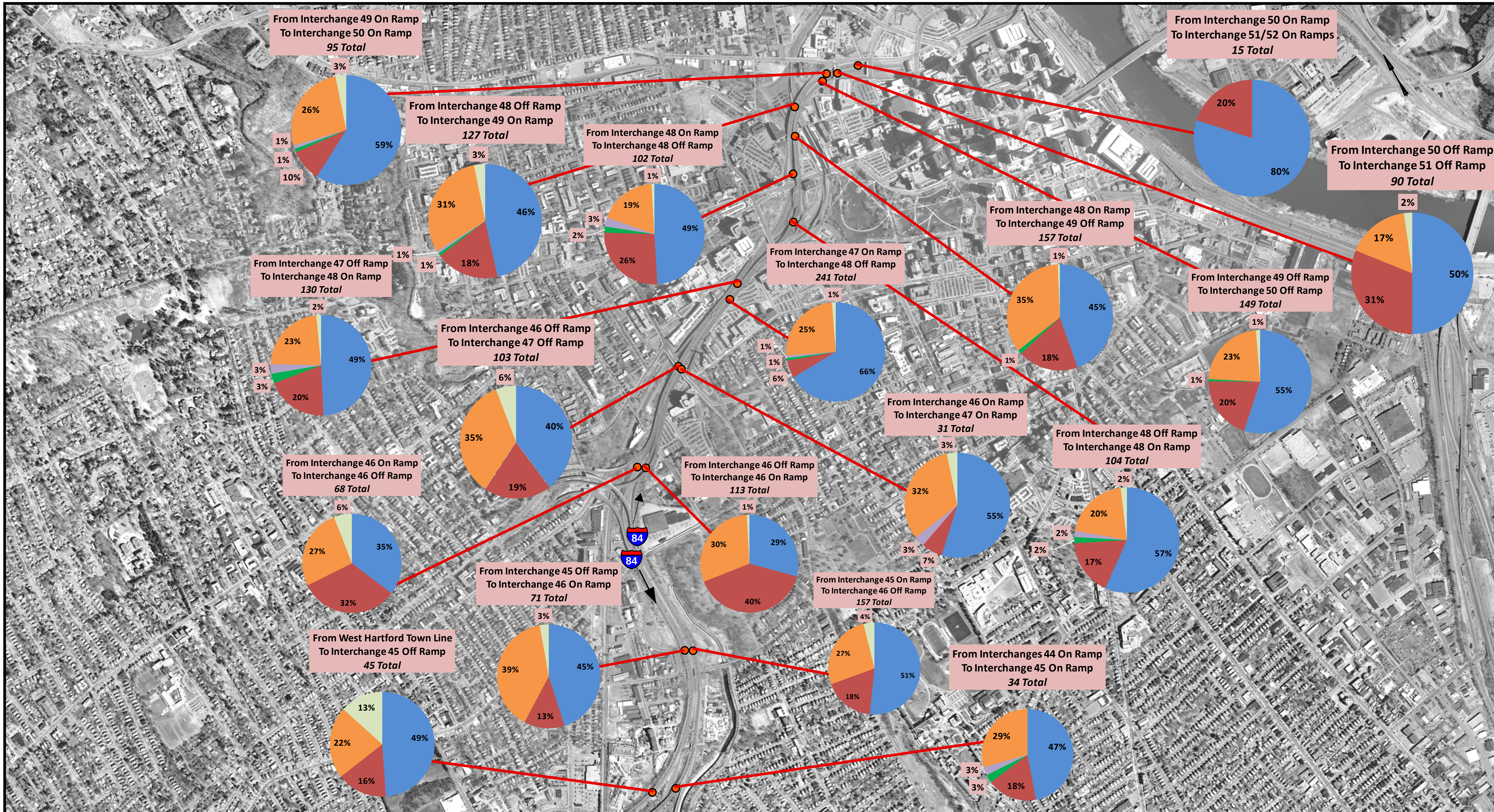
0 500 1,000 Feet

Sources of Data: City of Hartford, ESRI
http://www.ctfastrak.com/

The I-84 Hartford Project

I-84 Crash Rates

Date: 7/17/2015 | Drawn By: TranSystems | Figure No: 2-28



LEGEND

Accident Types
- Rear End
- Fixed Object
- Right Angle
- Turning
- Sideswipe
- Other

0 1,500 3,000 Feet

Sources of Data: DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Get Mapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

The I-84 Hartford Project

I-84 Mainline Crash Type Map

Date: 7/17/2015	Drawn By: Parsons Brinckerhoff	Figure: 2-29

2.3.2 I-84 Interchange Ramps

Crash data for I-84 interchange ramps between Interchange 45 (Flatbush Avenue) and the western half of Interchange 50 (Trumbull Street) was also obtained from CTDOT for the same January 31, 2009 to December 31, 2011 timeframe. Table 2-16, following, and Table 2-17, page 2-79, document the number and severity of crashes for eastbound and westbound interchange ramps. The ramp with the highest crash total was found to be the Interchange 48B eastbound off-ramp (Capitol Avenue) with 49 crashes. The next highest crash ramp locations were the I-84 Interchange 48B westbound on-ramp (Capitol Avenue) and the Interchange 48 westbound off-ramp (Asylum Avenue). These ramps experienced 41 crashes each. None of the interchange ramp crashes involved fatalities but 104 injuries were recorded during this time period. Interchange ramp crash types are illustrated on Figure 2-31 and Figure 2-32, pages 2-82 and 2-83.

Table 2-16: I-84 Eastbound Interchange Ramps Crash Summary

Interchange Ramp	From	To	Crash Total/Severity
Interchange 45 On-Ramp	Flatbush Avenue	I-84	7 Crashes, 0 Fatalities, 1 Injury
Interchange 46 Off-Ramp	I-84	Sisson Avenue	18 Crashes, 0 Fatalities, 10 Injuries
Interchange 46 On-Ramp	Sisson Avenue	I-84	3 Crashes, 0 Fatalities, 1 Injury
Interchange 47 On-Ramp	I-84	Sigourney Street	13 Crashes, 0 Fatalities, 1 Injury
Interchange 48A Off-Ramp	I-84	Asylum Street	9 Crashes, 0 Fatalities, 7 Injuries
Interchange 48B Off-Ramp	I-84	Capitol Avenue	49 Crashes, 0 Fatalities, 26 Injuries
Interchange 48 On-Ramp	Broad Street	I-84	Data Not Provided
Interchange 49 Off-Ramp	I-84	High Street	27 Crashes, 0 Fatalities, 9 Injuries
Interchange 50 Off-Ramp	I-84	Trumbull Street	16 Crashes, 0 Fatalities, 9 Injuries

Table 2-17: I-84 Westbound Interchange Ramps Crash Summary

Interchange Ramp	From	To	Crash Total/Severity
Interchange 50 On-Ramp	Chapel St. North	I-84	3 Crashes, 0 Fatalities, 1 Injuries
Interchange 49 On-Ramp	High Street	I-84	14 Crashes, 0 Fatalities, 6 Injuries
Interchange 48 Off-Ramp	I-84	Asylum Avenue	41 Crashes, 0 Fatalities, 14 Injuries
Interchange 48A On-Ramp	Asylum Street	I-84	No Data Provided
Interchange 48B On-Ramp	Capitol Avenue	I-84	41 Crashes, 0 Fatalities, 1 Injury
Interchange 47 Off-Ramp	I-84	Sigourney Street	Data Not Provided
Interchange 46 Off-Ramp	I-84	Sisson Avenue	20 Crashes, 0 Fatalities, 11 Injuries
Interchange 46 On-Ramp	Sisson Avenue	I-84	14 Crashes, 0 Fatalities, 5 Injuries
Interchange 45 Off-Ramp	I-84	Flatbush Avenue	14 Crashes, 0 Fatalities, 2 Injuries

2.3.3 I-84 Interchange Ramp Terminal Intersections

Crash data was also obtained for the ramp terminal intersections. The crash data corresponds to the period from January 1, 2009 to December 31, 2011. Intersection crash rates are determined relative to the number of vehicles entering the intersection, expressed as crashes per million entering vehicles. An analysis of these intersections indicates that the ramp terminal intersections experience crashes at rates of between 0.11 and 1.32 crashes per million entering vehicles. These rates are in line with rates for major intersections in urban areas in Connecticut. Table 2-18, following, summarizes the crashes reported at the intersections and provides the crash rates for each. Figure 2-31 and Figure 2-32, pages 2-82 and 2-83 illustrate the ramp terminal intersection crash rates.

Two intersections had crash rates exceeding 1.00 crashes per million entering vehicles: the Interchange 45 Ramps at Flatbush Avenue and the Interchange 46 Ramps at Sisson Avenue/West Boulevard. However, despite the high number of crashes, each intersection exhibited a low rate of injury crashes: 22 percent and 32 percent, respectively.

The intersection of the Interchange 50 eastbound off-ramp and Trumbull Street/Chapel Street South experienced a crash rate of 0.97 crashes per million entering vehicles. None of the 18 crashes reported at this intersection involved a fatality but 56 percent of the crashes reported resulted in injuries. The intersection of the Interchange 50 westbound on-ramp and Trumbull Street/Chapel Street North experienced 13 crashes, with a corresponding crash rate of 0.87 vehicles per million entering vehicles. There were no fatalities and 31 percent of the crashes involved injuries.

The intersections of the Interchange 49 westbound on-ramp and High Street/Chapel Street North and the Interchange 48A ramps and Asylum Street/Spruce Street had relatively high rates of crashes involving injuries (57 percent and 50 percent, respectively) but low crash rates overall.

Table 2-18: I-84 Interchange Ramp Terminal Intersections Crash Summary

Intersection	No. of Crashes	Crashes per Million Entering Veh.	Fatalities	Injuries	Percent with Injuries
Interchange 45 Ramps at Flatbush Avenue	36	1.23	0	11	22.2%
Interchange 46 Ramps at Sisson Avenue/West Boulevard	44	1.32	0	23	31.8%
Interchange 47 Eastbound On-Ramp at Sigourney Street	8	0.34	0	1	12.5%
Interchange 47 Westbound Off-Ramp at Sigourney Street	16	0.71	0	7	43.8%
Interchange 48 Eastbound On-Ramp at Broad Street	13	0.63	0	6	46.2%
Interchange 48B Ramps at Capitol Avenue/Oak Street	6	0.26	0	1	16.7%
Interchange 48A Ramps at Asylum Street/Spruce Street	2	0.11	0	1	50.0%
Interchange 48 Westbound Off-Ramp at Asylum Street/Spring Street	14	0.51	0	7	42.9%
Interchange 49 Eastbound Off-Ramp at High Street/Chapel Street South	6	0.53	0	2	33.4%
Interchange 49 Westbound On-Ramp at High Street/Chapel Street North	3	0.43	0	5	57.1%
Interchange 50 Eastbound Off-Ramp at Trumbull Street/Chapel Street South	18	0.97	0	16	55.6%
Interchange 50 Westbound On-Ramp at Trumbull Street/Chapel Street North	13	0.87	0	8	30.8%

LEGEND

Accident Types
- Rear End
- Fixed Object
- Right Angle
- Turning
- Sideswipe
- Other

0 1,300 2,600 Feet

Sources of Data: ESRI, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstop, and the GIS User community

The I-84 Hartford Project

I-84 Interchange Ramp and Terminal Intersection Crashes Map, West End

Date: 7/17/2015	Drawn By: Parsons Brinckerhoff	Figure 2-31

LEGEND

Accident Types
- Rear End
- Fixed Object
- Right Angle
- Turning
- Sideswipe
- Other

0 500 1,000 Feet

Sources of Data: ESRI, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstop, and the GIS User community

84 The I-84 Hartford Project

I-84 Interchange Ramp and Terminal Intersection Crashes Map, East End

Date: 7/17/2015	Drawn By: Parsons Brinckerhoff	Figure: 2-32

2.4 Existing Traffic Operations

The existing traffic operations within the Traffic Analysis Study Area have been analyzed and documented to identify deficiencies and establish a baseline condition against which future conditions can be evaluated.

2.4.1 Background

Traffic flow, whether for cars, bicycles, or pedestrians, is characterized by metric called Level of Service (LOS). LOS is a quantitative score that goes from A to F. LOS A represents the best operating conditions or a free-flow system; LOS F represents the worst conditions or a congested system. In general, roadways are designed for LOS C. When the LOS falls below a C, travel speeds begin to drop and the mobility of a facility is degraded.

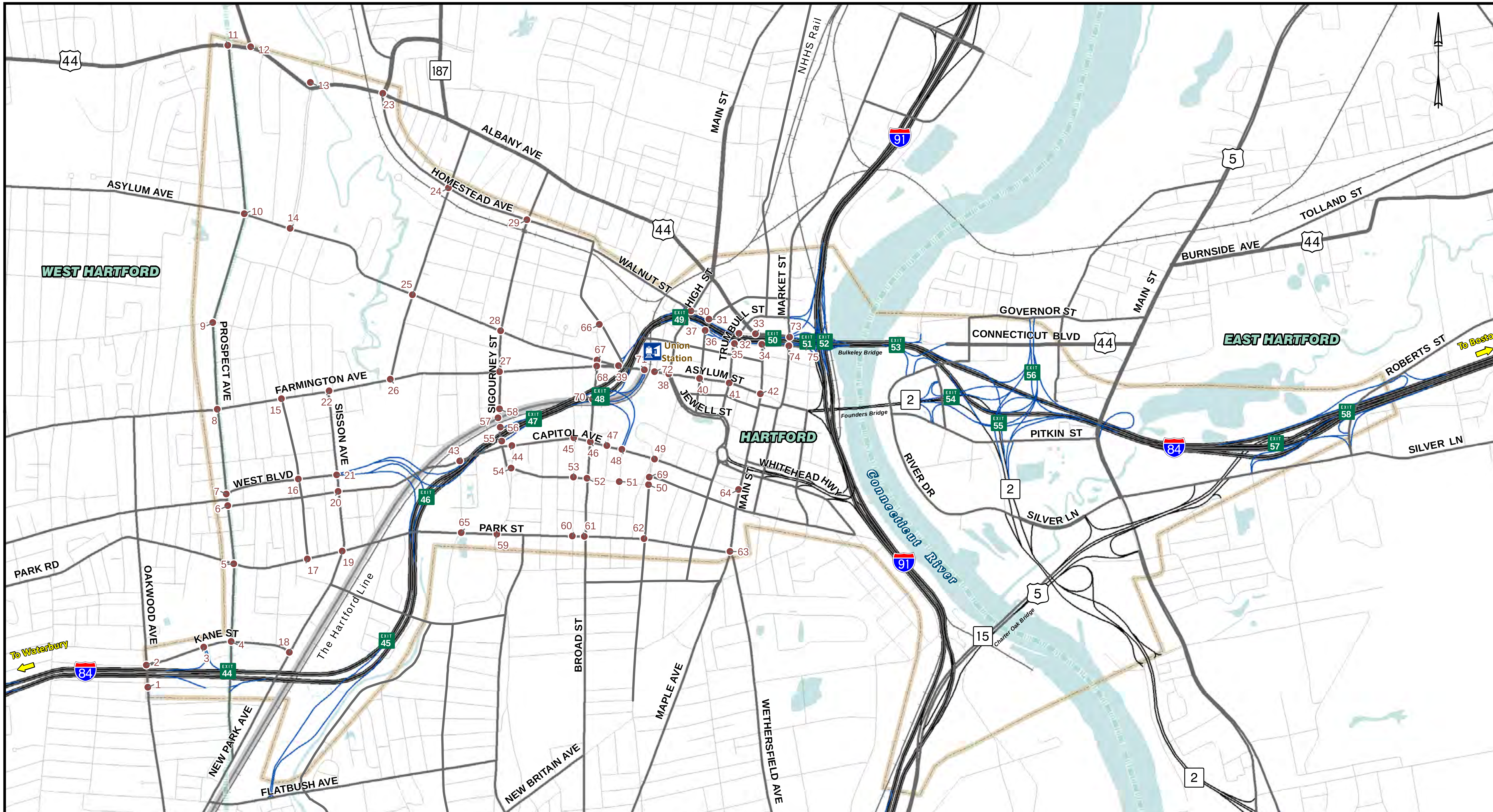
Level of Service is not the only metric used to rate road segments, but it is the most commonly used among transportation professionals since it can be applied to any type of transportation facility. On freeways, LOS is determined by the density of vehicles. At intersections, LOS is determined by the amount of delay a driver will experience on average. Freeway and intersection levels of service are the focus of this analysis.

2.4.2 Methodology / Criteria

Due the complexity of vehicle interactions within the study area, the analysis of existing traffic operations required the use of three different software suites: PTV Vissim 6.0, an in-depth microsimulation and visualization tool for all roadway classes; Trafficware Synchro 8 and SimTraffic 8, a macroscopic HCM-based intersection analysis tool and microsimulation intersection analysis tool, respectively; and McTrans HCS 2010, a macroscopic text-based program that uses Highway Capacity Manual (HCM) equations to derive freeway and ramp levels of service. Each software package has strengths and limitations, which are discussed below. An HCM-based approach is required by both the State and Federal Departments of Transportation.

The three different traffic models include different elements within the Traffic Analysis Study Area. The Vissim model focuses on the interactions between I-84 and major signalized intersections near the freeway. This model includes I-84 throughout the Traffic Analysis Study Area, all I-84 interchange ramps, and any local intersections that can be expected to back up onto the freeway or meter on-ramp traffic. All major signalized intersections and major east-west routes (non-freeway) within the Traffic Analysis Study Area were modeled using Synchro. The Traffic Analysis Study Area and intersections modeled using Synchro are illustrated in Figure 2-33, following. HCS analysis was undertaken for every freeway within the Traffic Analysis Study Area: I-84, I-91, CT 2, and CT 15.

As described in Section 2.2: Existing Traffic Data, accurate volumes, speeds, and origin-destination matrices are essential to traffic modeling. Obtaining this data for such a large study area presents a tremendous challenge. Direct measurements such as SkyComp (origin-destination matrices) and manual



LEGEND

- Synchro Study Intersection
- CTfastrak
- Railroad
- Traffic Analysis Area
- Town/City Limit
- Water
- I-84 Exit #
- Interstates
- I-84 Ramp
- Other Freeway
- Major Road
- Local Road

0 1,000 2,000 Feet

Sources of Data: City of Hartford, ESRI
http://www.ctfastrak.com/

The I-84 Hartford Project

Synchro Study Intersection Location Map

Date: 7/17/2015	Drawn By: TranSystems	Figure No: 2-33

turning counts provide a snapshot of a single day's traffic but there is no such thing as a typical day in the study area. A traffic crash anywhere in the region will impact traffic. Weather, construction, day of week, and time of year all play a role in traffic patterns. To ensure consistent results, correction factors from historical CTDOT's Traffic Monitoring Volume Information were developed and applied to field-measured counts.

As the manual turning counts were taken on different days, their traffic volumes do not always match on an intersection by intersection basis. In one case, there was a discrepancy of 190 vehicles between two adjacent intersections, a difference of nearly 30%. In cases like this, CTDOT Office of Planning 2013 turning counts, done as part of the CT*fastrak* project, were used to balance volumes. Similarly, SkyComp origin-destination data does not correspond exactly with the known freeway and ramp volumes, although it is generally close. The SkyComp results were balanced using the CDM Smith balanced count profile.

2.4.3 Vissim 6.0 Analysis

Overview

PTV Vissim is a multimodal four-dimensional microsimulation program based on an empirical driver behavior model. Version 6.00 was chosen because of its robust data collection abilities, improved interface, and because it was the most current version available at the time the model was created.

Strengths

Vissim is a powerful tool, capable of modeling the interaction of multiple modes of travel and classes of roadway. Unlike macrosimulation tools, Vissim models each vehicle or pedestrian, which allows for a level of detail conducive to photorealistic simulations. The software includes versatile signal controllers, customizable vehicle models and behavior, and video recording capabilities. It takes the grade of each road segment into account, along with the acceleration and braking characteristics of individual vehicles, to accurately model traffic speeds.

Unlike Synchro and HCS, which analyze traffic flow on a segmental basis, Vissim uses origin-destination data to better simulate weaving, lane use, and queuing. A vehicle entering the network will choose a route to its destination, much like a real driver, and will maneuver into the appropriate lane as far in advance of a turn as the modeler specifies.

Because each road segment is connected to and interacts with adjacent segments, congestion occurs in Vissim much the same as it does in reality. A bottleneck at one point will result in queues building upstream and reduced volumes downstream. Freeway congestion can affect secondary streets, and vice versa.

Limitations

Because Vissim is a stochastic program, multiple runs of the same model will produce varying results. It is critical to run each scenario multiple times and avoid outliers. Since the Vissim simulation is one connected network of roads, origin-destination data is essential in order to accurately model multi-lane roadways. Accurate speeds, vehicle distributions, and roadway geometry are also critical. Preparing the model itself is similarly time-consuming; a large model, containing miles of roadway, can take months or years for an engineer to build and calibrate. Traffic signals are especially hard to model, since there is no way to optimize timings or phasing, and the signal controller can only update once per second.

The non-deterministic nature of Vissim means that it does not comply with the HCM methodologies for freeway or intersection capacity. While it is possible to derive LOS from Vissim results, it will not necessarily be the same LOS that Synchro or HCS produces.

Finally, while Vissim is extraordinarily detailed, the intrinsic limits of microsimulation make it impossible to produce an exact replica of real-world traffic flow. Static vehicle routes mean that vehicles will follow their chosen route regardless of congestion. Rather than a continuously variable arrival rate, vehicle inputs are grouped into discrete time periods. Simulated driving behaviors, while advanced, do not replicate real-world drivers.

Vissim Model Development

The model's road network was drawn to scale on a geo-referenced background, using elevation data from the original I-84 construction plans, where available, and from Google Earth elsewhere. For the road network, the modeling limits extend beyond the Project Study Corridor so that queues would have more room to build, and vehicles had more distance to get in their preferred lanes. In the eastbound direction, I-84 is modeled from the Kane Street on-ramp past the Bulkeley Bridge, with a terminus just east of the off-ramp to Roberts Street (Exit 58). I-84 westbound is modeled from east of the Roberts Street on-ramp and extends to the Kane Street off-ramp (Exit 44).

The Vissim model also includes a detailed analysis of twelve signalized intersections and three unsignalized intersections at and near I-84 ramp termini. These intersections occasionally produce queues that impact traffic on I-84, and vice versa. The roadway network includes segments of I-91, Route 2, and Route 15; these freeways were included for potential future analysis of any alternatives that directly affect them. Although shoulders, parapets, and gore areas do not affect driver behavior in Vissim, they were included in the model to show edge-of-road and available space for maintenance and protection of traffic during construction. Bridge piers and abutments were added in critical locations such as the I-84 / I-91 interchange, as they are significant constraints to the highway geometry. Overhead signage, luminaires, and three-dimensional building models contribute to the model's visual accuracy and provide reference points when viewing the simulation.

On I-84 itself, speed decisions were placed on each segment of the freeway to match INRIX off-peak speed data. Reduced speed areas were placed around corners and curves. Along with the CTDOT standard speed distributions, 28 new distributions were added for speeds of 5 to 70 miles per hour. As previously noted, speeds in Vissim also depend on grade and vehicle power. CTDOT standard vehicle distributions, including weight and power, were used without modification.

Traffic control signals were coded with Synchro signal phasing, timings, coordination, and turning volumes. In total, twelve signalized intersections were modeled independently in Vissim, maintaining the same volumes and cycle lengths derived in Synchro. The three closely spaced intersections on Sigourney Street at I-84 were modeled using a single controller with nonstandard phasing, as exists in the field. Additional calibration was performed at the intersection of Asylum Street, Asylum Avenue, Farmington Avenue, Spring Street, and Garden Street, since Synchro had difficulty producing a model that could replicate real-world results.

Vissim Model Results and Conclusion

After careful calibration, traffic flow in the Vissim model closely matched conditions observed in the field.

Vissim Model Speed Results

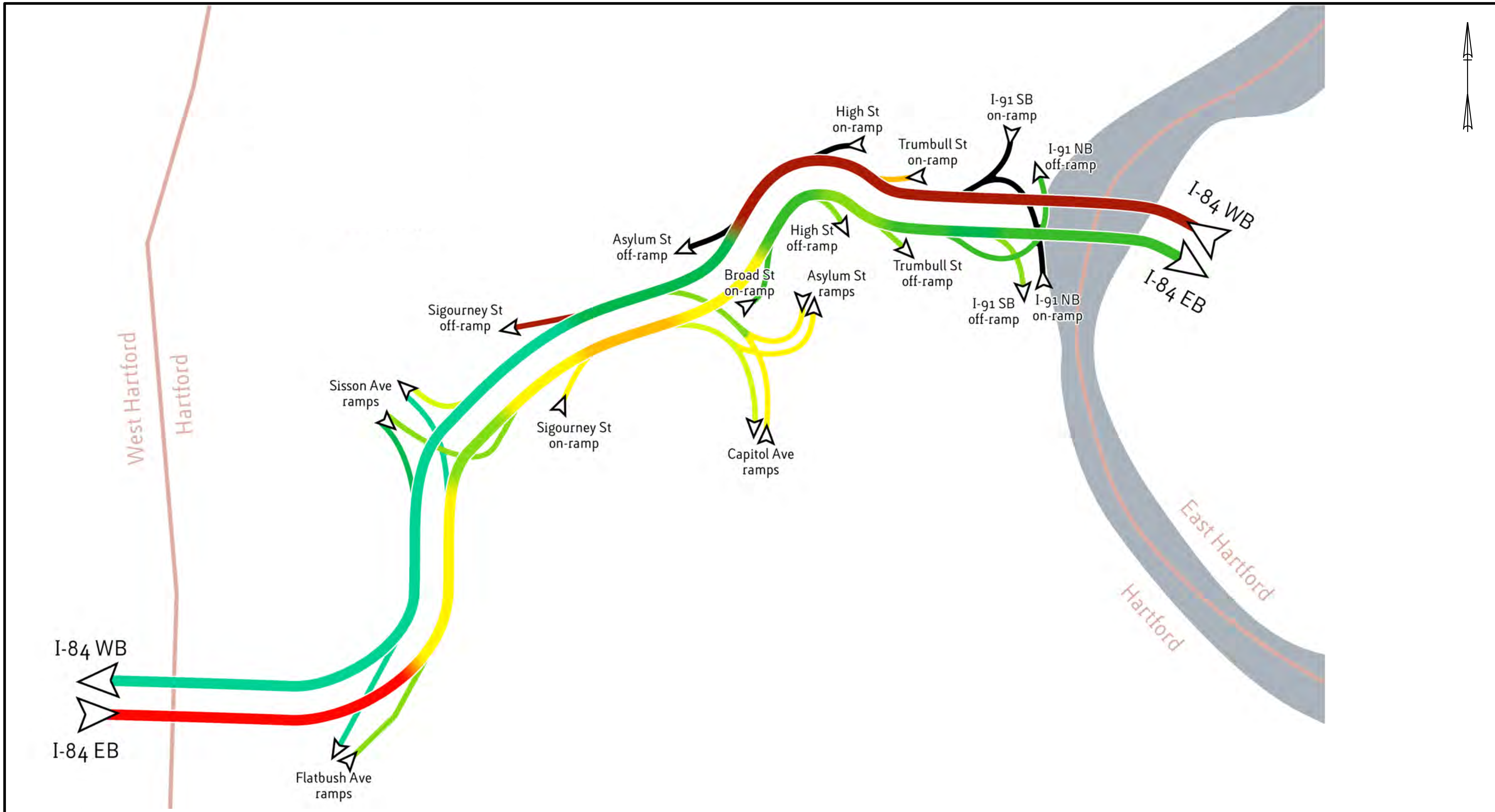
Average speeds for I-84 in Hartford in the morning and afternoon peaks are shown in Figure 2-34Figure 2-34, following, and Figure 2-35Figure 2-35, page 2-90, respectively. Note that speeds were collected lane-by-lane in 100-foot segments; while these diagrams summarize average speeds along a segment, like INRIX, more detailed data is also available. Speeds for the entire corridor are provided in Appendix A.2.8. More detailed results are provided in Appendix A.2.15.

In the morning peak, eastbound traffic is slowed west of the Flatbush Ave on-ramp. Speeds around 20 mph dominate in this area. The weave section between the Sigourney Street on-ramp and Exits 48A and 48B exhibits an average speed of 30 mph. Past this point, speeds quickly recover to uncongested levels.

Westbound traffic is very slow through East Hartford, hovering around 15 mph through the I-91 interchange and only increasing past the Asylum Street off-ramp (Exit 48). While the rightmost lane, a lane drop to Sigourney Street (Exit 47), remains congested, the adjacent lanes begin to move smoothly and speeds reach 60 mph soon thereafter.

Screenshot of Vissim Modeled Roadway

In the afternoon, average speeds are slower than in the morning. Eastbound traffic is backed up from West Hartford through Hartford, only improving marginally after crossing the Connecticut River. Westbound traffic is heavy throughout East Hartford and Hartford, only beginning to improve past the Flatbush Avenue off-ramp (Exit 45). Conditions at the I-91 interchange appear better in the model than in reality; this is due to the



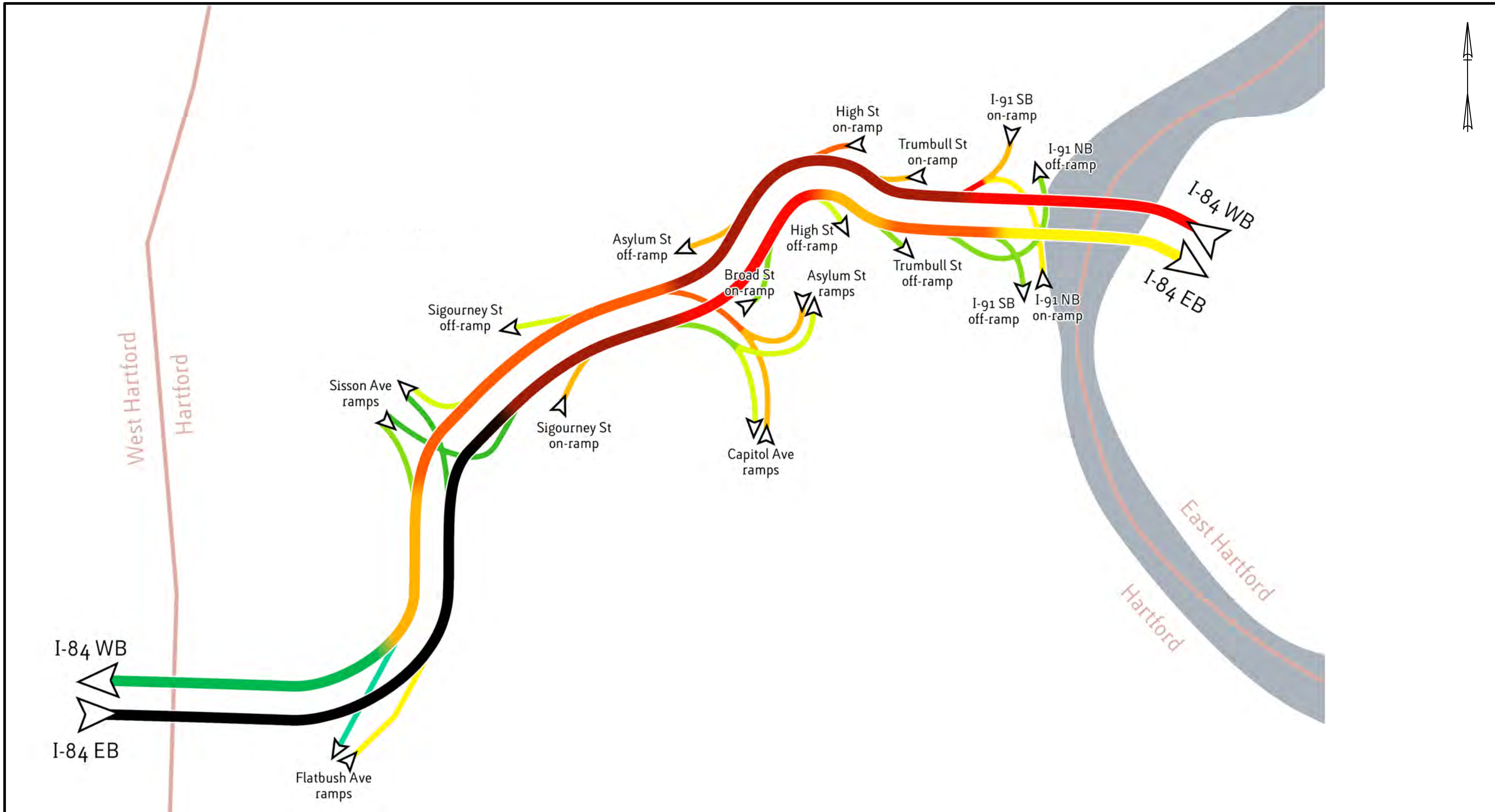
LEGEND

60 mph -		- 65 mph
50 mph -		- 55 mph
40 mph -		- 45 mph
30 mph -		- 35 mph
20 mph -		- 25 mph
10 mph -		- 15 mph
		- 5 mph

The I-84 Hartford Project

Existing (2012) Vissim Average Speed Map – AM Peak

Date: 5/19/2014	Drawn By: TranSystems	Figure No: 2-34



LEGEND

60 mph - 50 mph - 40 mph - 30 mph - 20 mph - 10 mph

- 65 mph - 55 mph - 45 mph - 35 mph - 25 mph - 15 mph - 5 mph

The I-84 Hartford Project

Existing (2012) Vissim Average Speed Map – PM Peak

Date: 5/19/2014	Drawn By: TranSystems	Figure No: 2-35

simulation limits. In the field, congestion on I-91 backs up onto I-84 but the source of this congestion is outside the simulation limits for the Vissim model.

It is important to note that the average speeds produced by Vissim are typically lower than those recorded by INRIX. There are several reasons for this. First off, INRIX removes all traffic data it considers to be due to non-recurring congestion. Given the frequency of traffic incidents and special events in the Hartford area, congestion is often much more extensive than what INRIX shows. Second, planning volumes are typically based on the 30th busiest hour of the year, which is heavier than average conditions. Third, Vissim splits traffic inputs into discrete periods of time. The model experienced peak traffic for 90 minutes in the morning and 150 minutes in the afternoon, whereas real traffic arrival rates are continuously variable. Finally, since the vehicle routes in Vissim were static, vehicles in the model stayed on their paths regardless of congestion, whereas some real-world vehicles would divert to other routes.

Vissim Model Level of Service Results

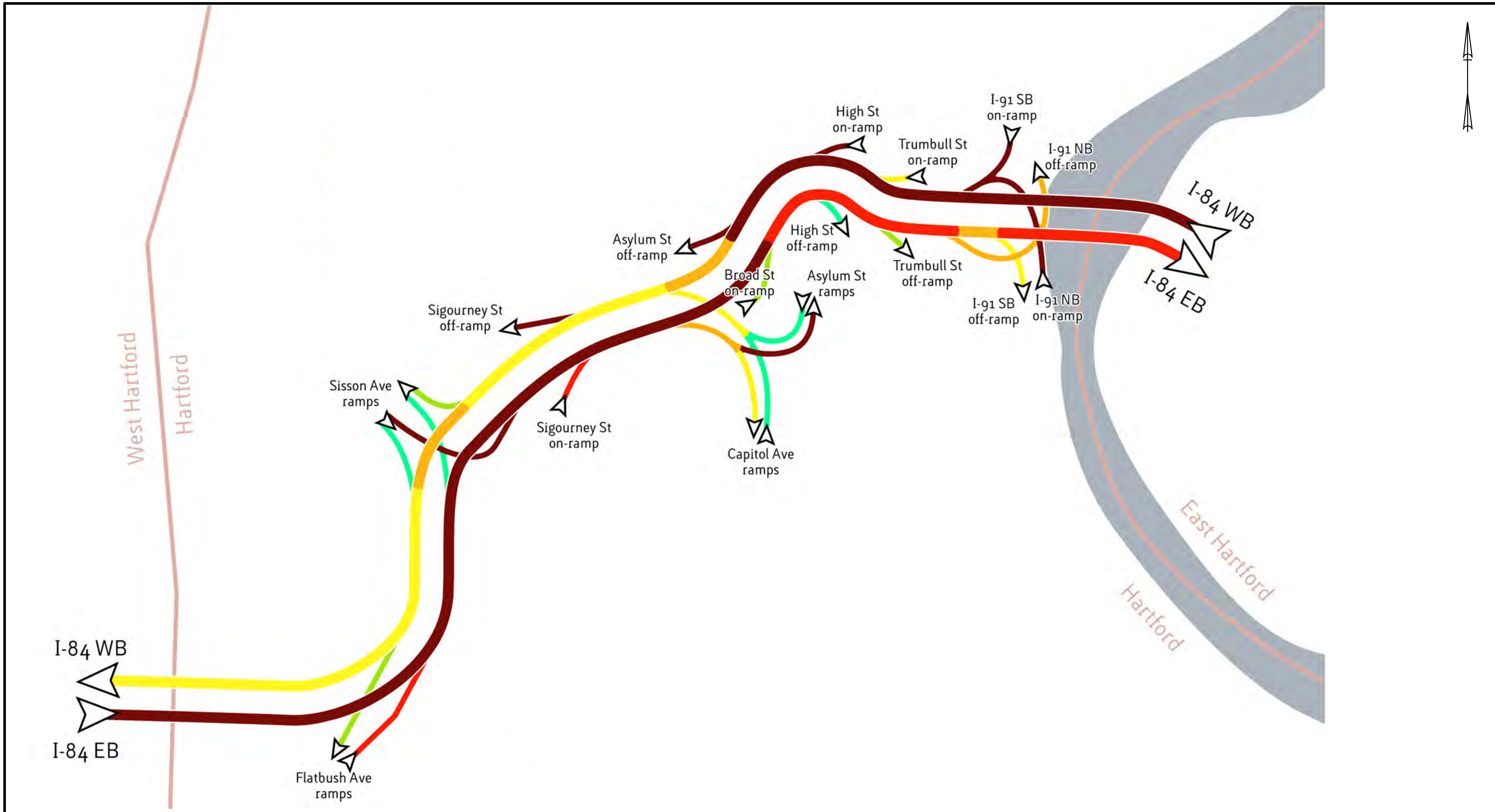
Density on I-84 through the Study Area was also analyzed in Vissim. The AM and PM LOS results for I-84 in Hartford are shown in Figure 2-36, following, and Figure 2-37, page 2-93, respectively. This density was then used to calculate Level of Service (LOS). In the morning peak, both directions of I-84, as well as several ramps, experience heavy congestion. I-84 eastbound operates at LOS F from West Hartford easterly to the Broad Street on-ramp, and then alternates between LOS E and D across the Connecticut River and into East Hartford. It is only after the CT 2 on-ramp that the LOS significantly improves. Westbound, traffic operates at LOS F from the East Hartford town line westerly to the Asylum Street off-ramp, and improves marginally thereafter, reaching LOS B after the Kane Street off-ramp (Exit 44).

The afternoon peak brings greater levels of traffic congestion. I-84 eastbound operates at LOS F from West Hartford through to the CT 2 on-ramp in East Hartford, and past this point, it never gets better than LOS D within the limits of the model. Westbound, the situation is similar, with LOS F traffic prevailing throughout East Hartford and Hartford, only improving to LOS E around the West Hartford town line.

Along with the main line, several ramps are influenced by this congestion. The on-ramps from I-91, in particular, are heavily congested during both peak periods. The High Street on-ramp is also congested in both peaks due to the heavy congestion and weaving at its terminus. Five off-ramps, including Asylum Street (Exit 48) and Sigourney Street (Exit 47), operate at LOS F during the morning peak. In the afternoon, six on-ramps operate at LOS F, including the ramp from I-91 southbound to I-84 westbound and the ramp from Asylum Street and Capitol Avenue.

Vissim Model Conclusion

Overall, the Vissim model is observed to accurately model the congestion that occurs on I-84 and nearby secondary streets on a day with moderately heavy traffic. With the model calibrated to existing



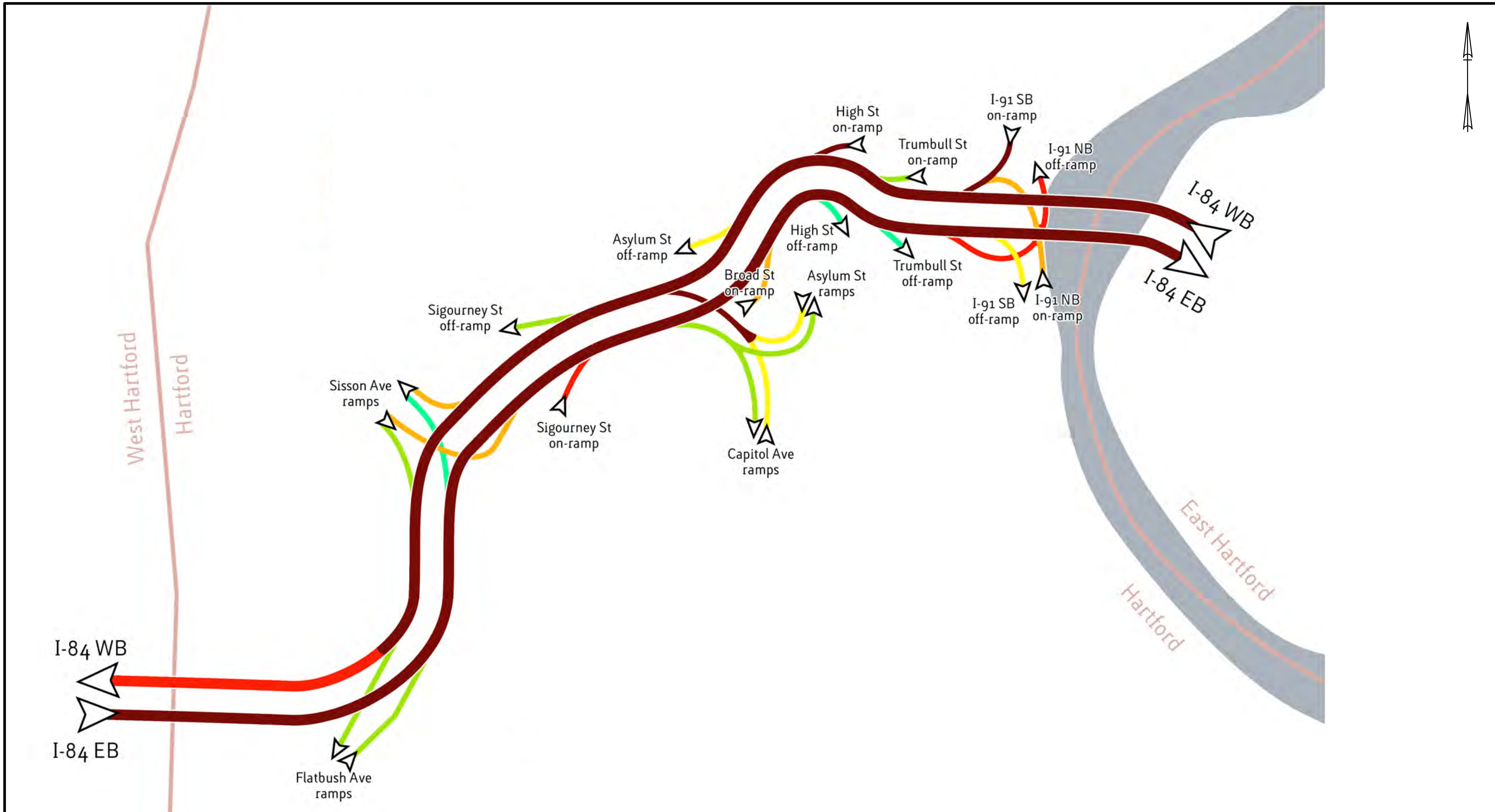
LEGEND

LOS A
LOS B
LOS C
LOS D
LOS E
LOS F

The I-84 Hartford Project

Existing (2012) Vissim Level of Service Map – AM Peak

Date: 5/19/2014	Drawn By: TranSystems	Figure No: 2-36



LEGEND

LOS A
LOS B
LOS C
LOS D
LOS E
LOS F

The I-84 Hartford Project

Existing (2012) Vissim Level of Service Map – PM Peak

Date: 5/19/2014	Drawn By: TranSystems	Figure No: 2-37

conditions, it can now be modified as needed to produce accurate and versatile simulations of no-build and future build traffic.

2.4.4 Synchro 8 Analysis

Overview

Trafficware's Synchro is an empirical macrosimulation modeler, primarily used for traffic control signals, but also capable of modeling unsignalized intersections. The SimTraffic module, available as a part of the Synchro suite, is a microsimulation program to analyze these same intersections. Version 8 was chosen as it follows the 2010 edition of the HCM and was the most current version available when the model was created. Unlike freeway analysis, where LOS is determined by the density of vehicles, intersection LOS is based on the amount of delay a driver will experience on average.

Strengths

Synchro analyzes signalized and unsignalized intersections using the HCM methodology, providing a deterministic, reproducible set of results for a given intersection. It has a streamlined interface to allow intersections to be coded in as little as a few minutes. After the requisite turning counts, lane arrangements, and signal timings have been set, this data can be sent directly to SimTraffic to perform a limited microsimulation of traffic flow.

When signal timings and phasing are known, they can be put directly into Synchro. When they are not known, timings and phasing can be optimized to minimize intersection delay. Multiple nearby intersections can be coordinated with an optimized offset in order to ensure good progression. This progression can be shown graphically on a time-space diagram.

SimTraffic, though not as detailed as Vissim, can produce a good approximation of the interaction between multiple intersections, including queue spillback and starvation.

Limitations

Since Synchro matches the HCM methodology, it looks at one intersection at a time, not considering interactions with nearby intersections. In some cases, such as with closely spaced intersections, acute angles between approaches, multi-lane roundabouts, or two-way left turn lanes, Synchro can produce results inconsistent with field data.

Synchro does not model freeway traffic, and thus cannot model the interaction between freeways and secondary roadways. Synchro offers only limited control over origin-destination data.

Driver behaviors are less flexible in Synchro than they are in Vissim, especially in merge areas. While SimTraffic can provide a more realistic picture of intersection operations, it does not produce LOS results, and multiple runs must be analyzed in order to avoid outliers.

Synchro Model Development

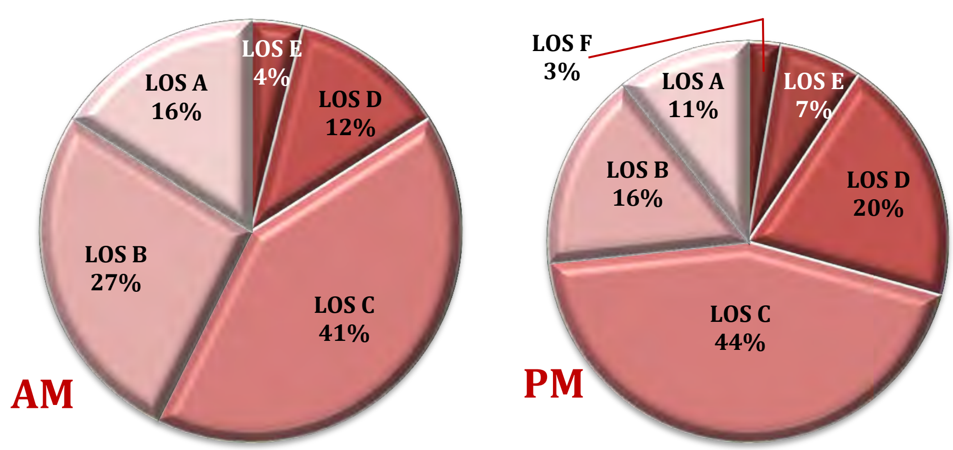
Where possible, real-world geometry, lane use, signal timings, turn restrictions, and speeds were replicated within Synchro. On Asylum Street westbound between Garden Street and Farmington Avenue, there exists a single, unstriped 36' travel lane, which operates as one, two, or three lanes depending on the time of day and amount of congestion. This was modeled in Synchro as three lanes. This location was also modeled in Vissim in order to verify the Synchro results.

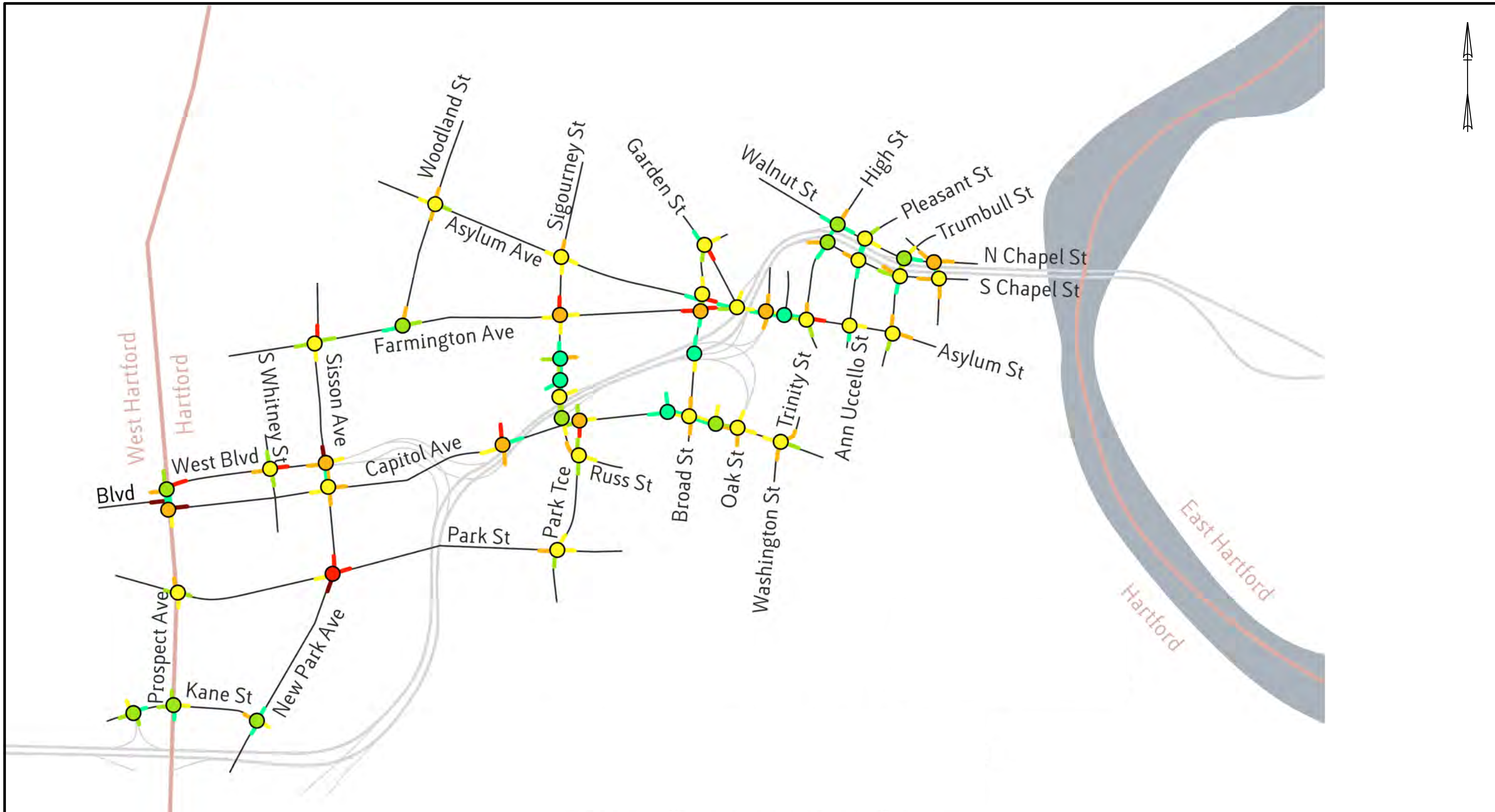
The City of Hartford runs a closed-loop computerized signal system, with phase lengths that change from cycle to cycle and adapt to traffic patterns; there is no single timing plan that exactly matches what is in the field. However, using the observed queue lengths as a target, signal timings were selected to produce the same overall results as the actual timings. Much of the field data was collected in 2012. To supplement the turning count movements, additional intersections were added to the Study Area and therefore additional field data was collected in 2014.

Synchro Model Results and Conclusion

Full Synchro results are provided in Appendix A.2.7. In summary, during the AM peak, 16% of the intersections studied operate at LOS D or worse, and during the PM peak, this figure climbs to 30%. In general, roadways are designed for LOS C. When the LOS falls below a C, travel speeds begin to drop and the mobility of a facility is degraded. Figure 2-38, below, summarizes the performance of all 75 intersections. Partial results for selected key intersections are shown in Figure 2-39, page 2-96, for the AM peak hour and in Figure 2-40, page 2-97, for the PM peak hour. As illustrated in the figures, Hartford's intersections experience greater congestion in the afternoon than in the morning. For example, Figure 2-39 shows only three intersections that have at least one approach at LOS F; Figure 2-40 shows eight. In Appendix A.2.7, the trend is further illustrated with six intersections that have at least one approach at LOS F in the morning and fifteen intersections with at least one approach at LOS F in the evening.

Figure 2-38: Summary of Synchro Intersection Peak Hour Results





LEGEND

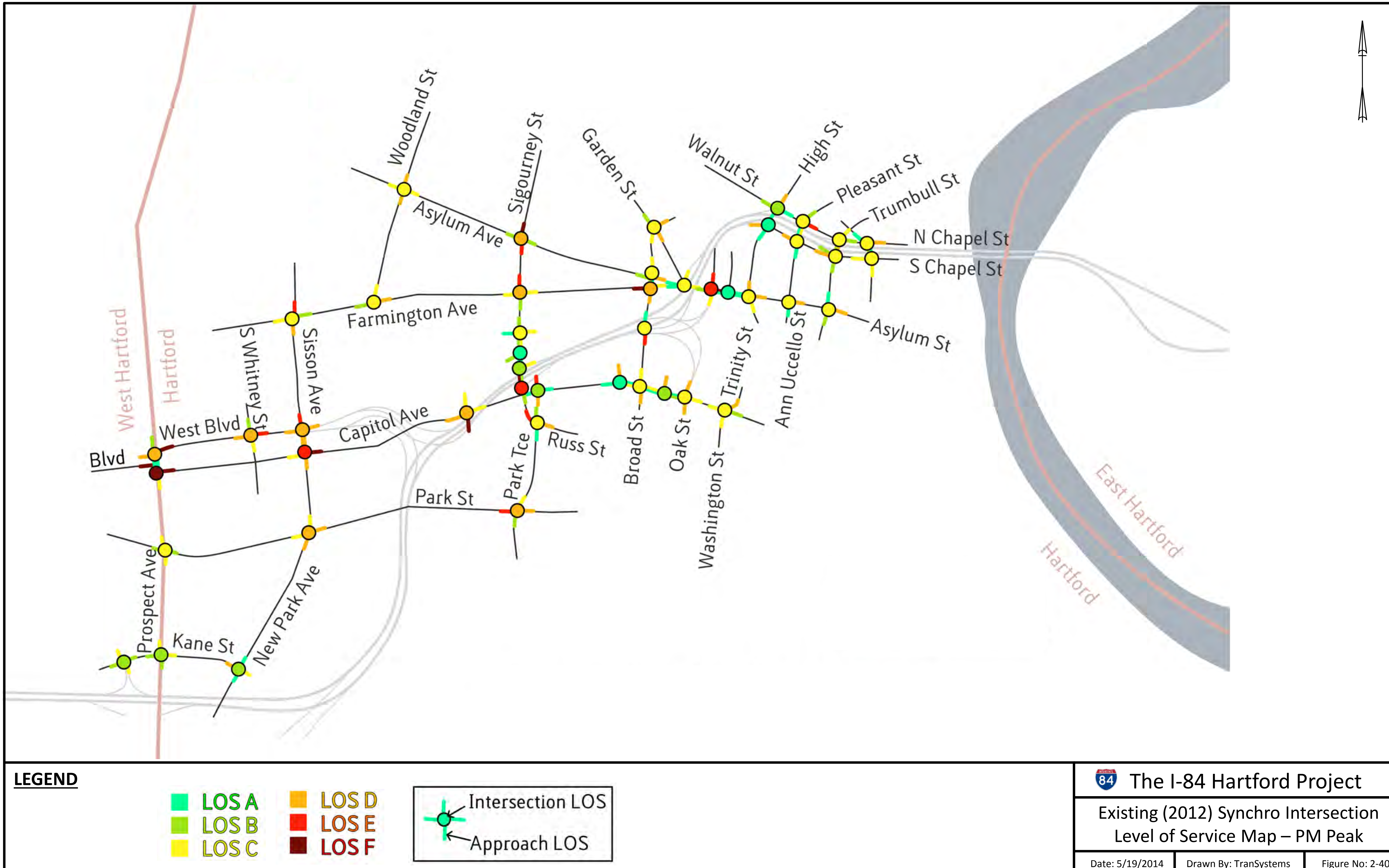
LOS A
LOS B
LOS C
LOS D
LOS E
LOS F

Intersection LOS
Approach LOS

The I-84 Hartford Project

Existing (2012) Synchro Intersection Level of Service Map – AM Peak

Date: 5/19/2014	Drawn By: TranSystems	Figure No: 2-39



The I-84 Hartford Project

Existing (2012) Synchro Intersection Level of Service Map – PM Peak

Date: 5/19/2014	Drawn By: TranSystems	Figure No: 2-40

It should be noted there are several exceptions to this trend. For example, the intersections along westbound-only North Chapel Street are busiest in the morning, carrying inbound traffic. Similarly, the intersection of Park Street and New Park Avenue is also busier in the morning, likely due to its location adjacent to an elementary school. The majority of the PM peak period is after the time period where activity related to the school would affect operations.

To further illustrate the congestion in Hartford, five intersections are summarized in Table 2-19, following. These intersections were selected as they are directly impacted by operations on I-84.The intersection of Sigourney Street and the I-84 eastbound on-ramp, for example, was included due to its heavy volumes and significant delays for southbound movements during evening hours. In the PM peak, the delay is over 85 seconds per vehicle with a LOS of F. This is also an excellent example of general traffic patterns observed in Hartford; inbound movements are busy during the AM peak, and outbound movements are busy in the PM peak.

As mentioned previously, Synchro’s limitations can skew some results. One such case is the intersection of Asylum Street with Union Place, which is calculated to be a LOS A, even though it is frequently blocked in the PM peak by the queue from the Spruce Street intersection 170 feet to the west.

While Synchro’s level of service does not indicate this interaction, its microsimulation package, SimTraffic, does. It was the SimTraffic queues that were calibrated to field conditions, and so the simulation timings and phasing are accurate, even if the calculated level of service is somewhat better than what exists in the field. To ensure the quality of the Synchro model as it relates to I-84, the most critical intersections at and near ramp termini were also modeled in Vissim, with results similar to Synchro.

Table 2-19: Summary of Selected Synchro Intersection Analysis

Intersection/Direction	AM Peak Hour		PM Peak Hour	
	LOS	Approach Delay (sec/veh)	LOS	Approach Delay (sec/veh)
Sigourney Street & I-84 Eastbound On-Ramp				
Northbound - Sigourney Street	C	27.2	B	19.7
Southbound - Sigourney Street	B	14.4	F	86.9
Overall	**B**	**18.5**	**E**	**56.8**
Sigourney Street & I-84 Westbound Off-Ramp				
Northbound - Sigourney Street	B	18.2	B	15.8
Southbound - Sigourney Street	B	11.3	A	8.1
Westbound - I-84 Eastbound Off-Ramp	C	24.0	C	21.2
Overall	**C**	**20.7**	**B**	**13.7**
Asylum Street & Garden Street & I-84 Westbound Off-Ramp				
Southbound - I-84 Westbound Off-Ramp	C	25.2	C	33.2
Eastbound – Asylum Street & Farmington Avenue	B	11.2	A	9.5
Westbound - Asylum Street	C	21.9	C	21.1
Overall	**C**	**21.4**	**C**	**20.8**
Broad Street/Cogswell Street & Asylum Avenue				
Northbound - Broad Street	B	16.7	A	7.5
Southbound - Cogswell Street	C	28.7	C	21.4
Eastbound - Asylum Avenue	A	5.5	B	14.8
Westbound - Asylum Avenue	E	60.7	D	40.9
Overall	**C**	**31.7**	**C**	**22.2**
Broad Street & Farmington Avenue				
Northbound - Broad Street	A	4.8	D	49.1
Southbound - Broad Street	B	10.9	B	15.4
Eastbound - Farmington Avenue	E	65.4	F	85.4
Westbound - Farmington Avenue	E	55.8	C	27.0
Overall	**D**	**35.8**	**D**	**49.7**

2.4.5 HCS 2010 Analysis

Overview

McTrans HCS 2010 is an empirical traffic analysis tool for freeways and secondary roads. It is built around the methodology of the 2010 edition of the HCM. The freeway analysis portion of HCS 2010 breaks a facility down into ramps, weaving segments, and basic segments. The use of HCS 2010 is required by the FHWA and CTDOT. Version 6.50 was used, as it was the most current version when the analysis was performed.

Strengths

Because it follows the HCM, HCS 2010 results are determinate and reproducible for any road segment. Very little input information is needed compared to a full traffic simulation. If the freeflow speed is not known, it can be approximated. The only origin-destination information required is for weaving segments. The software itself is simple to use and produces fast results for both design and analysis.

Limitations

Despite its ease of use, HCS 2010's simplicity means that its capabilities are limited. The HCM methodologies are very useful for determining level of service on isolated roadway segments, but although its empirical equations have corrections for two ramps in proximity, Hartford-area freeways have exits with such close spacing that HCS 2010 cannot analyze them as they are. For example, where multiple weaving segments overlap, HCS 2010 can only analyze one at a time; in reality, the actual LOS is likely to be worse than these calculations show.

Like Synchro, HCS 2010 analyzes each segment individually. The software may show a freeway segment at LOS A while an adjacent off-ramp is at LOS F; in reality, the ramp would queue onto the freeway and degrade its capacity. Consequently, when any roadway segment is congested, the results for surrounding segments can be incorrect.

The HCM's empirical equations do not cover posted speeds below 55 mph, nor do they apply to freeway segments with only a single through lane in each direction. The equations do not take into account the behavior of drivers, nor the vehicles they drive. The HCM does not look at horizontal curvature, sight distance restrictions, or traffic control at ramp termini. Freeways in and around Hartford are outliers that exceed the limits of the HCM methodology; McTrans recommends using microsimulation tools, such as Vissim, to get a better picture of these roads.

HCS 2010 Analysis Development

HCS was used to analyze I-84, I-91, CT 2, and CT 15 within Hartford and East Hartford. Each roadway was broken down into freeway segments, weaving segments, and ramp segments. On CT 2, where the mainline is reduced to one lane in each direction, the freeway segment was analyzed as a ramp. When available, weave analysis made use of origin-destination data from SkyComp; elsewhere, volumes were distributed proportionally. Speeds were taken from posted speed limits and advisory speeds, except for the segments of I-91 and I-84 in Hartford that are signed for 50 mph. HCS 2010 requires a minimum speed of 55 mph for freeways, so this speedwas used instead.

For locations with multiple overlapping weaves, the worst results were used. Similarly, for ramp analysis, adjacent on- or off-ramps may change results. HCS 2010 allows one adjacent ramp to be included, but in Hartford, there are typically two or more ramps within 1,500 feet. As with the weaving segments, multiple analyses were run, and the worst results were chosen.

HCS 2010 Analysis Results and Conclusion

Broadly speaking, freeway segment analysis yielded results that match INRIX speed data: in the morning peak, traffic is heaviest on I-84 eastbound in West Hartford, and I-84 westbound in East Hartford. In the evening peak, traffic in both directions is worst within Hartford. Full HCS 2010 results are given in Appendix A.2.6. The results show a wide variation in level of service from one segment to the next. For example, in the morning peak, the I-84 eastbound off-ramp to Trumbull Street was calculated to be LOS B, even though I-84 immediately upstream is LOS F. This is a consequence of HCS 2010's piece-by-piece approach, which tends to underestimate congestion in complex corridors. These results are considered inaccurate and should not be used for planning purposes.

2.5 Roadway Geometry Review

2.5.1 Introduction

The primary purpose of the Roadway Geometry Review Section of this Analysis, Needs, and Deficiencies Report is to evaluate existing conditions within the Project Study Corridor and identify locations that do not meet current highway design guidelines and related criteria. Evaluations include the degree to which these criteria are not met and their impacts on safety and traffic operations.

The focus of this review is the 2.5 mile corridor along I-84 from just east of Interchange 45 (Flatbush Avenue) in Hartford to Interchanges 51 & 52 (I-91) in Hartford. The eastbound and westbound I-84 mainline sections and associated entrance and exit ramps within the Project Study Corridor were evaluated. This includes Interchange 46 (Sisson Avenue), Interchange 47 (Sigourney Street), Interchange 48 (Capitol Avenue/Broad Street/Asylum Street), Interchange 49 (Ann Uccello Street/High Street), Interchange 50 (Main Street/Trumbull Street/Morgan Street), Interchange 51 (I-91 Northbound), and Interchange 52 (I-91 Southbound). Interchange 45 (Flatbush Avenue) is just outside the Project Study Corridor and was not evaluated.

The original highway mainline and interchange elements were constructed in the 1960s and, as such, were designed to the design standards and anticipated traffic volumes of the time. Over the past fifty years, interstate roadway design standards have evolved and traffic volumes within the study corridor, including large commercial vehicles, have significantly increased. As a result, congestion and the rate of reported crashes have also increased. Substandard geometric features affect traffic operations and contribute negatively to the highway's ability to safely carry traffic and, therefore, have been identified, evaluated, and compared to the most up-to-date standards established in the Connecticut Department of Transportation, *Highway Design Manual (2003 Edition including Revisions to February 2013*) (CTHDM) and American Association of State Highway and Transportation Officials (AASHTO), *A Policy on Geometric Design of Highways and Streets (6th Edition, 2011*).

2.5.2 Methodology

Based on multiple field visits, reviews of available design and record plans, and inspection reports, the existing geometric conditions of the I-84 mainline and interchanges within the Project Study Corridor were evaluated using the applicable design criteria. In addition, existing aerial photography and ground survey mapping of the existing conditions were used to further assess and verify the existing geometric conditions.

Controlling design criteria are those CTHDM highway design elements that are judged to be the most critical indicators of a highway's safety and its overall serviceability. The controlling design criteria used for this evaluation include the following:

- Posted Speed Limit
- Shoulder Width
- Travel and Auxiliary Lanes
- Maximum and Minimum Grades

- Horizontal Curvature
- Superelevation
- Stopping Sight Distance
- Vertical Curvature
- Cross Slopes
- Vertical Clearances
- Roadside Clear Zones

In addition to controlling design criteria, the following operational characteristics were evaluated and included for a comprehensive roadway geometry review:

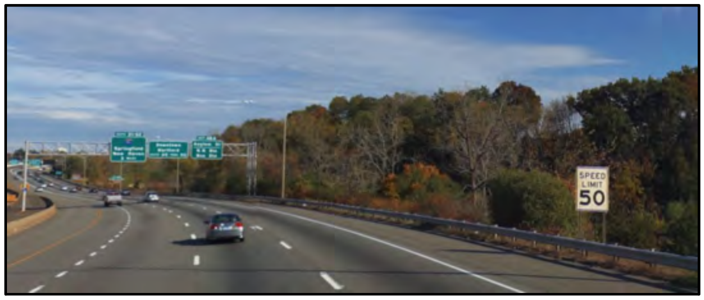
- Basic Number of Lanes and Lane Balance
- Interchange Spacing, Uniformity, and Decision Sight Distance
- Highway/Ramp Weaving
- Interchange Ramp Acceleration and Deceleration Lengths

Minimum design values for each controlling design criteria previously listed are predicated on roadway classifications and selected corresponding speed. Based on the Federal Functional Classification System, CTDOT classifies I-84 through the Project Study Corridor as an Urban Freeway (Built-up). For this study, the following geometric conditions for the mainline were reviewed based on recommended standards from the CTHDM (Figure 5A) for Urban Freeways (Built-up). Table 2-20, below, summarizes typical design criteria for various speeds applicable for this class of freeway for comparison purposes only.

Table 2-20: I-84 Mainline Design Criteria

Design Element	50 mph	55 mph
Travel Lane Width	12’	12’
Shoulder Width - Right	10’*	10’*
Shoulder Width - Left	10’*	10’*
Cross Slope - Travel Lane	1.5% - 2.0% for lanes adjacent to crown, 2.0% for lanes away from crown	1.5% - 2.0% for lanes adjacent to crown, 2.0% for lanes away from crown
Roadside Clear Zone	20’	22’
Stopping Sight Distance	425’	495’
Minimum Radius (e=6.0%)	840’	1065’
Maximum Superelevation	6%	6%
Maximum Grade	5%	5%
Minimum Grade	0.5%	0.5%
Vertical Clearance (Highway over Arterial/Freeway)	16’-3”	16’-3”
Vertical Clearance (Highway over Collector/Local)	14’-6”	14’-6”
Vertical Clearance (Highway over Non-Electrified RR)	20’-6”	20’-6”
*Where truck volumes exceed 250 DDHV, shoulder should be 12 feet		

Posted Speed Limit



Typical 50 mph Posted Speed Limit Signage along I-84

The posted speed limit for a facility creates a definite driver expectation of safe operating speed for the highway. Per CTHDM, the posted speed limit of a State highway is determined based upon several contributing factors, such as roadway geometrics, functional classification and type of area, type and density of roadside development, crash experience, pedestrian activity, and the 85th percentile speed for the facility. The 85th percentile speed is the speed below which 85 percent of vehicles travel on a given highway. CTHDM recommends that for new construction/major reconstruction projects, the facility should be designed to a speed equal to or greater than the anticipated posted or regulatory speed limit for the completed facility. This requirement recognizes the important relationship between likely travel speeds and the highway design.

Throughout the Project Study Corridor, the posted speed limit for the I-84 mainline is 50 mph. For highways that are classified as Urban Freeways (Built-up), the CTHDM recommends that the facility be designed for speeds ranging from 50-55 mph. For the purposes of this evaluation, the mainline was reviewed for compliance with the controlling design criteria using the posted speed of 50 mph. Design elements, including those that are non-compliant with the current design standards, are discussed in the following sections.

2.5.3 Review of Mainline Geometrics

The I-84 mainline was evaluated for compliance with the design criteria previously listed in Section 2.5.2 Methodology. The roadway deficiencies evaluated and described below will be used to help support the project Purpose & Need and will affect the development of future alternatives. It is assumed that future design efforts will further evaluate these design elements and recommend appropriate corrective measures. The results of the mainline review are summarized in Table 2-21, following.

Table 2-21: I-84 Mainline Review

Design Element*	CTHDM Section	Standard	Begin to Interchange 46		Interchange 46		Interchange 46 to Interchange 47		Interchange 47 to Interchange 48		Interchange 48 to Interchange 50		Interchange 50 to End	
Functional Classification		Urban Freeway	EB (Begin to Ex)	WB (Begin to En)	EB (Ex to En)	WB (En to Ex)	EB (46 En to 47 En)	WB (46 Ex to 47 Ex)	EB (47 Ex to 48 Ex)	WB (47 Ex to Broad)	EB (48 Ex to 50 Ex)	WB (Broad to 50 En)	EB (50 Ex to 50 En)	WB (50 En to 50 Ex)
Posted/Evaluated Speed	6-2.02	50 mph	50 mph	50 mph	50 mph	50 mph	50 mph	50 mph	50 mph	50 mph	50 mph	50 mph	50 mph	50 mph
Travel Lane Width	10-1.01	12'	12'	12'	12'	12'	12'	12'	12'	12'	12'	12'	12'	12'
Right Shoulder Width	10-1.02	10'**	8'-12'	9'-14'	4'-7'	3'-10'	2'-3'	2'-3'	3'	3'-8'	3'	2'-10'	3'-12'	3'-16'
Left Shoulder Width	10-1.02	10'**	6'-12'	4'-7'	3'-10'	3'-9'	2'-3'	2'-3'	2'	3'	2'-3'	4'-8'	2'-4'	3'-6'
Cross Slope Travel Lane	10-1.01	1.5% - 2.0% for lanes adjacent to crown, 2.0% for lanes away from crown	Banked	Banked	Banked	Banked	Banked	Banked	Banked	Banked	Banked	Banked	Banked	Banked
Roadside Clear Zone	13-2.0	20'	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stopping Sight Distance***	7-1.0	425'	354' H	355' H	370' H	343' H	341' H	342' H	257' H	>425'	254' H	303' H	304' H	>425'
Minimum Radius (e=6.0%)	8-2.02	840'	1,763'	1,763'	1,206'	1,146'	1,637'	1,637'	1,909'	4,874'	928'	982'	1,286'	1,231'
Maximum Superelevation	8-2.02	6.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	2.00%	2.00%	6.25%	6.25%	6.25%	6.25%
Maximum Grade	9-2.03	5.00%	2.50%	3.00%	3.20%	4.00%	1.84%	1.70%	3.98%	5.00%	2.70%	5.00%	5.00%	5.00%
Minimum Grade	9-2.03	0.50%	2.04%	0.82%	3.00%	2.88%	1.32%	1.12%	1.17%	0.50%	0.50%	N/A	0.01%	0.50%
Vertical Clearance - Highway over Arterial/Freeway	9-4.0	16'-3"	15'-1" (over Park)	18'-8"	13'-11" (under ramp)	15'-2" (under ramp)	15'-6" (over Sigourney)	14'-2" (over Sigourney)	>16'-3"	13'-10" (under Broad)	15'-8" (over Broad) 13'-6" (over Asylum)	14'-0" (under Asylum) 16'-2" (under High)	14'-7" (under Trumbull)	15'-10" (under platform)
Vertical Clearance - Highway over Collector/Local	9-4.0	14'-6"	N/A	N/A	N/A	N/A	14'-1" (over Laurel)	13'-7" (over Laurel)	>14'-6"	>14'-6"	N/A	N/A	N/A	N/A
Vertical Clearance - Highway over Non-Electrified RR	9-4.0	20'-6"	N/A	N/A	N/A	N/A	N/A	N/A	18'-1"	18'-3"	19'-2"	18'-4"	N/A	N/A

* CTHDM Controlling Design Criteria.
** Where truck volumes exceed 250 DDHV, a 12-foot wide shoulder is desirable.
*** Notation after distance is for limiting horizontal (H) or vertical (V) curvature.
Values depicted in red represent elements that are less than the minimum required for the posted speed limit and roadway classification.

Lane Width

Typical Section of I-84 - Minimum 12-Foot Travel/Auxiliary Lane Width

The traveled way is defined as the portion of roadway for the through movement of vehicles, exclusive of shoulders and auxiliary lanes. Auxiliary lanes are those portions of the roadway adjoining the traveled way for purposes supplementary to through traffic movement, such as for speed change, weaving, or truck climbing. There are several locations throughout the study area where auxiliary lanes are present on the mainline between interchange entrance and exit ramps. The minimum required travel/auxiliary lane width for a roadway is dependent upon the functional classification, traffic volumes, and rural/urban location of the roadway. The minimum required travel/auxiliary lane width of 12 feet is met throughout the I-84 mainline within the Project Study Corridor.

Shoulder Width

Per AASHTO, a shoulder is the portion of the roadway contiguous with the traveled way that accommodates stopped vehicles, emergency use, and lateral support of subbase, base, and surface courses. Roads with a narrow traveled way, narrow shoulders, and an appreciable traffic volume tend to provide poor service, have a relatively high crash rates, and need frequent and costly maintenance.

Advantages of well-designed and properly maintained shoulders are as follows:

- Space is provided away from the traveled way for vehicles to stop because of mechanical difficulties, flat tires, or other emergencies.
- Space is provided for evasive maneuvers to avoid potential crashes or reduce their severity.
- The sense of openness created by shoulders of adequate width contributes to driving ease and reduced stress.
- Space is provided for vehicles to pull over to allow emergency vehicles to pass.
- Highway capacity is improved because uniform speed is encouraged.
- Space is provided for maintenance operations such as snow removal.
- Space is provided to capture stormwater runoff, thus reducing the need for excessive drainage structures and preventing flooding and ponding on the highway.

It is desirable on heavily traveled, high-speed highways, and highways carrying a large number of trucks for the shoulder to be continuous and wide enough for a vehicle to be driven completely and safely off the traveled way. The full benefits of a shoulder may not be realized unless it provides a driver with refuge at any point along the traveled way. A continuous shoulder provides a sense of security such that almost all drivers making emergency stops will leave the traveled way.

Deficient Left and Right Shoulders along I-84

For State routes it is a requirement that all shoulders be paved. The minimum required shoulder width for a roadway is dependent upon the functional classification, traffic volumes, rural/urban location of the roadway, and if curbing is present. For the I-84 mainline throughout the Project Study Corridor, the CTHDM (Figure 5A) requires that both left and right shoulders be a minimum 10 feet wide with a desirable width of 12 feet where truck volumes exceed 250 Directional Design Hourly Volume (DDHV). Although the truck volumes exceed 250 DDHV within the I-84 Project Study Corridor, a minimum width of 10 feet was selected as the controlling design criteria considering urban conditions and adjacent land use.

Mainline shoulder widths within the Project Study Corridor were evaluated. Locations where the existing shoulder was found to be less than the required 10 foot width are depicted in Figure 2-41, following, and in Figure 2-42, page 2-109. Approximately 85% of the Project Study Corridor has shoulders of deficient width.

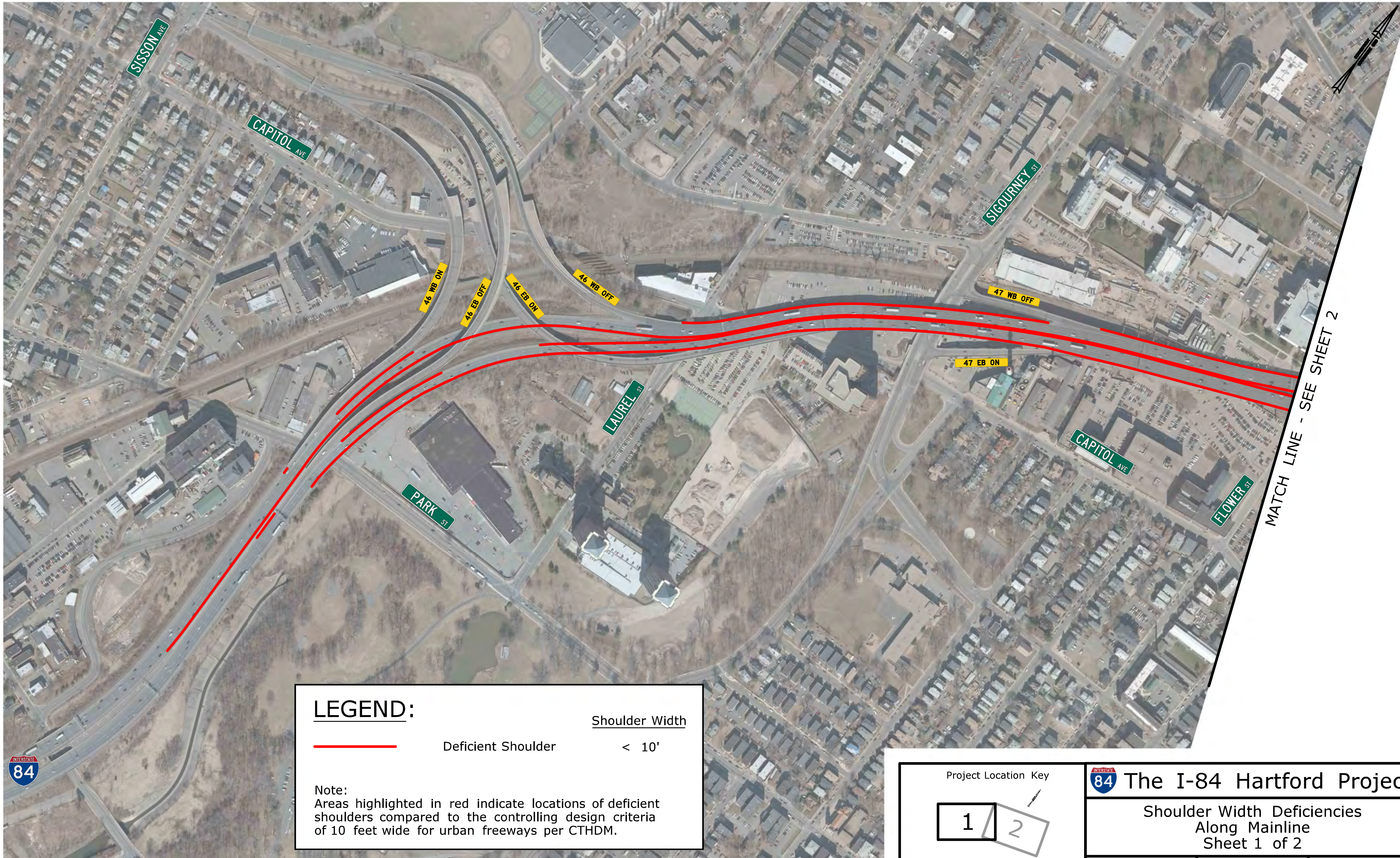
Horizontal Curvature

Per CTHDM (Figure 5A), for a speed of 50 mph, the minimum radius required for a simple curve is 840 feet. When compound curves are used on the mainline, it is required that the radius of the flatter circular arc not be more than 50% greater than that of the sharper arc.

All curves analyzed within Project Study Corridor for I-84 mainline meet or exceed the minimum required 840 foot radius. Additionally, there are several locations on the mainline where compound curves exist. Each location was evaluated for compliance with the 50% requirement and curves which exceeded this limitation are depicted in Table 2-22, below.

Table 2-22: Deficient Compound Curves

Mainline Location	Larger Radius (feet)	Smaller Radius (feet)	Increase in Radius (%)
I-84 Westbound at Sisson Avenue	1763	1146	54
I-84 Eastbound at Sigourney Street	5713	1659	244
I-84 Westbound at Sigourney Street	5759	1637	252
I-84 Westbound at Broad Street	9220	1412	553



LEGEND:

	Shoulder Width
Deficient Shoulder	< 10'

Note:
Areas highlighted in red indicate locations of deficient shoulders compared to the controlling design criteria of 10 feet wide for urban freeways per CTHDM.

Project Location Key

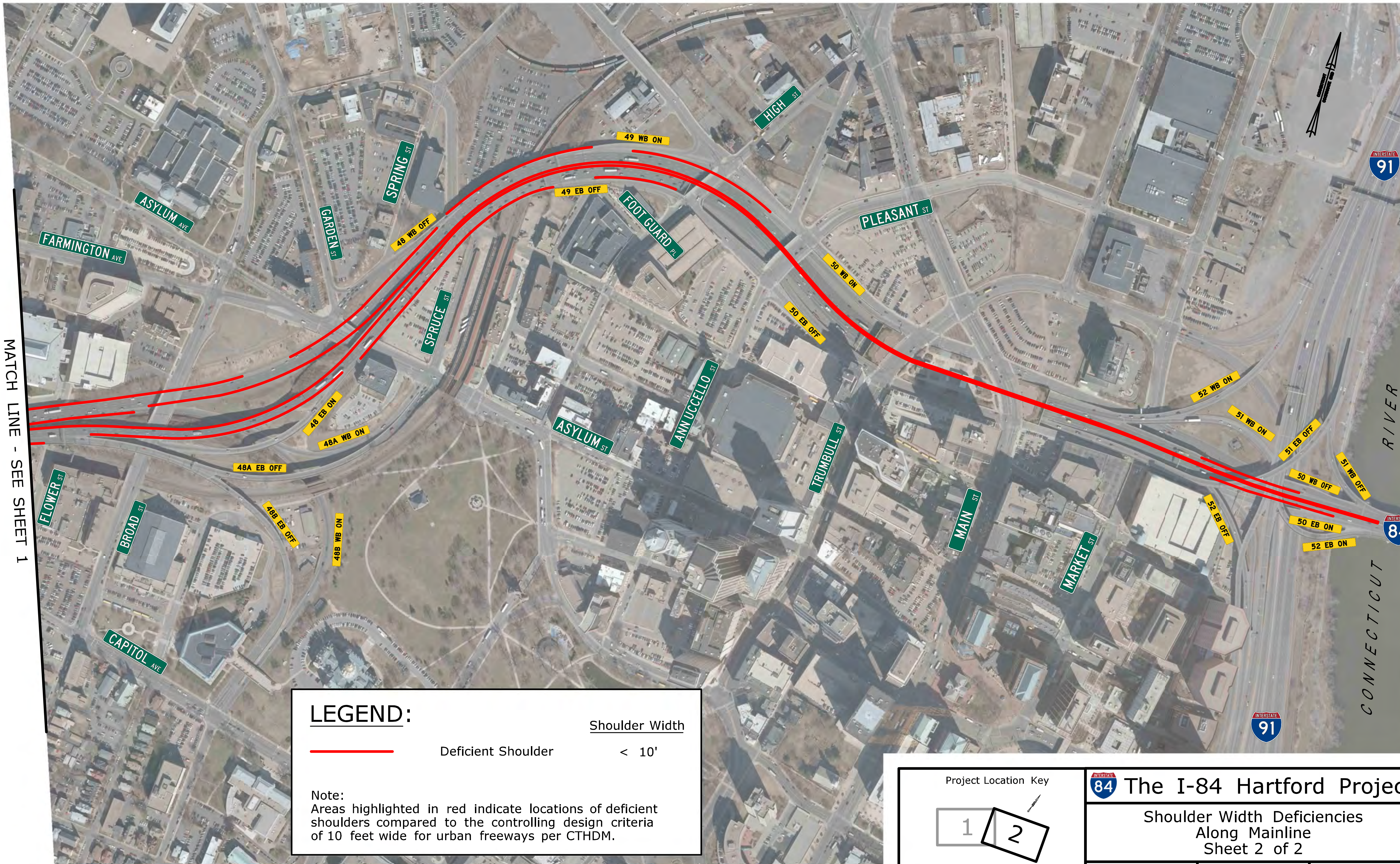
1 2

Not to Scale

The I-84 Hartford Project

Shoulder Width Deficiencies Along Mainline Sheet 1 of 2

Date: 1/20/2015 | Drawn By: JLD | Fig. No: 2-41



LEGEND:

	Shoulder Width
Deficient Shoulder	< 10'

Note:
Areas highlighted in red indicate locations of deficient shoulders compared to the controlling design criteria of 10 feet wide for urban freeways per CTHDM.

Project Location Key

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Not to Scale

The I-84 Hartford Project

Shoulder Width Deficiencies Along Mainline Sheet 2 of 2

Date: 1/20/2015 | Drawn By: JLD | Fig. No: 2-42

Superelevation

Superelevation is the amount of cross slope or "bank" provided on a horizontal curve to counterbalance the centrifugal force of a vehicle traversing the curve. The maximum rate of superelevation depends on several factors including climatic conditions, terrain, type of area (rural or urban), and highway functional classification. Safety and operational concerns related to inadequate superelevation are similar to those of horizontal alignment. Inadequate superelevation can result in vehicles skidding as they travel through a curve, which may potentially result in a run-off-road crash. Trucks and other large vehicles with high centers of mass are more likely to roll over on curves with inadequate superelevation.

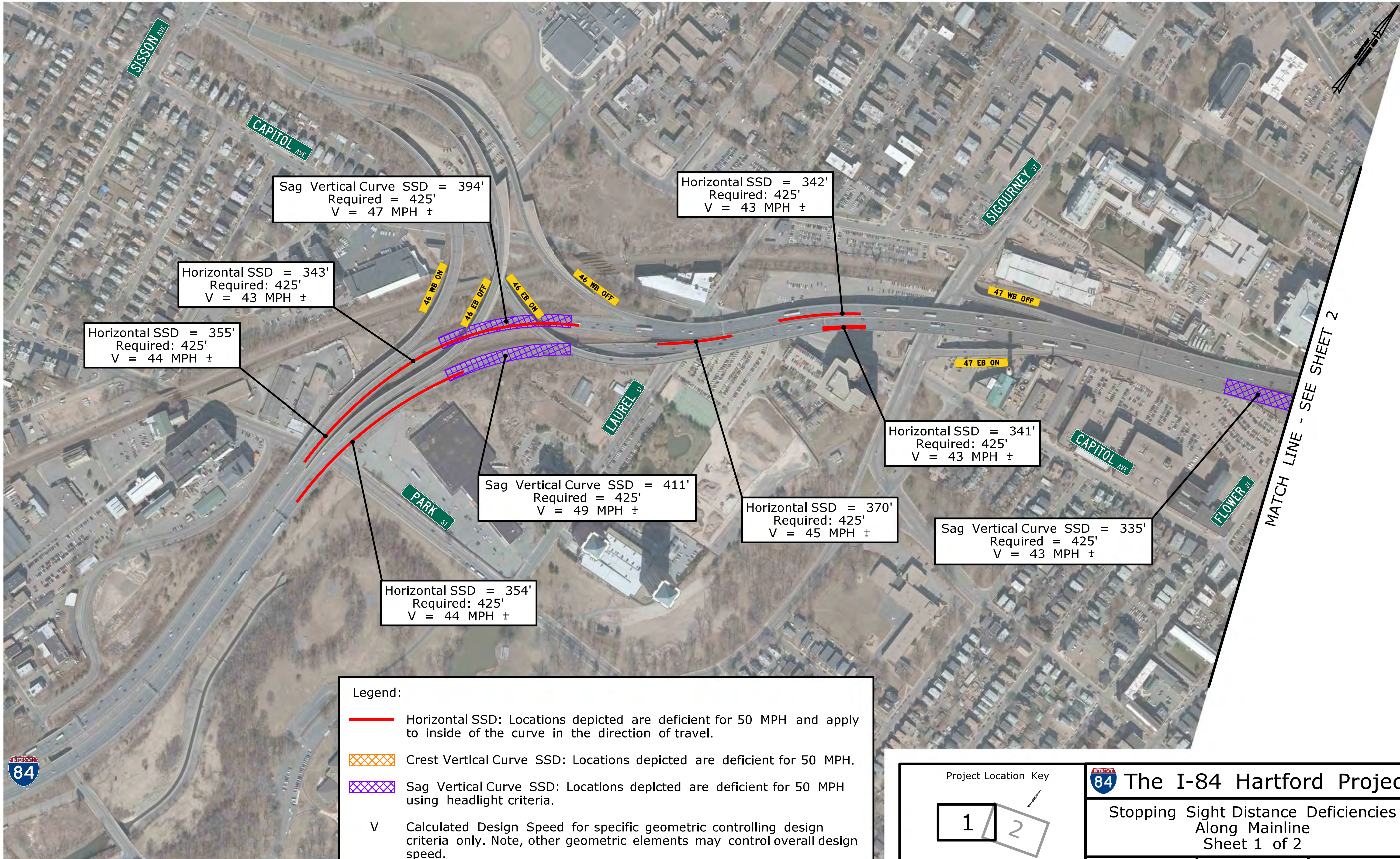
Per CTHDM (Figure 5A), the maximum superelevation rate for the mainline is 6%. Based on available data, the I-84 mainline conforms to this requirement. It should be noted that when the highway was originally constructed in the 1960s, the common acceptable unit of measurement for roadway cross slope was in terms of inches per foot. A maximum superelevation rate of ¾ inch per foot, which is equivalent to 6.25%, was used because it was easier for the construction contractor to build. Although this value provides more superelevation (i.e., a steeper banked section) than the current maximum superelevation rate, the curves within the study corridor with a superelevation rate of 6.25% are not considered deficient.

Stopping Sight Distance

Stopping sight distance (SSD) is the length needed for a driver to see an object, make a decision to apply the brake, then apply the brake and come to a complete, controlled stop. SSD is significantly influenced by vertical alignments and objects that restrict the line of sight on the inside of horizontal curves. Higher-speed facilities, such as expressways, require longer distances to stop and, thusly, a more forgiving design than lower-speed facilities. The CTHDM (Figure 5A) requires a minimum SSD of 425 feet for a speed of 50 mph.

For horizontal curves, physical obstructions such as bridge piers, bridge parapets, barrier curbs, back slopes, and vegetation can limit sight distance on the inside of the curve. The existing mainline within the Project Study Corridor was evaluated for SSD on each horizontal curve. The SSDs on several horizontal curves were found to be deficient, generally due to bridge parapets and barrier curbs obstructing a driver's view and limiting sight distance along the inside of the curve. These deficiencies are depicted in Figure 2-43, following, and in Figure 2-44, page 2-112.

Typical Horizontal and Vertical Curvature Combination Affecting Sight Distance



Legend:

- Horizontal SSD: Locations depicted are deficient for 50 MPH and apply to inside of the curve in the direction of travel.
- Crest Vertical Curve SSD: Locations depicted are deficient for 50 MPH.
- Sag Vertical Curve SSD: Locations depicted are deficient for 50 MPH using headlight criteria.
- V Calculated Design Speed for specific geometric controlling design criteria only. Note, other geometric elements may control overall design speed.

Project Location Key

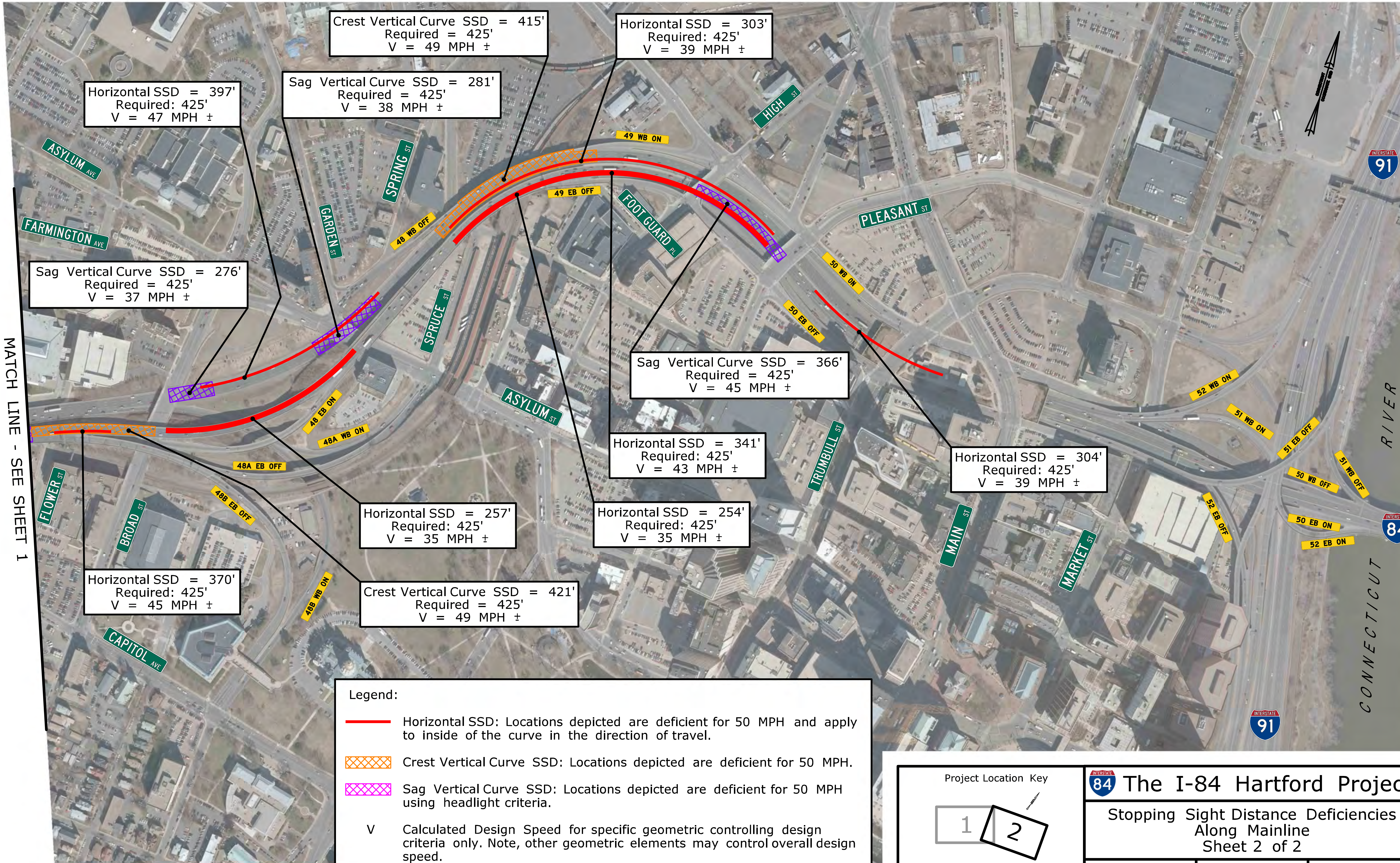
1 2

Not to Scale

The I-84 Hartford Project

Stopping Sight Distance Deficiencies Along Mainline Sheet 1 of 2

Date: 1/20/2015	Drawn By: JLD	Fig. No: 2-43



Legend:

- Horizontal SSD: Locations depicted are deficient for 50 MPH and apply to inside of the curve in the direction of travel.
- Crest Vertical Curve SSD: Locations depicted are deficient for 50 MPH.
- Sag Vertical Curve SSD: Locations depicted are deficient for 50 MPH using headlight criteria.
- V Calculated Design Speed for specific geometric controlling design criteria only. Note, other geometric elements may control overall design speed.

Project Location Key

1 2

Not to Scale

84 The I-84 Hartford Project

Stopping Sight Distance Deficiencies Along Mainline
Sheet 2 of 2

Date: 1/20/2015	Drawn By: JLD	Fig. No: 2-44

The length of vertical curves is dependent on an acceptable rate of change between the two tangent grades. Higher-speed roadways require longer curves, whereas lower-speed roadways have shorter minimum curve lengths. Crest vertical curves, commonly referred to as "hills," are designed to provide a driver sufficient SSD over the crest for the intended speed. Sag vertical curves, commonly referred to as "valleys," are designed so that a vehicle's headlights can illuminate the roadway ahead during nighttime conditions. The distance of the illuminated roadway should be equal to the required SSD for the intended speed.

Each existing mainline vertical curve within the Project Study Corridor was analyzed for deficiencies. Crest curves were evaluated based on minimum stopping sight distance, while sags were evaluated upon headlight sight distance. Deficiencies are depicted in Figure 2-43, page 2-111, and in Figure 2-44, page 2-112.

Maximum and Minimum Grades

Roadway grades significantly impact vehicular operations and safety, particularly for large trucks. The maximum longitudinal grade requirement for a roadway is primarily dependent upon the functional classification of the road, while the minimum grade is typically based upon providing enough pitch to facilitate adequate surface drainage.

For the I-84 mainline throughout the Project Study Corridor, the CTHDM (Figure 5A) requires a maximum grade of 5% and a minimum grade of 0.5%. The maximum grade is based on I-84's functional classification: Urban Freeway (Built-up). The existing I-84 profile grades meet these requirements with the exception of the platform section between Trumbull Street and Main Street, where the grade is essentially flat. However, since this section is not exposed to rainwater, the minimum grade requirement for drainage is not applicable. The maximum grades on I-84 occur between Myrtle Street and High Street where the highway rises up to clear the Amtrak railroad tracks. There is also a 5% grade on I-84 westbound between Flower Street and Broad Street to clear the Amtrak railroad tracks in front of the Aetna campus.

Cross Slopes

A roadway cross slope is the cross-sectional grade intended to convey surface water away from the travel lanes. Per the CTHDM (Figure 5A), the roadway cross slope for tangent sections is required to be between 1.5% - 2.0% for lanes adjacent to the crown and 2.0% for lanes away from the crown. All tangent sections along the existing mainline within the Project Study Corridor were evaluated for cross slope and no major deficiencies were found.

Vertical Clearances

Vertical clearance is the distance above a roadway that is free from obstructions. The minimum vertical clearances for a roadway depend on the functional classification and the facility type. Table 2-23, below, provides design values from the CTHDM for the various highway functional classifications and facility types. These minimum vertical clearances, which apply to the entire roadway width, were used to evaluate the grade-separated intersections within the Project Study Corridor.

Deficient Vertical Clearance on I-84 Eastbound

Table 2-23: Minimum Vertical Clearances

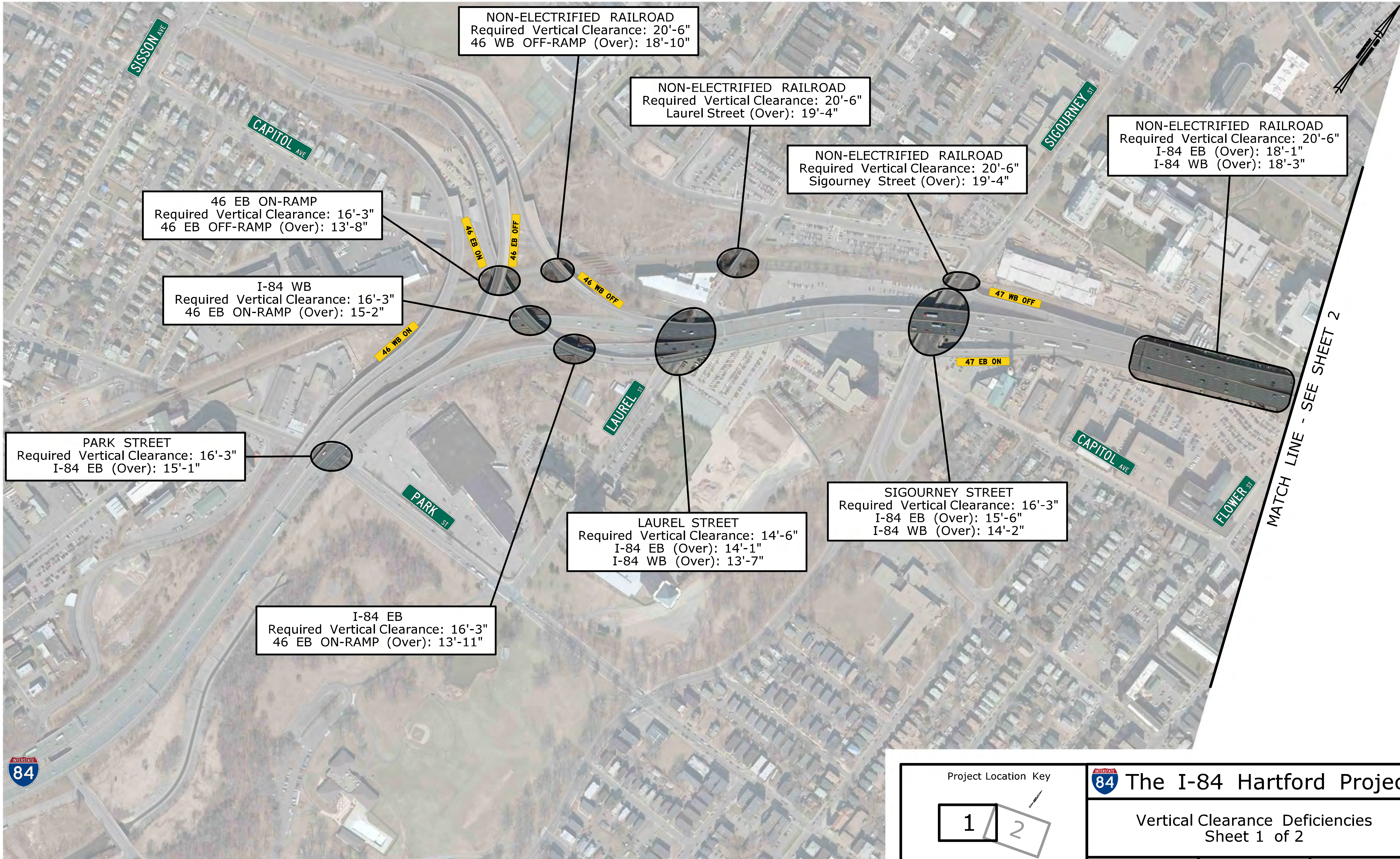
Classification Type	Minimum Vertical Clearance
Freeway/Expressway/Arterial under	16’-3”
Parkway/Collector/Local under	14’-6”
Railroad under Highway (electrified)	22’-6”
Railroad under Highway (non-electrified)	20’-6”
Railroad under Freeway (see below note)	23’-0”
Highway under Overhead Signs	18’-0”
Highway under Pedestrian Bridge	17’-6”

Note: Connecticut General Statutes, Section 13b-251 requires a clearance of 22’-6” over electrified railroads. The 23’-0” value is recommended but not required.

The existing mainline was evaluated using bridge inspection reports provided by the Department against the minimum required clearances for the study area. It was found that there were multiple bridge structures which do not provide adequate vertical clearances and have visible damage from impacts, as shown in Table 2-24, following. Vertical clearance deficiencies are depicted in Figure 2-45, page 2-116, and in Figure 2-46, page 2-117.

Table 2-24: Visible Damage from Bridge Inspection Reports

Description (Damage Location)	Bridge No.	Comment
I-84 Westbound over Park Street	03399A	Minor scrapes/gouges on girder flange
I-84 Eastbound over Park Street	03400A	Scrapes on girder flange
46 Eastbound Off-Ramp over 46 Eastbound On-Ramp/RR	03400C	Flanges bent/dented/gouged
46 Westbound Off-Ramp over Capitol/RR	03402A	Flanges bent/gouged and bowed web
Sigourney St. over Capitol Avenue	03023	Flange has minor scrapes/dent
I-84 Eastbound over local roads/RR	03160A	Isolated gouges in flanges/webs
I-84 Westbound over Sigourney Street	03160B	Flanges have bends and scrapes. Flange damaged and repaired during CT*fastrak* construction 2014/2015.
Pedestrian Walk over 48B On-Ramp	03385	Flanges bent/twisted/gouged
Amtrak RR over 48B On-Ramp	03305	Flanges have random dents
Broad Street over I-84 Westbound	03302	Flanges scraped/gouged/dented, web stiffeners and lateral bracing are bent, and girder web dented
Asylum Street over I-84 Westbound	01764	Gouge in cover plate
I-84 Eastbound over Asylum Street/Amtrak RR	01765	Diaphragm member bowed/bent, flanges and stiffener plate scraped/gouged, and previous damage to stiffener/connection plate weld repaired
I-84 Westbound over Amtrak/local roads	01766	Girder flanges have minor scrapes
Hartford Platform Center over I-84	06559B	Girder flanges have minor to moderate scrapes
I-91 Off (839) over 52 Eastbound Off-Ramp	01428B	Girder web has minor gouges, flange has scrapes
52 Westbound On-Ramp over I-91 Off-Ramp (186)	05921	Flanges have minor scrapes from construction
I-91 Southbound over I-84 & 50 Eastbound On-Ramp	01428A	Flanges - minor scrapes and gouges
52 Eastbound On-Ramp over I-91 Northbound/50 Westbound On-Ramp	01428D	Flanges are bent/dented
50 Westbound Off-Ramp over I-91	06048	Prestressed concrete deck units/flanges are scraped
50 Eastbound On-Ramp over I-91	06049	Prestressed concrete deck units are scraped



Project Location Key

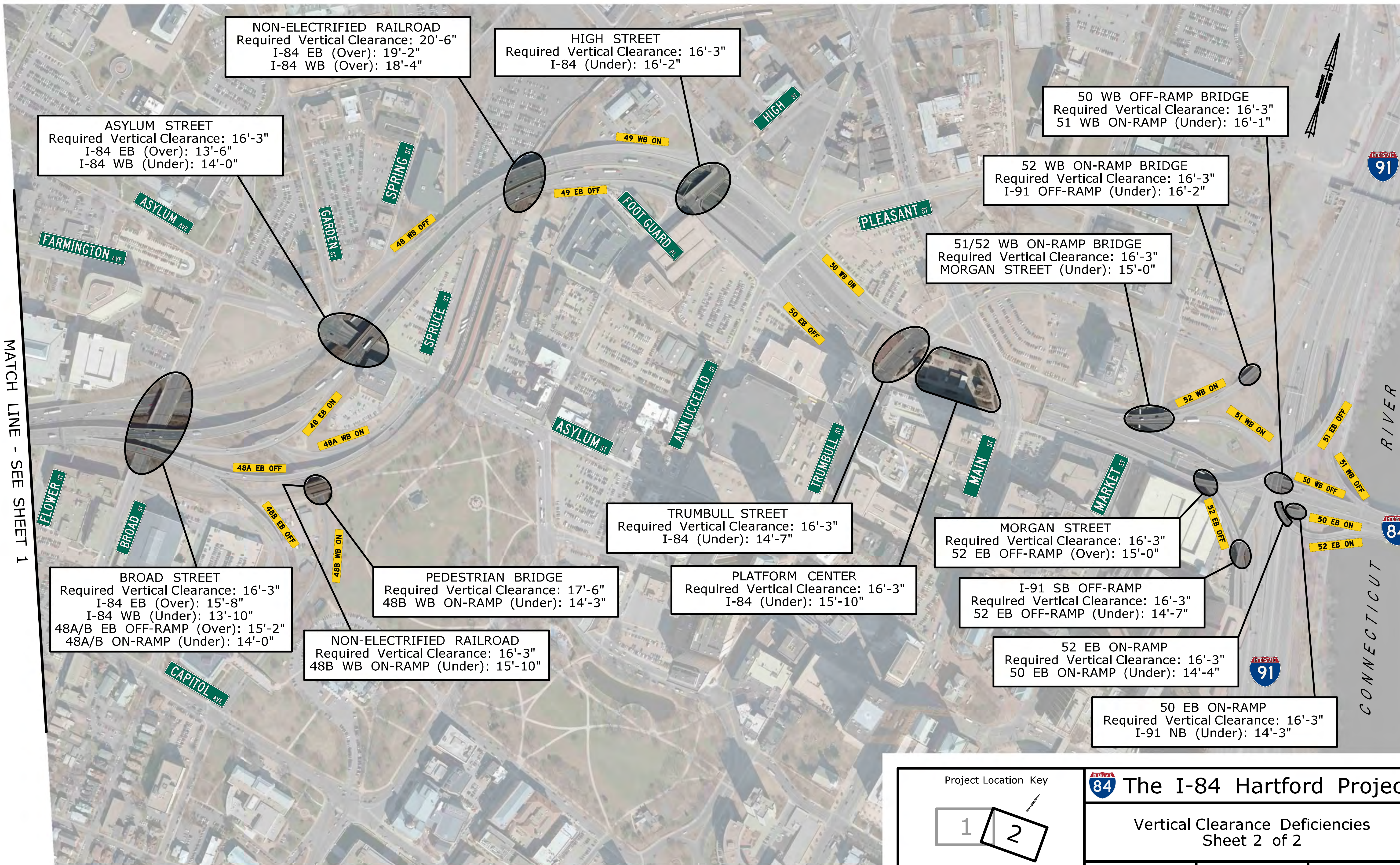
1 2

Not to Scale

The I-84 Hartford Project

Vertical Clearance Deficiencies
Sheet 1 of 2

Date: 1/20/2015	Drawn By: JLD	Fig. No: 2-45



Project Location Key

1 2

Not to Scale

84 The I-84 Hartford Project

Vertical Clearance Deficiencies
Sheet 2 of 2

Date: 1/20/2015	Drawn By: JLD	Fig. No: 2-46

Roadside Clear Zones

Longitudinal Concrete Barrier along Both Sides of Mainline

Per AASHTO, clear zone is used to designate the unobstructed, traversable area provided beyond the edge of the traveled way for the recovery of 80-85% of errant vehicles. The clear zone distance for the I-84 mainline is measured from the edge of the travel way, whereas the clear zone distance for a highway ramp is measured from the edge of pavement. Typically, the clear zone width beyond the edge of pavement is a relatively flat, turfed area suitable for the recovery of errant vehicles. The desired minimum width is dependent upon traffic volumes, speeds, and roadside geometry.

The CTHDM (Figure 13-2A), provides clear zone values as a function of speed, traffic volume, and the rate of fill slopes with a positive or negative shelf. Each application of the clear zone distance should be evaluated individually. The minimum recommended clear zone distance for a posted speed of 50 mph is 20 feet, per CTHDM (Figure 13-2A). The majority of the mainline within the Project Study Corridor does not achieve this requirement due to the urban location and because the majority of the highway is supported by bridges. In general, it is not practicable to provide a lateral clear zone on a bridge because the additional width would require a significant expenditure.

There are several areas where leading-end bridge parapets are within the clear zone. These blunt ends are protected with an impact attenuator consisting of either a guiderail transition or a barrel array. Leading-end guiderail end-anchorages are located outside the clear zone.

There are several areas where the I-84 substructure pier columns are within the clear zone of local roads. Laurel Street has pier columns along both edges of road and within a raised median. These vertical obstructions are located 1.5 feet or greater beyond the curbline, which is required in an urban environment. However, this 1.5 foot minimum clearance is required for the placement of utility poles and is not considered a clear zone, but an “operational offset”.

Basic Number of Lanes and Lane Balance

Per AASHTO, designation of the basic number of lanes is fundamental to establishing the number and arrangement of lanes on a freeway. Consistency should be maintained in the number of lanes provided along any route of arterial character. Stating it another way, the basic number of lanes is defined as a minimum number of lanes designated and maintained over a significant length of a route, irrespective of changes in traffic volume and lane balance needs. The basic number of lanes is a constant number of lanes assigned to a route, exclusive of auxiliary lanes.

I-84 was evaluated to determine the basic number of lanes within the Project Study Corridor. The results are depicted in Figure 2-47, page 2-121 and in Figure 2-48, page 2-122. From Waterbury to the Massachusetts State Line (approximately 60 miles), I-84 has three basic lanes in each direction, with the exception of the Project Study Corridor. I-84 eastbound provides three basic lanes leading up to the overhead sign support just east of the Sigourney Street eastbound on-ramp. At this point, the third I-84 basic lane becomes an auxiliary lane for I-91. I-84 does not regain the third basic lane until it merges with the I-84 eastbound on-ramp from Route 2 in East Hartford, a distance of approximately 2.5 miles.

I-84 westbound provides three basic lanes leading up to the Bulkeley Bridge, where an overhead sign support designates the third basic lane as an "exit only" lane for Main Street. I-84 westbound regains the third basic lane at the Capitol Avenue/Asylum Street left-hand on-ramp, a distance of approximately 1.4 miles.

These changes in the basic number of lanes within the Project Study Corridor violate the recommendation made by AASHTO regarding the need to maintain consistency in the basic number of lanes for a facility.

Lane balance is an important operational characteristic that affects traffic flow. Per AASHTO, to facilitate efficient traffic operation through and beyond an interchange, there should be balance in the number of traffic lanes on the freeway and ramps. Generally, the number of lanes in the freeway mainline should not be reduced by more than one lane at an exit or increased by more than one lane at an entrance. Sudden lane discontinuities generate unnecessary weaving and maneuvering by drivers. This disrupts traffic flow and contributes to driver confusion and traffic accidents.

I-84 Eastbound – Two Basic Lanes & One Dedicated I-91 Lane with Two Lane Off-Ramp for Exit 48A&B

As applied to interchange design, auxiliary lanes may be provided to comply with the principle of lane balance. Operational efficiency may be improved by using a continuous auxiliary lane between the entrance and exit terminals where interchanges are closely spaced. They also can play an important role in the ability of the freeway system to efficiently and safely accommodate higher traffic volumes without the addition of basic freeway lanes.

The following auxiliary lanes were identified within the Project Study Corridor along I-84 eastbound:

- Sisson Avenue On-Ramp (Exit 46) to Asylum Street Off-Ramp (Exit 48A)
- Sigourney Street On-Ramp (Exit 47) to Capitol Avenue Off-Ramp (Exit 48B)
- Broad Street On-Ramp (Exit 48) to I-91 Northbound On-Ramp (Exit 51)
- I-84 Basic Lane at Sigourney Street reassigned to I-91 Southbound Off-Ramp (Exit 52)

The following auxiliary lanes were identified within the Project Study Corridor along I-84 westbound:

- I-91 Northbound (Exit 51) On-Ramp to Sisson Avenue Off-Ramp (Exit 46)
- I-91 Southbound (Exit 52) On-Ramp to Sigourney Avenue Off-Ramp (Exit 47)
- High Street On-Ramp (Exit 49) to Asylum Street Off-Ramp (Exit 48)

I-84 was evaluated for compliance with the lane balance principle within the Project Study Corridor. Locations that did not conform are depicted in Figure 2-47, following and in Figure 2-48, page 2-122. Generally, I-84 throughout the Project Study Corridor utilizes a series of continuous auxiliary lanes between entrance and exit ramps to comply with the lane balance principle; however, the following locations were found to be non-compliant:

- I-84 eastbound – two eastbound auxiliary lanes are dropped at the Asylum Street/Capitol Avenue exit ramps (48A/B Eastbound Off)
- I-84 westbound – two westbound auxiliary lanes are added at the I-91 Northbound/Southbound entrance ramps (51 &52 Westbound On-Ramps)

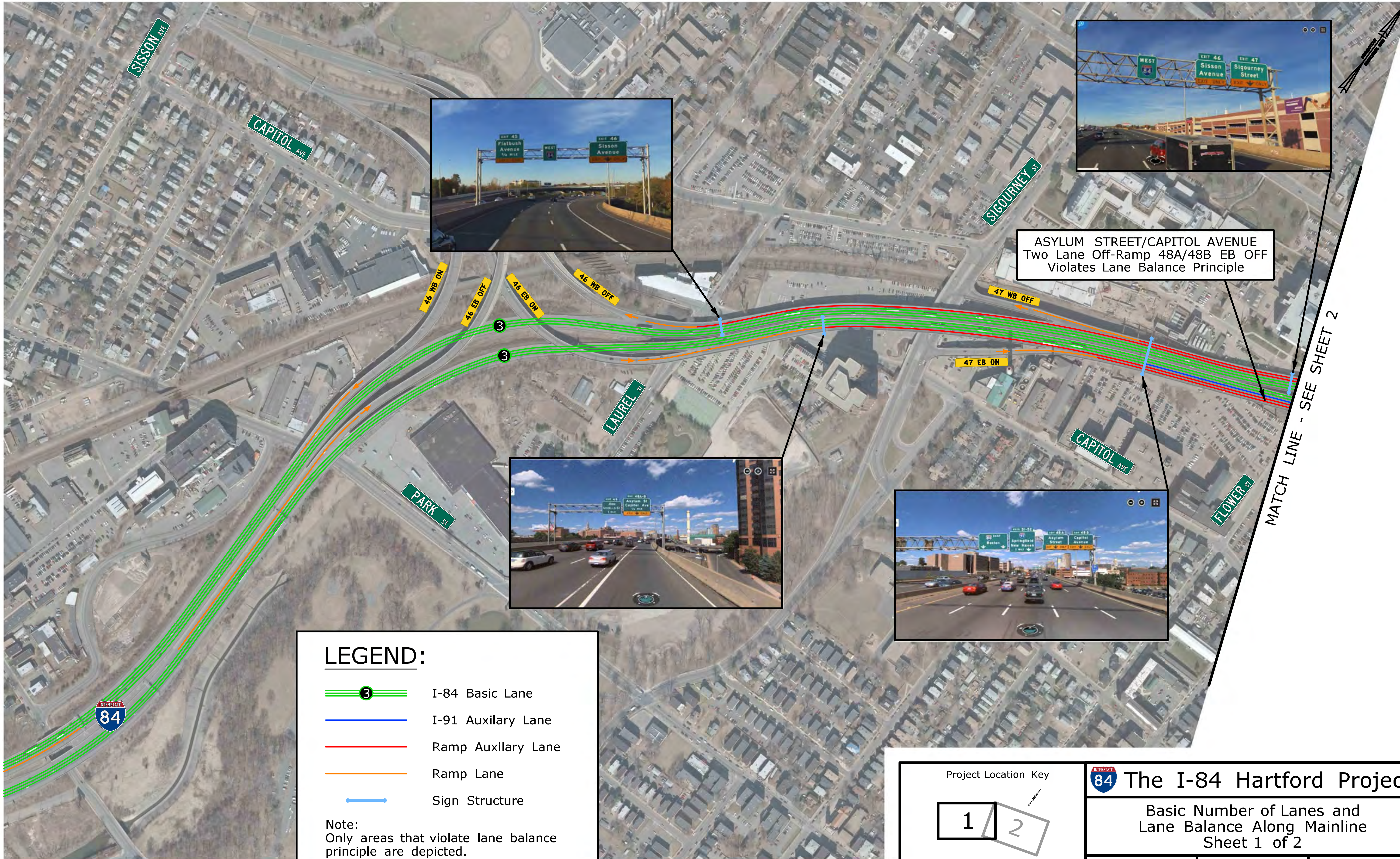
Interchange Spacing, Uniformity, and Decision Sight Distance

The spacing of interchanges has a major effect on the operation of a facility. AASHTO recommends a minimum interchange spacing of one mile in urban areas. This minimum distance between ramp junctions depends to a large degree on whether effective signing can be provided to inform, warn, and control drivers as well as to provide sufficient distance for vehicles to safely maneuver on and off the highway.

Interchanges should also be uniform to the maximum extent possible, especially in urban areas where they are typically more closely spaced. An inconsistent arrangement of ramps between successive interchanges may cause driver confusion, resulting in drivers slowing down in high speed lanes and making unexpected maneuvers.

Additionally, AASHTO recommends that, in locations where a driver needs to make complex or instantaneous decisions, where information is difficult to perceive, or when unexpected or unusual maneuvers are needed, that decision sight distance (DSD) should be provided. DSD is the distance needed for a driver to detect an unexpected or otherwise difficult-to-perceive information source or condition in a roadway environment that may be visually cluttered, recognize the condition or its potential threat, select an appropriate speed and path, and initiate and complete complex maneuvers. DSD offers drivers additional margin for error and affords them sufficient length to maneuver their vehicles at the same or reduced speed, rather than to just stop. In urban locations where the mainline geometry is typically complex and interchanges are closely spaced, it is desirable to provide DSD approaching an exit or entrance ramp.

In terms of uniformity, exit and entrance ramps on the left-hand side of the traveled way are an example of an inconsistent interchange arrangement. These types of ramps violate driver expectancy and therefore should be avoided whenever possible. I-84 throughout the Project Study Corridor has



LEGEND:

(green lines with 3)	I-84 Basic Lane
(blue line)	I-91 Auxilary Lane
(red line)	Ramp Auxilary Lane
(orange line)	Ramp Lane
(light blue line)	Sign Structure

Note:
Only areas that violate lane balance principle are depicted.

Project Location Key

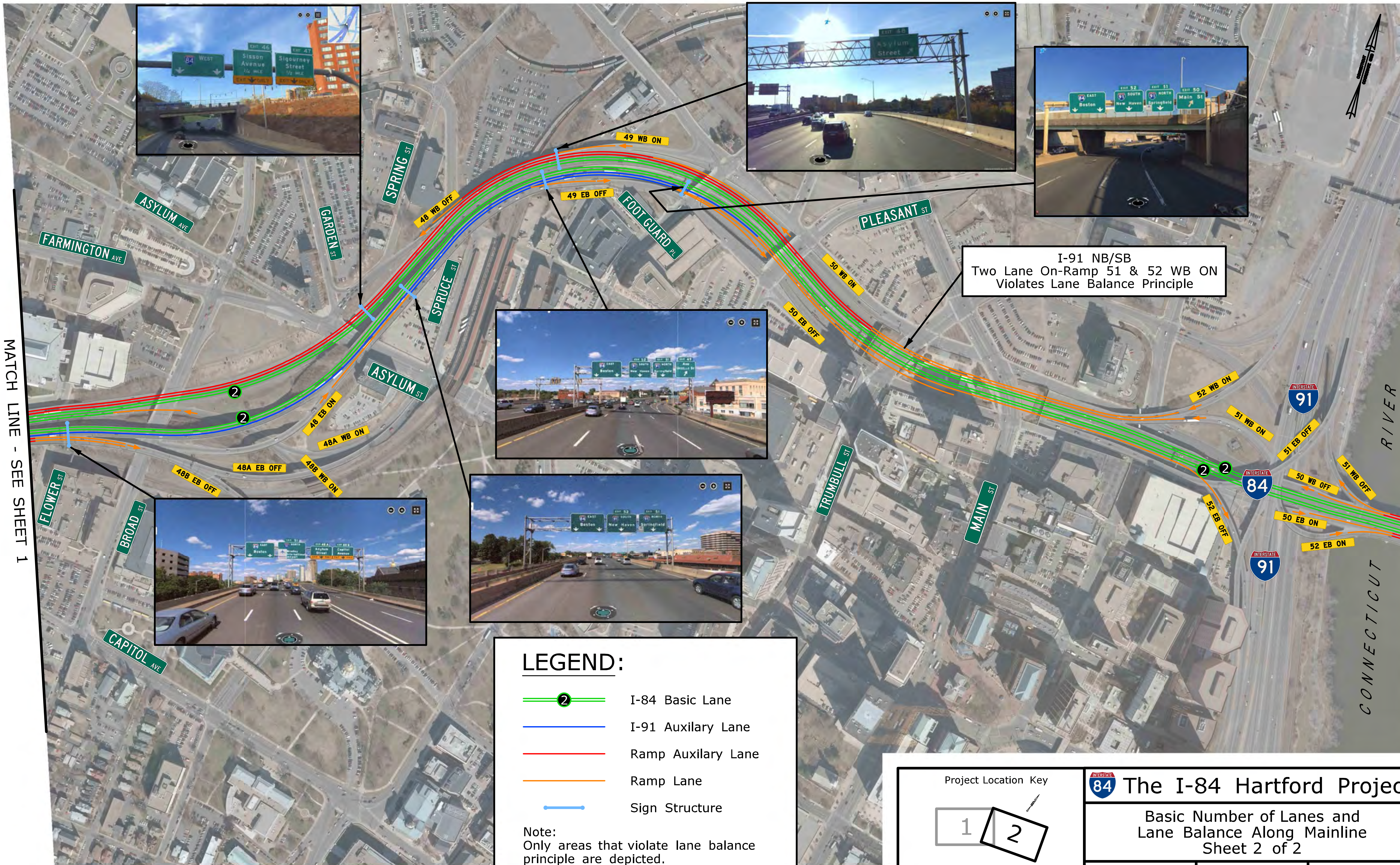
1 2

Not to Scale

The I-84 Hartford Project

Basic Number of Lanes and
Lane Balance Along Mainline
Sheet 1 of 2

Date: 1/20/2015	Drawn By: JLD	Fig. No: 2-47



LEGEND:

- I-84 Basic Lane
- I-91 Auxilary Lane
- Ramp Auxilary Lane
- Ramp Lane
- Sign Structure

Note:
Only areas that violate lane balance principle are depicted.

Project Location Key

1 2

Not to Scale

The I-84 Hartford Project

Basic Number of Lanes and Lane Balance Along Mainline
Sheet 2 of 2

Date: 1/20/2015	Drawn By: JLD	Fig. No: 2-48

three left-hand exit and entrance ramps that do not adhere to the uniformity principle as depicted in Figure 2-47, page 2-121, Figure 2-48, page 2-122, and identified below:

- I-84 Eastbound 46 (Left Hand Off-Ramp) to Sisson Avenue
- I-84 Westbound 45 (Left Hand Off-Ramp) to Flatbush Avenue (Ramp is just outside of the Project Study Corridor)
- I-84 Westbound 48A/B (Left Hand On-Ramp) from Asylum Street/Capitol Avenue

The successive spacing, uniformity, and DSD for ramps within the Project Study Corridor have been evaluated against the recommended design values provided in AASHTO/CTHDM. The results of the evaluation are depicted in Table 2-25 and Table 2-26, following.

Table 2-25: I-84 Eastbound Ramps

Terminal	Type	Left Hand Terminal	Decision Sight Distance to Ramp (1,030' Required)	Recommended Separation Distance (feet)	Measured Separation Distance (feet)
46 OFF	Exit-Entrance	Yes	>1,030	500	2,690
46 ON			>1,030		
46 ON	Entrance-Entrance		>1,030	1,000	1,210
47 ON			575		
47 ON	Entrance-Exit		575	2,000	950
48A&B OFF			>1,030		
48A&B OFF	Turning		>1,030	600	620
48B OFF			450		
48A&B OFF	Exit-Entrance		>1,030	500	1,550
48 ON			550		
48 ON	Entrance-Exit		550	2,000	1,200
49 OFF			200		
49 OFF	Exit-Exit		200	1,000	900
50 OFF			400		
50 OFF	Exit-Exit		400	1,000	500
51 OFF			750		
51 OFF	Exit-Exit		750	1,000	2,200
52 OFF			>1,030		
52 OFF	Exit-Entrance		>1,030	500	950
50 ON			>1,030		
50 ON	Entrance-Entrance		>1,030	1,000	35
52 ON			>1,030		
Values depicted in **RED** represent values led than the minimum recommended					

Table 2-26: I-84 Westbound Ramps

Terminal	Type	Left Hand Terminal	Decision Sight Distance to Ramp (1,030' Required)	Recommended Separation Distance (feet)	Measured Separation Distance (feet)
51 OFF	Exit-Exit		>1,030	1,000	**160**
50 OFF			>1,030		
50 OFF	Exit-Entrance		>1,030	500	1,370
51/52 ON			>1,030		
51/52 ON	Entrance-Entrance		>1,030	1,000	1,600
50 ON			**790**		
50 ON	Entrance-Entrance		**790**	1,000	**875**
49 ON			**600**		
49 ON	Entrance-Exit		**600**	2,000	**545**
48 OFF			**640**		
48 OFF	Exit-Entrance		**640**	500	1,365
48A&B ON		**Yes**	**980**		
48A&B ON	Entrance-Exit	**Yes**	**980**	2,000	**1,090**
47 OFF			>1,030		
47 OFF	Exit-Exit		>1,030	1,000	2,000
46 OFF			**1,010**		
46 OFF	Exit-Entrance		**1,010**	500	2,075
46 ON			**750**		
Values depicted in **RED** represent values led than the minimum recommended					

Highway/Ramp Weaving

There are several weaving sections within the study corridor. A weave section is a highway segment where vehicles trying to exit the facility are competing with vehicles trying to enter the facility. The weave becomes constrained when the mixing volumes are heavy and the weave section is relatively short. Constrained weaves are a source of congestion because mainline vehicles reduce their speed to find an acceptable gap between the vehicles entering the mainline. For multilane highways, the speed differential between the free-flow vehicles (vehicles not exiting the highway) and the weaving vehicles can lead to rear-end and sideswipe accidents.

On I-84 eastbound, the first weave section begins at the Sigourney Street on-ramp. The on-ramp enters the highway as an auxiliary lane that is designated as an exit-only for Asylum Street / Capitol Street (Exit 48A/B) with an overhead sign structure at its merge with I-84. The weave length is approximately 2,150 feet long. The minimum distance between an on-ramp and off-ramp is 2,000 feet; however, a preliminary traffic analysis for this section determined that a distance of over one mile would be needed between the ramps to improve the traffic operation. There is another weaving section within the aforementioned section. The Sigourney Street eastbound on-ramp merges to the right of the Sisson Avenue auxiliary lane. This lane add becomes an exit-only lane for Capitol Avenue (Exit 48B) approximately 950 feet after the merge with I-84. Between these ramps, the outside basic lane for I-84 eastbound is designated as an I-91 auxiliary lane. I-84 eastbound vehicles entering from the Sigourney Street on-ramp must make three lane changes (two within 950 feet) to reach the I-84 through lanes. This weaving action creates a significant amount of friction between the ramps, auxiliary lanes, and the mainline.

The final eastbound weaving section is between the Broad Street on-ramp and the I-91 interchange. The Broad Street on-ramp enters the highway as a lane-add to the right of the I-91 auxiliary lane. The lane-add is immediately signed as an exit-only lane for I-91 south (Exit 51), and the I-91 auxiliary lane becomes an exit-only lane for I-91 north (Exit 52). I-84 eastbound vehicles entering from Broad Street must make two lane changes while negotiating the sharp horizontal curve, steep vertical downgrade and the weaving vehicles from the auxiliary lane and I-84. The distance between the Broad Street on-ramp and the I-91 north off-ramp is approximately 1,800 feet. There are also two lower volume off-ramps within this section, Ann Uccello Street (Exit 49) and Main Street (Exit 50).

For I-84 westbound, the first weaving segment is between the High Street on-ramp and the Asylum Street off-ramp (Exit 48). The High Street on-ramp enters the mainline as an auxiliary lane that ends as an exit only lane at Asylum Street, a distance of approximately 500 feet. The Asylum Street off-ramp has the highest morning peak hour volume within the study corridor, whereas the High Street on-ramp is significantly lower. The traffic queues for the Asylum Street off-ramp extend well beyond the on-ramp from High Street. The traffic queue essentially acts like a barrier to the vehicles entering the highway, causing significant friction to both traffic streams.

The westbound weaving sections are between the left-hand on-ramp from Capitol Avenue/Asylum Street and the exit-only lane drops at Sigourney Street (Exit 47) and Sisson Avenue (Exit 46). This maneuver is prohibited with signage prior to the merge with the highway; however, without a physical barrier to prevent the move, many vehicles attempt it. Within a distance of approximately 1,100 feet, vehicles attempt to cross four lanes of traffic to reach the Sigourney Street off-ramp. The distance between the Capitol Avenue/Asylum Street on-ramp and the Sisson Avenue off-ramp is approximately 4,100 feet.

2.5.4 Interchange Ramp Review

Methodology

The Project Study Corridor includes eight full or partial interchanges consisting of multiple ramps of varying lengths and complexities. These interchanges are listed in Table 2-1 which is included in Section 2.1.1: Mainline and Interchange Ramps.

Per AASHTO, the term "ramp" includes all types, arrangements, and sizes of turning roadways that connect two or more legs at an interchange. A ramp is typically characterized as a transition segment between facilities. On-ramps provide a long enough distance for vehicles to accelerate to an acceptable speed prior to entering the highway, whereas off-ramps provide enough distance to decelerate from highway speeds to a complete stop or to the first governing geometric constraint. Ramps can adversely influence operating conditions on freeways if the demand for their use is excessive or if their design is deficient. In urbanized areas, high turning volumes and close spacing between adjacent ramp terminals may result in congestion on the crossroad that affects traffic on the ramp and may spill back onto the mainline freeway. These effects may include queue spillback, stop-and-go travel, heavy weaving volumes, and poor traffic signal progression.

The design speed of a ramp is dependent on the mainline design speed, the type of interchange (system vs. service), and the type of connection (direct vs. semi-direct). Recommended ramp speeds are depicted in Table 2-27, below, and were used to evaluate the existing ramp conditions. For direct connections, the ramps should be designed to handle speeds between the mid and high ranges but not less than 40 mph. For semi-direct connections, the ramps should be designed to handle speeds between the mid and high ranges but not less than 30 mph. These values apply to the sharpest, or controlling, ramp curve, usually on the ramp proper. These speeds do not pertain to the ramp terminals, which should be properly transitioned and provided with speed change facilities adequate for the highway speed involved.

Table 2-27: Interchange Ramp Design Speed

Mainline Speed (mph)	50
Ramp Speed (mph)	
High Range (85%)	45
Mid Range (70%)	35
Low Range (50%)	25

The existing geometry of each entrance ramp was used to calculate an existing ramp speed. Typically, this speed is controlled by the minimum horizontal radius, vertical curvature, and the stopping sight distance of the ramp. For on-ramps, acceleration lengths were obtained using the speed differential between the calculated speed of the ramp and the posted speed of the mainline.

Off-ramps were evaluated to determine if the existing deceleration lengths were adequate. The required deceleration length is the distance needed for a vehicle to safely decelerate from the mainline traveling speed. This distance may be required to decelerate to a lower speed curve on the ramp or to make a complete stop. Since the majority of the off-ramps within the Project Study Corridor experience heavy vehicular volume with corresponding queues that routinely back up the ramps, deceleration distance was measured to the back of the queues instead of the intersection stop bar.

Queue lengths were available from three sources: Synchro, Vissim, and SkyComp. Queue lengths calculated in Synchro were significantly lower than those observed in the field, even for 2040 design year volumes, since the program analyzes each intersection individually and neglects complex interactions between intersections. In the Vissim simulations, ramp queues routinely extended onto the I-84 mainline and merged with mainline queues, and thus cannot be easily measured. SkyComp ramp queue lengths are derived from actual field observations, and are therefore considered the most accurate. Although 2040 no-build queues are not available for SkyComp, traffic growth rates are projected to be relatively flat, so the current SkyComp queue lengths were also used for the design year analysis.

The results of this evaluation, shown in Table 2-28, following, indicate that the Exit 47 westbound off-ramp, Exit 48B eastbound off-ramp, and Exit 48 westbound off-ramp do not provide sufficient deceleration distances to the SkyComp observed queue lengths. For these ramps, the queue lengths back up onto the mainline, leaving stopped vehicles adjacent to the mainline travel lanes. All other ramps within the Project Study Corridor, other than those locations noted, provide ample deceleration distance to the SkyComp observed queue lengths.

CTHDM recommends that the minimum paved width of a one-way, one-lane ramp should be 26 feet. This cross section consists of a 12 foot traveled way, a 4 foot left shoulder and a 10 foot right shoulder when viewed in the direction of travel. It should be noted that the current ramp pavement marking requirements differ from what was required when I-84 was originally constructed: the previous requirements consisted of a 14 foot traveled way, 4 foot left shoulder and 8 foot right shoulder.

Table 2-28: Deceleration Lengths

Intersection Location	2013 95th Percentile Queue Length		2040 95th Percentile Queue Length	
Interchange 46 Eastbound and Westbound Off-Ramps at Sisson Avenue/ West Boulevard	487’	Yes	468’	Yes
Interchange 47 Westbound Off-Ramp at Sigourney Street	*1,300’	**No**	*1,300’	**No**
Interchange 48B Eastbound Off-Ramp at Capitol Avenue/Oak Street	400’	**No**	540’	**No**
Interchange 48A Eastbound Off-Ramp at Asylum Street/Spruce Street	293’	Yes	431’	Yes
Interchange 48 Westbound Off-Ramp at Asylum Street	*2,500’	**No**	*2,500’	**No**
Interchange 49 Eastbound Off-Ramp at High Street/Chapel Street South	71’	Yes	81’	Yes
Interchange 50 Eastbound Off-Ramp at Trumbull Street/Chapel Street South	251’	Yes	269’	Yes
Interchange 50 Westbound Off-Ramp at Market Street/North Morgan Street	183’	Yes	222’	Yes

Note: “Yes” indicates that deceleration lengths are sufficient based on indicated queue; “**No**” indicates that deceleration lengths are deficient based on indicated queue.
* Observed 2014 SkyComp queue length utilized in place of 95th percentile values

The results of these evaluations are described in the following sections and summarized in Table 2-29, following. Each interchange and its ramps are described in detail in the following section. The section focuses on assessing individual ramp geometric designs, widths, and acceleration/deceleration lengths.

Table 2-29: Interchange Ramp Review

Design Element	CTHDM Section	CTDOT Standard	Interchange 46 (Sisson Avenue)				Interchange 47 (Sigourney Street)	
			46 EB OFF	46 EB ON	46 WB ON	46 WB OFF	47 EB ON	47 WB OFF
			To Sisson	From Sisson	From Sisson	To Sisson	From Sigourney	To Sigourney
Functional Classification/Ramp Type	-	Urban Freeway	Directional	Directional	Directional	Directional	Semi-Directional	Semi-Directional
Posted Speed (Mainline)	6-2.02	50 mph	50 mph	50 mph	50 mph	50 mph	50 mph	50 mph
Posted Speed (Ramp)	-	-	None	30 mph	30 mph	None	None	25 mph[1]
Evaluated Speed	12-4.01	35 mph / 40 mph	40 mph	40 mph	40 mph	40 mph	35 mph	35 mph
Controlling Criteria Speed[2]	-	-	**30 mph**	**25 mph**	**30 mph**	**30 mph**	35 mph	35 mph
Travel Lane Width	12-4.02	12'	14'	14'	14'	14'	12'	12'
Right Shoulder Width	12-4.02	10'	**6'**-10'	**2'**-35'	**3'**-10'	**2'-6'**	**3'**	**3'**
Left Shoulder Width	12-4.02	4'	**3'**-7'	4'	6'-40'	**2'-3'**	**3'**	**3'**
Cross Slope Travel Lane & Right Shoulder	12-4.02 Fig. 12-4B	1.5%	2%	1%	2%	N/A	2%	2%
Cross Slope Left Shoulder	12-4.02 Fig. 12-4B	4%	Same as travel lane	Same as travel lane	Same as travel lane	Same as travel lane	Same as travel lane	Same as travel lane
Roadside Clear Zone	13-2.0	14'	Acceptable	Acceptable	Acceptable	Acceptable	N/A	N/A
Acceleration or Deceleration Length/Available Length	12-3.0	Variable Depending on Grade (Criteria/Actual)	315'/>315'	N/A (Auxiliary Lane)	450'/>450'	N/A (Auxiliary Lane)	N/A (Auxiliary Lane)	435'/**0'**[3]
Stopping Sight Distance[4]	7-1.0	250' / 305'	**212' H**	**175' H**	**207' H**	**225' H**	291' H	293' V
Minimum Radius (e=6.0%)	8-2.02	385' / 510'	**480'**	**400'**	550'	635'	1000'	5130'
Maximum Superelevation	8-2.02	6%	6.0%	6.0%	6.0%	6.0%	N/A	N/A
Maximum Grade	12-4.04	5-7% / 4-6%	4.0%	3.9%	4.1%	1.4%	4.9%	5.1%
Minimum Grade	9-2.03	0.5%	2.3%	3.2%	1.5%	0.9%	1.0%	1.0%
Vertical Clearance - Overhead Sign	9-4.0	18'-0"	N/A	N/A	N/A	N/A	Adequate	Adequate
Vertical Clearance - Highway over Arterial/Freeway	9-4.0	16'-3"	**13'8" (over 46 EB On)**	**13'8" (under 46 EB Off) 13'-11" (over I-84 EB) 15'-2" (over I-84 WB)**	N/A	N/A	N/A	N/A
Vertical Clearance - Highway over Collector/Local	9-4.0	14'-6"	>14'-6"	>14'-6"	>14'-6"	>14'-6"	N/A	N/A
Vertical Clearance - Highway over Non-Electrified RR	9-4.0	20'-6"	>20'-6"	>20'-6"	>20'-6"	>20'-6"	N/A	N/A

1. Ramp advisory speed warning sign
2. Controlling criteria speed is maximum allowable speed based upon deficiencies in stopping sight distance or curvature.
3. 2040 95th percentile queue extends beyond the painted ramp gore, rendering the deceleration length deficient.
4. Notation after distance is for limiting horizontal (H) or vertical (V) curvature.

Values depicted in **red** represent elements that are less than the minimum required for the evaluated speed and roadway classification.

Table 2-29 (ctd.): Interchange Ramp Review

Design Element	CTHDM Section	CTDOT Standard	Interchange 48 (Capitol Avenue/Asylum Street)					
			48B EB OFF	48A EB OFF	48 EB ON	48B WB ON	48A WB ON	48 WB OFF
			To Capitol	To Asylum	From Broad	From Capitol	From Asylum	To Asylum
Functional Classification/Ramp Type	-	Urban Freeway	Semi-directional	Semi-directional	Semi-Directional	Semi-directional	Semi-directional	Semi-Directional
Posted Speed (Mainline)	6-2.02	50 mph	50 mph	50 mph	50 mph	50 mph	50 mph	50 mph
Posted Speed (Ramp)	-	-	30 mph[1]	30 mph[1]	None	None	None	25 mph[1]
Evaluated Speed	12-4.01	35 mph	35 mph	35 mph	35 mph	35 mph	35 mph	35 mph
Controlling Criteria Speed[2]	-	-	**25 mph**	35 mph	**30 mph**	**25 mph**	**30 mph**	**30 mph**
Travel Lane Width	12-4.02	12'	12'	12'	14'	14'	14'	12'
Right Shoulder Width	12-4.02	10'	**3'**	**6'**	**3'**-10'	10'	**2'-7'**	**2'-6'**
Left Shoulder Width	12-4.02	4'	**3'**-8'	6'	**2'**-4'	**2'-3'**	**2'**	6'
Cross Slope Travel Lane & Right Shoulder	12-4.02 Fig. 12-4B	1.5%	Banked	Banked	Banked	Banked	Banked	1%
Cross Slope Left Shoulder	12-4.02 Fig. 12-4B	4%	N/A	Same as travel lane	Same as travel lane	Same as travel lane	Same as travel lane	4%
Roadside Clear Zone	13-2.0	14'	Acceptable	Acceptable	N/A	Acceptable	Acceptable	Acceptable
Acceleration or Deceleration Length/Available Length	12-3.0	Variable Depending on Grade (Criteria/Actual)	N/A (Auxiliary Lane)	N/A (Auxiliary Lane)	N/A (Auxiliary Lane)	N/A (Auxiliary Lane)	N/A (Auxiliary Lane)	435'/**0'**[3]
Stopping Sight Distance[4]	7-1.0	250'	**180' V**	290' H	**240' H**	**155' H**	**209' V**	**207' V**
Minimum Radius (e=6.0%)	8-2.02	385'	410'	830'	500'	410'	400'	N/A
Maximum Superelevation	8-2.02	6%	6.0%	6.0%	6.0%	6.0%	6.0%	N/A
Maximum Grade	12-4.04	5-7%	3.5%	5.9%	2.2%	5.0%	4.6%	4.7%
Minimum Grade	9-2.03	0.5%	0.8%	0.5%	**0.2%**	3.8%	1.0%	0.5%
Vertical Clearance - Overhead Sign	9-4.0	18'-0"	**17'8"**	**17'8"**	N/A	N/A	N/A	N/A
Vertical Clearance - Highway over Arterial/Freeway	9-4.0	16'-3"	**15'-2"**	**15'-2"**	>16'-3"	>16'-3"	>16'-3"	N/A
Vertical Clearance - Highway over Collector/Local	9-4.0	14'-6"	N/A	>16'-3"	N/A	**14'-0"**	**14'-0"**	N/A
Vertical Clearance - Highway over Non-Electrified RR	9-4.0	20'-6"	24'-8"	N/A	N/A	**15'-10" (under RR) 14'-3" (under ped. bridge)**	N/A	N/A

1. Ramp advisory speed warning sign
2. Controlling criteria speed is maximum allowable speed based upon deficiencies in stopping sight distance or curvature.
3. 2040 95th percentile queue extends beyond the painted ramp gore, rendering the deceleration length deficient.
4. Notation after distance is for limiting horizontal (H) or vertical (V) curvature.

Values depicted in **red** represent elements that are less than the minimum required for the evaluated speed and roadway classification.

Table 2-29 (ctd.): Interchange Ramp Review

Design Element	CTHDM Section	CTDOT Standard	Interchange 49 (High Street)		Interchange 50 (Main Street/Trumbull Street/Morgan Street)			
			49 EB OFF	49 WB ON	50 EB OFF	50 EB ON	50 WB ON	50 WB OFF
			To High	From High	To Trumbull	From Morgan	From Trumbull	To Market
Functional Classification/Ramp Type	-	Urban Freeway	Semi-Directional	Semi-Directional	Semi-Directional	Semi-Directional	Semi-Directional	Semi-Directional
Posted Speed (Mainline)	6-2.02	50 mph	50 mph	50 mph	50 mph	50 mph	50 mph	50 mph
Posted Speed (Ramp)	-	-	25 mph[1]	None	30 mph[1]	None	None	None
Evaluated Speed	12-4.01	35 mph	35 mph	35 mph	35 mph	35 mph	35 mph	35 mph
Controlling Criteria Speed[3]	-	-	**20 mph**	35 mph	35 mph	35 mph	**25 mph**	**30 mph**
Travel Lane Width	12-4.02	12'	14'	14'	12'	12'	12'	12'
Right Shoulder Width	12-4.02	10'	**2'-4'**	**2'-8'**	**2'**-10'	**1'**-10'	10'	**3'**
Left Shoulder Width	12-4.02	4’	**2'**-8'	**3'**	6'	**3'**	**2'**	**3'**
Cross Slope Travel Lane & Right Shoulder	12-4.02 Fig. 12-4B	1.5%	1%	1%	2%	2%	2%	2%
Cross Slope Left Shoulder	12-4.02 Fig. 12-4B	4%	Same as travel lane	Same as travel lane	Same as travel lane	Same as travel lane	Same as travel lane	Same as travel lane
Roadside Clear Zone	13-2.0	14’	N/A	N/A	N/A	N/A	N/A	N/A
Acceleration or Deceleration Length/Available Length	12-3.0	Variable Depending on Grade (Criteria/Actual)	435'/**0’**	N/A (Auxiliary Lane)	285'/**0’**	N/A (Auxiliary Lane)	550'/**250'**	N/A (Auxiliary Lane)
Stopping Sight Distance[4]	7-1.0	250’	**150’ H**	300' H	270' V	**210' V**	**181' V**	**215' V**
Minimum Radius (e=6.0%)	8-2.02	385’	475’	600'	640’	800’	780’	2280’[7]
Maximum Superelevation	8-2.02	6%	N/A	N/A	6%	N/A	3%	N/A
Maximum Grade	12-4.04	5-7%	5.4%	3.8%	5.5%	4.7%	7.0%	5.0%
Minimum Grade	9-2.03	0.5%	1.0%	3.0%	1.9%	**0.4%**	0.6%	0.5%
Vertical Clearance - Overhead Sign	9-4.0	18'-0"	N/A	N/A	N/A	N/A	N/A	N/A
Vertical Clearance - Highway over Arterial/Freeway	9-4.0	16'-3"	N/A	N/A	>16'-3"	**14'-3" (over I-91) 14'-4" (under 52 EB On)**	>16'-3"	**16'-1" (over 51 WB On)**
Vertical Clearance - Highway over Collector/Local	9-4.0	14'-6"	N/A	N/A	N/A	N/A	N/A	N/A
Vertical Clearance - Highway over Non-Electrified RR	9-4.0	20'-6"	N/A	N/A	N/A	N/A	N/A	N/A

1. Ramp advisory speed warning sign
2. Controlling criteria speed is maximum allowable speed based upon deficiencies in stopping sight distance or curvature.
3. Notation after distance is for limiting horizontal (H) or vertical (V) curvature.
4. CTDOT Project #0063-0375 reconstruction plans show an initial S-curve with radii between 200’ and 280’ when the Exit 50 WB off-ramp deviates from the I-84 WB mainline. Each curve has a length less than 50’ and the tangent between the curves is greater than 100’. Due to the short length of this S-curve, drivers use the off-ramp as a taper style exit in reality. For the purposes of this table, the following curve of a 2280’ radius is displayed since the initial S-curve radii would falsely indicate a deficiency.

Values depicted in **red** represent elements that are less than the minimum required for the evaluated speed and roadway classification.

Table 2-29 (ctd.): Interchange Ramp Review

Design Element	CTHDM Section	CTDOT Standard	Interchange 51 (I-91 Northbound)			Interchange 52 (I-91 Southbound)		
			51 EB OFF	51 WB ON	51 WB OFF	52 EB OFF	52 EB ON	52 WB ON
			To I-91 NB	From I-91 NB	To I-91 NB	To I-91 SB	From I-91 SB	From I-91 SB
Functional Classification/Ramp Type	-	Urban Freeway	Directional	Directional	Directional	Directional	Directional	Directional
Posted Speed (Mainline)	6-2.02	50 mph	50 mph	50 mph	50 mph	50 mph	50 mph	50 mph
Posted Speed (Ramp)	-	-	35 mph/30 mph[1]	None	25 mph[2]	35 mph/25 mph[1]	25 mph[2]	35 mph[2]
Evaluated Speed	12-4.01	40 mph	40 mph	40 mph	40 mph	40 mph	40 mph	40 mph
Controlling Criteria Speed[3]	-	-	**30 mph**	**25 mph**	**25 mph**	**25 mph**	**15 mph**	40 mph
Travel Lane Width	12-4.02	12'	14'	12'-14'	12'	14'	14'	14'
Right Shoulder Width	12-4.02	10'	10'	**6'**-10'	**2'**-10'	**3'-6'**	**4'**	10'
Left Shoulder Width	12-4.02	4'	6'	**3'**-6'	4'-6'	**3'**	4'	6'
Cross Slope Travel Lane & Right Shoulder	12-4.02 Fig. 12-4B	1.5%	2%	2%	1.5%	N/A	2%	1.5%
Cross Slope Left Shoulder	12-4.02 Fig. 12-4B	4%	Same as travel lane	Same as travel lane	Same as travel lane	N/A	Same as travel lane	Same as travel lane
Roadside Clear Zone	13-2.0	14'	N/A	N/A	N/A	N/A	N/A	N/A
I-84 Acceleration or Deceleration Length/Available Length	12-3.0	Variable Depending on Grade (Criteria/Actual)	N/A (Auxiliary Lane)	N/A (Auxiliary Lane)	N/A (Auxiliary Lane)	N/A (Auxiliary Lane)	N/A (Auxiliary Lane)	N/A (Auxiliary Lane)
I-91 Acceleration or Deceleration Length/Available Length	12-3.0	Variable Depending on Grade (Criteria/Actual)	N/A (Auxiliary Lane)	N/A (Auxiliary Lane)	385'/>385'	N/A (Auxiliary Lane)	N/A (Auxiliary Lane)	N/A (Auxiliary Lane)
Stopping Sight Distance[4]	7-1.0	305'	**218' H**	**188' H**	**165' H**	**175' H**	**105' V**	325' H
Minimum Radius (e=6.0%)	8-2.02	510'	**455'**	**330'**	**355'**	**355'**	**180'**	680'
Maximum Superelevation	8-2.02	6%	6%	6%	6%	N/A	6%	6%
Maximum Grade	12-4.04	4-6%	5.3%	5.6%	3.1%	N/A	4.9%	2.2%
Minimum Grade	9-2.03	0.5%	**0.4%**	0.9%	0.8%	N/A	1.2%	1.0%
Vertical Clearance - Overhead Sign	9-4.0	18'-0"	N/A	N/A	N/A	N/A	N/A	N/A
Vertical Clearance - Highway over Arterial/Freeway	9-4.0	16'-3"	>16'-3"	**16'-1" (under 50 WB Off)**	N/A	**14'-7" (under I-91 SB Off)**	**14'-4" (over 50 EB On)**	**16'-2" (over I-91 Off)**
Vertical Clearance - Highway over Collector/Local	9-4.0	14'-6"	N/A	N/A	N/A	>14'-6"	N/A	N/A
Vertical Clearance - Highway over Non-Electrified RR	9-4.0	20'-6"	N/A	N/A	N/A	N/A	N/A	N/A

1. For Exits 51/52 EB off, there is a regulatory speed limit sign posted at 35 mph. The Exit 51EB off-ramp has a ramp advisory speed warning sign for 30 mph. The Exit 52 EB off-ramp has a ramp advisory speed warning sign for 30 mph.
2. Ramp advisory speed warning sign
3. Controlling criteria speed is maximum allowable speed based upon deficiencies in stopping sight distance or curvature.
4. Notation after distance is for limiting horizontal (H) or vertical (V) curvature.

Values depicted in **red** represent elements that are less than the minimum required for the evaluated speed and roadway classification.

Interchange 46 (Sisson Avenue)

Figure 2-49: Interchange 46 (Sisson Avenue)

Interchange 46 is a three-legged directional service interchange connecting the I-84 mainline with Sisson Avenue. The interchange layout is unchanged from its original construction in the 1960s. The interchange provides local access to the Hartford neighborhoods of the West End and Parkville and to the adjacent town of West Hartford. The interchange consists of four direct connection ramps which cross over the railroad, *CTfastrak,* Capitol Avenue, and Forest Street on elevated viaduct structures. The four ramps combine to form a divided, two-way, at-grade roadway prior the ramp terminal at the four-way signalized intersection with Sisson Avenue and West Boulevard. The eastbound off-ramp is a left-hand exit from the I-84 mainline which does not meet driver expectancy. Generally, the eastbound on- and westbound off-ramps carry high traffic volumes, the westbound on- and eastbound off-ramps carry mid-level traffic volumes.

The original design provided for a combined system and service interchange with connections to a planned freeway (CT 189) in addition to local access at Sisson Avenue. The ramps were constructed with additional width to accommodate this connection from the I-84 mainline across the railroad, CT*fastrak*, and Capitol Avenue. Each ramp has a 'stub' where the freeway connection would have continued to the north. Plans to construct the planned freeway were abandoned in 1970s, eliminating the system interchange component.

Interchange 46 – Eastbound On-Ramp 'Stub'

Service interchanges are not typically designed with directional ramps because high speed connections are not generally warranted, especially in urban areas. Direct connection ramps are, by design, high speed and high volume connections meant to convey a significant volume of traffic to another high speed facility (typically another highway). In order to meet driver expectancy, direct connection ramps should provide a high range design speed of 40 mph, as defined in Table 2-27: Interchange Ramp Design Speed, page 2-127. However, based on the existing geometric features, none of the four ramps provide design speeds of 40 mph. The eastbound on-ramp meets criteria for 25 mph, the eastbound off-ramp and westbound off-ramps meet criteria for 30 mph, and the westbound on-ramp meets criteria for 35 mph. The limiting design element in all cases is SSD on horizontal curves, where a driver's sight lines are obstructed by bridge parapets or barrier curbs. Additionally, the minimum horizontal curve radius on the eastbound on-ramp is deficient for 40 mph. The two on-ramps of Interchange 46 have posted speed limits of 30 mph. The two off-ramps do not have posted speed limits or ramp advisory speed warning signs.

The ramp widths were evaluated against the CTHDM minimum overall width of 26 feet (with a 12 foot travel lane, 4 foot left shoulder and 10 foot right shoulder). All four ramps were found to have segments that do not meet the minimum overall width requirement. The ramps each have a 14 foot travel lane with left and right shoulders lower than the required values. These narrow shoulder widths contribute to the SSD deficiencies as the view-obstructing objects (bridge parapet or barrier curb) are closer to the travel lane.

The eastbound off-ramp deceleration lane has a parallel-type design which does not meet CTDOT's current policy (CTHDM 12-3.01.01), but are allowed where site restrictions exist. The deceleration length is of sufficient length to both the governing geometric control (a horizontal curve with a design speed of 40 mph) and the design year queue length from the ramp terminal intersection at Sisson Avenue (as discussed previously). The eastbound on-ramp joins the I-84 mainline as an auxiliary lane which extends to the Interchange 48 off-ramp. Therefore, sufficient acceleration distance is provided.

The westbound off-ramp exits the I-84 mainline as an auxiliary lane drop. The available deceleration distance to the 2040 95th percentile queue from the terminal intersection is sufficient. The westbound on-ramp acceleration lane is of sufficient length to allow acceleration from the governing geometric control (a horizontal curve with a design speed of 45 mph).

Interchange 47 (Sigourney Street)

Figure 2-50: Interchange 47 (Sigourney Street)

Interchange 47 is a partial-diamond service interchange consisting of an eastbound on-ramp and a westbound off-ramp. Each semi-direct ramp connects the I-84 mainline with Sigourney Street at signalized intersections. The interchange layout is unchanged from its original construction in the 1960s. The interchange provides local access to the Hartford neighborhoods of Asylum Hill and Frog Hollow. The Aetna office campus, with approximately 4,500 employees, is located immediately to the north of the interchange. Each ramp descends from the I-84 viaduct to Sigourney Street (which is elevated above the railroad, CTfastrak, and parking). The entirety of each ramp is located on a bridge structure. Generally, both ramps carry high amounts of traffic, particularly during AM and PM peak periods. The CTHDM recommends that incomplete interchanges, such as Interchange 47, be avoided if practical as the missing movements may cause driver confusion.

Due to their short length, the two ramps of Interchange 47 function as transition zones between the I-84 mainline and the local street network. The ramp design speeds vary throughout the length of the ramps, between the mainline design speed and a stop condition at the signalized terminal intersections. The design elements were assessed to determine the necessary acceleration/deceleration lengths and to assess compliance with the minimum mid range design speed of 35 mph, as defined in Table 2-27: Interchange Ramp Design Speed, page 2-127. The geometric design element of note on the westbound off-ramp is the crest vertical curve where the ramp bifurcates from the I-84 mainline. This vertical curve provides stopping sight distance for 40 mph and sufficient deceleration distance is provided from the painted gore for this element. The geometric design element of note on the eastbound on-ramp is the available stopping sight distance on the horizontal curve approaching the I-84 mainline. The stopping sight distance, limited by the bridge parapet/barrier curb, meets criteria for 35 mph. The westbound off-ramp has a 25 mph ramp advisory speed warning sign. The eastbound on-ramp does not have a posted speed limit or advisory speed warning sign. Overall, the two ramps meet desired criteria for available stopping sight distance and minimum horizontal curvature.

The ramp widths were evaluated against the CTHDM minimum overall width of 26 feet (with a 12 foot travel lane, 4 foot left shoulder and 10 foot right shoulder). Both ramps fail to meet the minimum width requirements due to the insufficient left and right shoulder widths.

The eastbound on-ramp joins the I-84 mainline as an auxiliary lane which extends to the Interchange 48 off-ramp. Therefore, sufficient acceleration distance is provided. The westbound off-ramp exits the I-84 mainline as an auxiliary lane drop. The 2040 95th percentile queue length extends beyond the ramp gore onto the I-84 mainline. Therefore, sufficient deceleration distance is not provided.

Interchange 48 (Capitol Avenue, Broad Street, and Asylum Street)

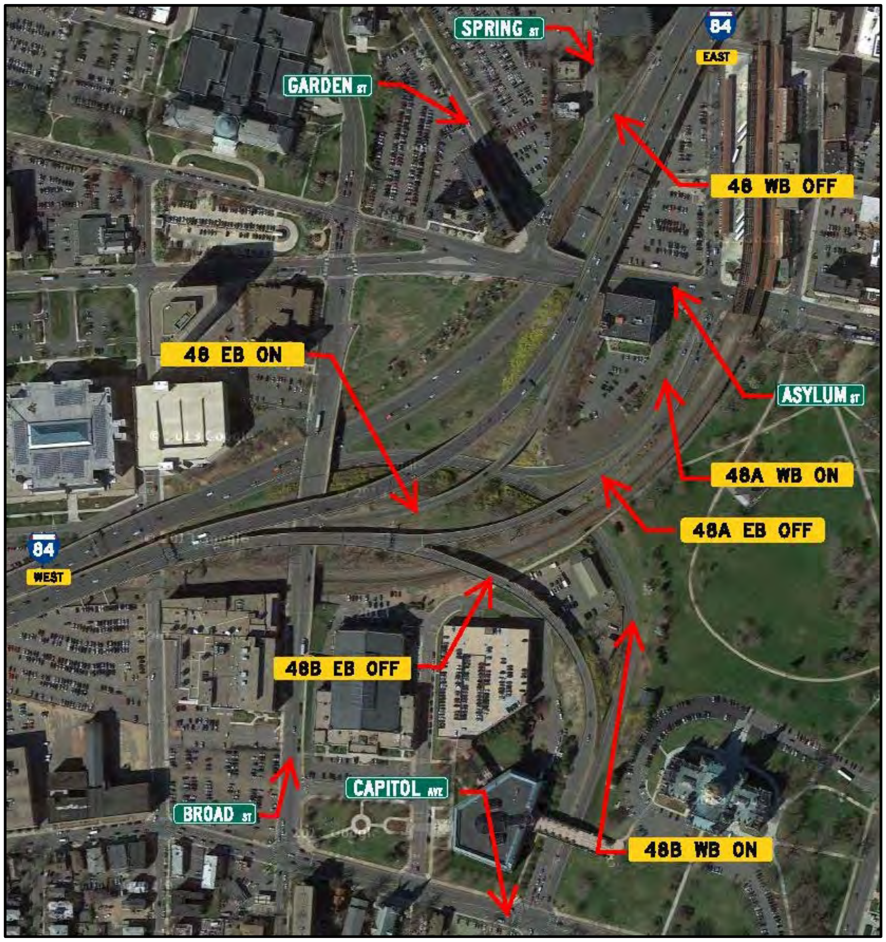


Figure 2-51: Interchange 48 (Capitol Avenue, Broad Street, and Asylum Street)

Interchange 48 is a complex service interchange providing access to the Hartford neighborhoods of Frog Hollow and Asylum Hill as well as South Downtown and Downtown areas. The interchange provides access to the State Capitol, Hartford Hospital, and many other commercial and cultural resources. Interchange 48 consists of six semi-direct ramps, including three on- and three off-ramps. The eastbound on- and westbound off-ramps form a split partial-diamond interchange. The eastbound on-ramp begins at a signalized intersection at Broad Street and climbs to meet the I-84 mainline at the bridge structure over Asylum Street. The westbound off-ramp separates from I-84 following the bridge over the railroad and terminates at a signalized intersection with Asylum Street and Garden Street. Spring Street, a one-way, southbound roadway, intersects the off-ramp prior to the terminal intersection.

The remaining four ramps are connections from I-84 to Asylum Street or Capitol Avenue. The eastbound off- and westbound on-ramps of Interchange 48 each split following their bifurcation from the I-84 mainline. The ramps serving Asylum Street are signed as Interchange 48A and the ramps serving Capitol Avenue are signed as Interchange 48B. The eastbound off-ramps are predominantly elevated, passing over Broad Street, the railroad and other ramps. The westbound on-ramps are predominantly at-grade roadways, passing under elevated sections of I-84, the railroad and other ramps. The westbound on-ramp enters I-84 on the left as a lane addition, which does not meet driver expectancy.

Interchange 48 was originally constructed as a combined service/system interchange with a planned freeway connection to the east (I-491) as well as local access. However, the planned highway was never constructed. The interchange was substantially reconfigured in the 1980s and 1990s, with the removal and replacement of several ramps. The westbound on- and eastbound off-ramps to Asylum Street were added, as was the eastbound on-ramp from Broad Street. Eastbound and westbound on-ramps in the northwest quadrant (from Farmington Avenue and Broad Street respectively) were removed.

Generally, the eastbound off- and westbound on-ramps to and from Capitol Avenue and Asylum Street carry mid-level traffic volumes, when combined (as at their split from the I-84 mainline) the total volume is high. The eastbound on-ramp from Broad Street and the westbound off-ramp to Asylum Street carry high traffic volumes. Within the local street system, Interchange 48 acts as an incomplete interchange at each ramp terminal intersection. At no location is complete access to I-84 provided. This can lead to driver confusion as they search for the proper location to enter the freeway.

The Interchange 48 ramps were evaluated as semi-direct connections, which should provide design speeds not less than 35 mph, as defined in Table 2-27: Interchange Ramp Design Speed, page 2-127. The eastbound off- and westbound on-ramps to/from Capitol Avenue do not provide the 35 mph design speed. The eastbound off-ramp to Capitol Avenue meets design criteria for 25 mph. The limiting design element is the stopping sight distance provided by the sag vertical curve adjacent to the Legislative Office Building garage. All other geometric elements of the ramp meet criteria for 35 mph or higher. The eastbound off-ramp to Asylum Street meets design criteria for 35 mph. The westbound on-ramp from Capitol Avenue meets design criteria for 25 mph. The limiting design element is the stopping sight distance available along the horizontal curve underneath the railroad bridge. Additionally, the sag vertical curve near the Legislative Office Building garage provides stopping sight distance which meets design criteria for 30 mph. All other geometric elements of the ramp meet criteria for 35 mph or higher. The westbound on-ramp from Asylum Street meets design criteria for 30 mph. The limiting design element is the stopping sight distance provided by the sag vertical curve where the ramp passes under the eastbound on-ramp from Broad Street. All other geometric elements of the ramp meet criteria for 35 mph or higher. The eastbound off-ramps both have ramp advisory speed warning signs for 30 mph. The westbound on-ramps do not have ramp advisory speed warning signs.

The eastbound on-ramp from Broad Street and the westbound off-ramp to Asylum Street serve as transition zones between mainline I-84 and the signalized terminal intersections. The design elements were assessed to determine the necessary acceleration/deceleration lengths and to assess compliance with the minimum mid range design speed of 35 mph, as defined in Table 2-27: Interchange Ramp Design Speed, page 2-127. Both ramps meet design criteria for 30 mph. The limiting design element for the eastbound on-ramp is the stopping sight distance provided by the horizontal curve where the ramp spans over the westbound on-ramps. All other geometric elements of the ramp meet criteria for 35 mph or higher. The limiting design element of the westbound off-ramp is the stopping sight distance provided by the sag vertical curve where the ramp bifurcates from the I-84 mainline. All other geometric elements of the ramp meet criteria for 35 mph or higher. The westbound off-ramp has a ramp advisory speed warning sign for 25 mph.

The ramp widths were evaluated against the CTHDM minimum overall width of 26 feet (with a 12 foot travel lane, 4 foot left shoulder and 10 foot right shoulder). All six Interchange 48 ramps fail to meet the minimum width requirements due to the deficient shoulder widths, see Table 2-28, page 2-132 for details.

The eastbound off-ramps separate from the mainline as a two-lane auxiliary lane drop. There is sufficient deceleration length from the painted ramp gore to both the controlling geometric features and to the 2040 95th percentile back of queue from the terminal intersections. The westbound on-ramps join the I-84 mainline as a lane addition, which becomes a basic lane of the I-84 mainline. Therefore, the acceleration distance is sufficient. The eastbound on-ramp from Broad Street joins the I-84 mainline as an auxiliary lane which extends to the Interchange 52 off-ramp. Therefore, sufficient acceleration distance is provided. The westbound off-ramp exits the I-84 mainline as an auxiliary lane drop. The 2040 95th percentile queue length extends beyond the ramp gore onto the I-84 mainline. Therefore, sufficient deceleration distance is not provided.

Interchange 49 (Ann Uccello Street and High Street)

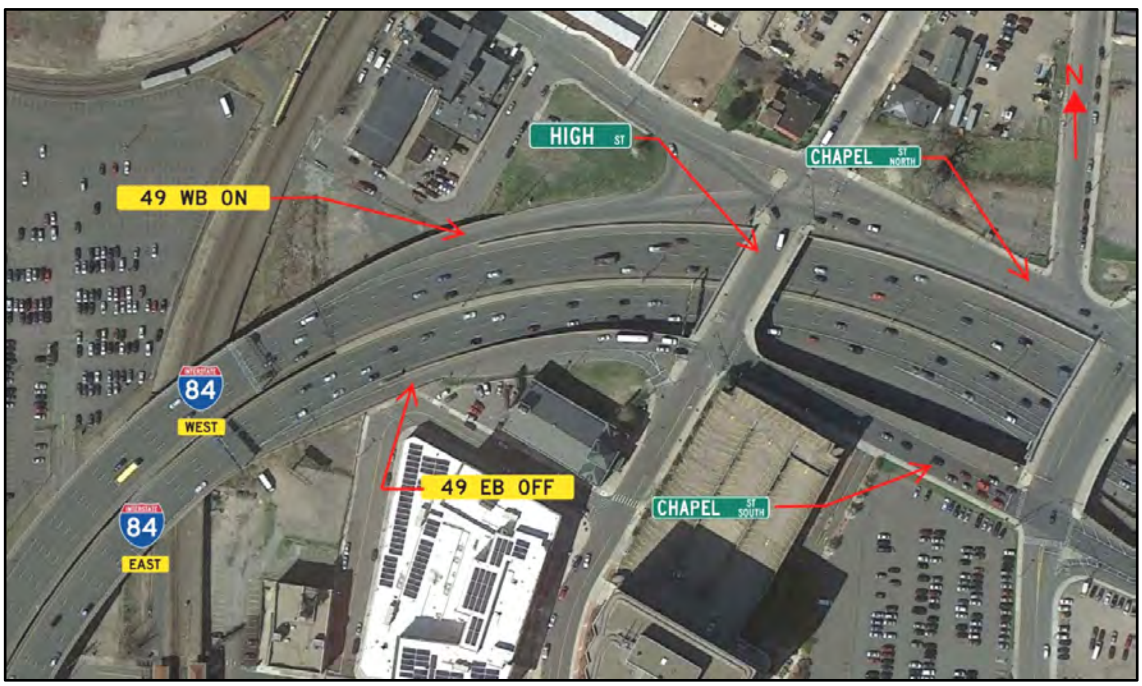


Figure 2-52: Interchange 49 (Ann Uccello Street and High Street)

Interchange 49 is a partial-diamond service interchange consisting of an eastbound off-ramp and a westbound on-ramp. The eastbound off-ramp connects the I-84 mainline with High Street and the westbound on-ramp connects the I-84 mainline with the intersection of High Street, Walnut Street and Chapel Street North. The interchange was reconstructed in the late 1980s/early 1990s, but the general layout of the ramps remains consistent with the initial construction in the 1960s. The interchange provides local access to the Hartford neighborhood of Clay-Arsenal and the Downtown and Downtown North areas. The ramps terminate at High Street with signalized intersections. Access to Ann Uccello Street is provided via a frontage road (Chapel Street South/North). Each ramp ascends from the I-84 mainline to the local streets above. Retaining walls are used to transition the grade separation between the ramps, the mainline and adjacent local streets. Generally, the westbound on-ramp carries mid-level traffic volumes and the eastbound off-ramp has low traffic volumes.

Due to their short lengths, the two semi-direct ramps function as transition zones between the I-84 mainline and the local street network. The ramp speeds transition between the mainline running speed and the signalized intersections. The design elements were assessed to determine the necessary acceleration/deceleration lengths and to assess compliance with the minimum mid range design speed of 35 mph, as defined in Table 2-27: Interchange Ramp Design Speed, page 2-127. The limiting design element on the eastbound off-ramp is the stopping sight distance at the horizontal curve where the ramp departs mainline I-84. This design element meets criteria for 20 mph, which falls below the minimum mid range ramp design speed of 35 mph. The limiting design element on the westbound on-ramp is the stopping sight distance at the horizontal curve where the ramp meets the I-84 mainline. This design element meets criteria for 30 mph. The eastbound off-ramp has a ramp advisory speed warning sign for 25 mph. The westbound on-ramp does not have a ramp advisory speed warning sign.

The ramp widths were evaluated against the CTHDM minimum overall width of 26 feet (with a 12 foot travel lane, 4 foot left shoulder and 10 foot right shoulder). Both ramps fail to meet the minimum width requirements due to the deficient shoulder widths. These deficient shoulders contribute to the limited stopping sight distances because the view-obstructing elements (typically barrier curb) are closer to the travel lane.

Acceleration and deceleration lengths were assessed based on the documented geometric controlling criteria. The eastbound off-ramp departs the mainline with a horizontal curve where the available stopping sight distance meets criteria for 20 mph. A deceleration lane is not provided prior to the ramp bifurcation. Therefore, the deceleration distance for the eastbound off-ramp is deficient. The westbound on-ramp enters the mainline as an auxiliary lane which extends to the Interchange 48 off-ramp. Sufficient acceleration distance is provided; however, the weave distance between the on-ramp and off-ramps does not meet minimum standards for length and level of service.

Interchange 50 (Main Street - US 44, Trumbull Street, and Morgan Street)

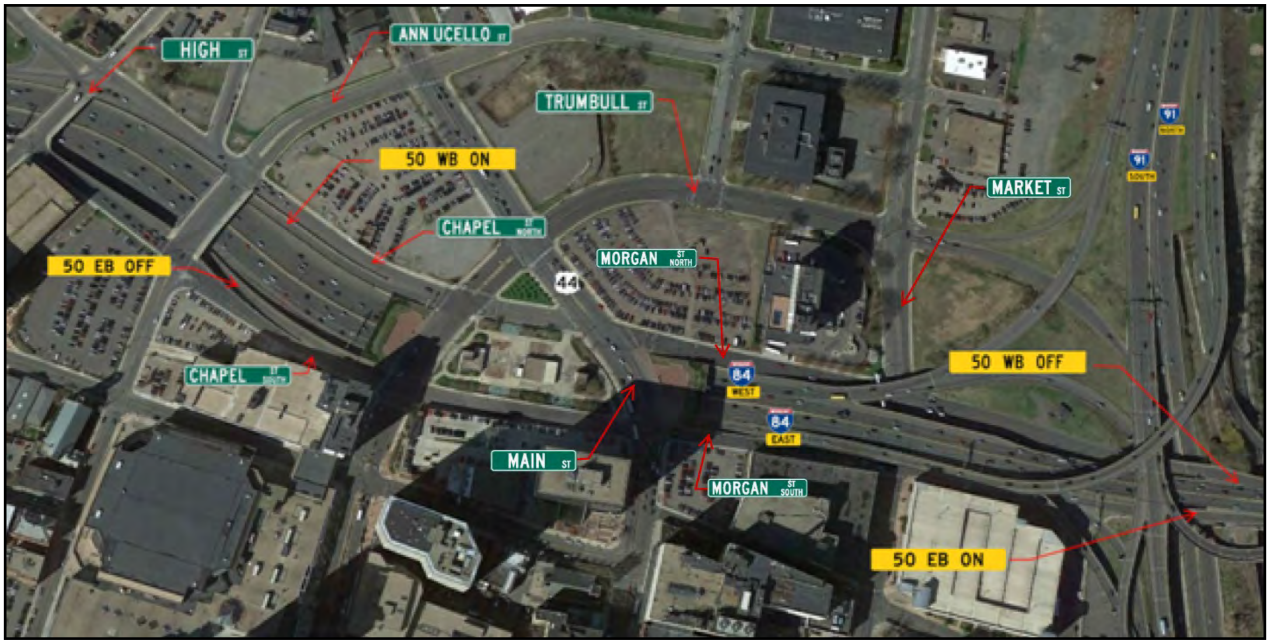


Figure 2-53: Interchange 50 (Main Street - US 44, Trumbull Street, and Morgan Street)

Interchange 50 is a split diamond service interchange with four semi-direct ramps. The interchange was substantially reconstructed in the late 1980s/early 1990s to remove three ramps to/from Ann Uccello Street. The interchange provides local access to the Downtown and North Downtown areas in Hartford. The western half of the interchange includes an eastbound off-ramp and a westbound on-ramp. The eastbound off-ramp climbs from the I-84 mainline to merge with Chapel Street South just prior to the signalized intersection with Trumbull Street. Drivers are prohibited from turning right onto southbound Trumbull Street by regulatory signing. The westbound on-ramp descends from the signalized intersection of Chapel Street South and Trumbull Street to the I-84 mainline. Retaining walls are used to transition the grade separation between the ramps, the mainline and adjacent local streets. Generally, both the eastbound off- and westbound on-ramps carry low traffic volumes.

The eastern half of the interchange includes an eastbound on-ramp and a westbound off-ramp. The eastbound on-ramp climbs from the signalized intersection of South Morgan Street and the I-91 southbound on-ramp to the I-84 mainline. The westbound off-ramp bifurcates from the I-84 mainline at the western limit of the Bulkeley Bridge and descends to the signalized intersection of Market Street and North Morgan Street. There is a driveway curb-cut on the westbound off-ramp serving maintenance access to the incident management sub-station. This driveway serves very low volumes but the inclusion of a driveway on an off-ramp does not meet driver expectancy.

The eastern and western halves of the interchange are connected by one-way frontage roads. West of Main Street, the frontage roads are named Chapel Street North and South, east of Main Street the road names change to North Morgan Street and South Morgan Street. The frontage roads continue westerly and terminate at the Interchange 49 on- and off-ramps. Generally, the eastbound on- and westbound off-ramps carry high traffic volumes.

Due to their short lengths, the four ramps of Interchange 50 function as transition zones between the I-84 mainline and the local street network. The design elements were reviewed to determine the necessary acceleration/deceleration lengths and to assess compliance with the minimum mid range design speed of 35 mph, as defined in Table 2-27: Interchange Ramp Design Speed, page 2-127. The eastbound on- and off-ramps meet the minimum design criteria for 35 mph.

The westbound off-ramp meets design criteria for 35 mph with the exception of the vertical sag curve at the signal-controlled intersection with Market Street, which is good for 30 mph. The westbound on-ramp does not meet the minimum design criteria for 35 mph. The limiting design element is the stopping sight distance provided by the sag vertical curve as the ramp descends to meet I-84 mainline, which is good for 25 mph. The eastbound off-ramp has a 30 mph ramp advisory speed warning sign. The other three ramps do not have advisory speed warning signs.

The ramp widths were evaluated against the CTHDM minimum overall width of 26 feet (with a 12 foot travel lane, 4 foot left shoulder and 10 foot right shoulder). The right shoulder width for the eastbound off-ramp is deficient. The other three ramps for Interchange 50 have deficient left and right shoulder widths.

Existing acceleration and deceleration lengths were reviewed based on the controlling geometric criteria. The sag vertical curve at the eastbound off-ramp bifurcation is good for 35 mph with no deceleration lane. Therefore, vehicles exiting the highway must decelerate within the general purpose lanes, which is a deficiency. The eastbound on-ramp enters the mainline as an auxiliary lane which extends to the Interchange 55 off-ramp. Therefore, sufficient acceleration distance is provided. The westbound off-ramp departs the I-84 mainline as an auxiliary lane drop and there are no deficiencies associated with deceleration to the end of intersection queue. The westbound on-ramp joins the mainline following a sag vertical curve which provides stopping sight distance for 25 mph. Sufficient acceleration length is not provided from this geometric feature to the end of the acceleration lane.

Interchange 51/52 (Interstate 91)

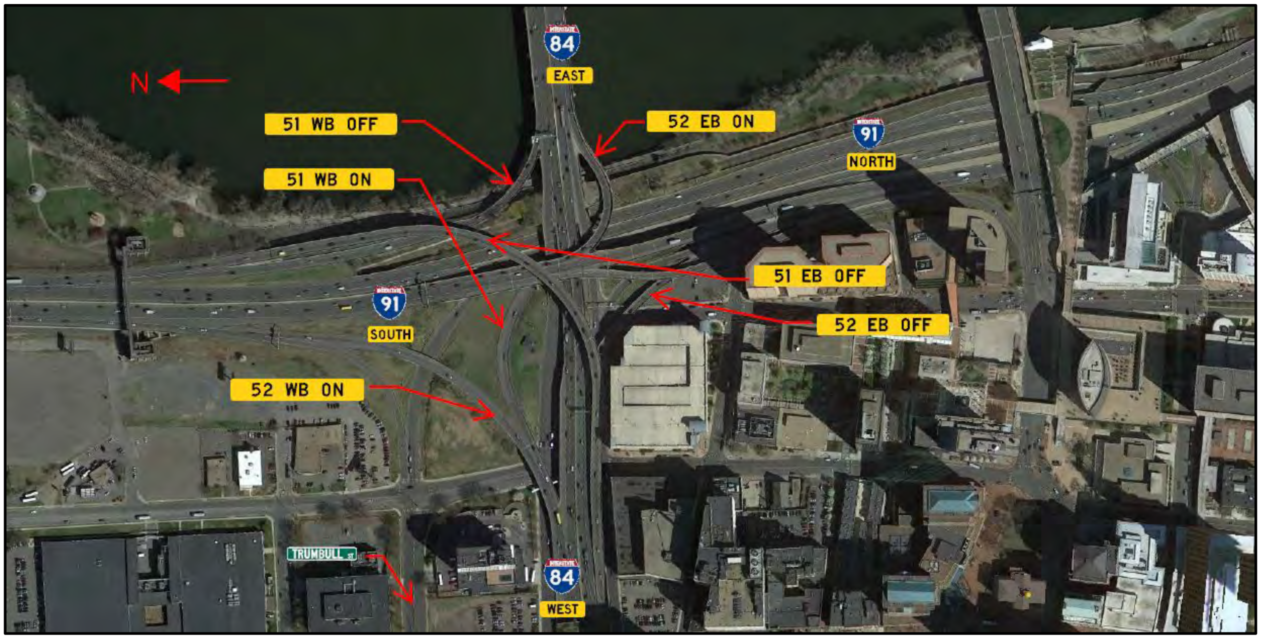


Figure 2-54: Interchanges 51 and 52 (Interstate 91)

Interchanges 51 and 52 have been evaluated as one four-level stack system interchange providing connections between I-84 and I-91. Serving nearly 275,000 vehicles per day, the interchange of I-84 and I-91 is Connecticut's busiest. This interchange carries both local and regional traffic, and is especially significant for destinations to the west and north of the city, as there are no other freeways in the area. All long-distance traffic between I-84 to the west and I-91 to the north must pass through this interchange. As a direct junction between two major interstates, the I-84 / I-91 interchange is a crucial crossroads for interstate travel and for New England as a whole.

Connections are provided for six of the eight potential maneuvers, the interchange lacks a connection from I-91 northbound to I-84 eastbound and from I-84 westbound to I-91 southbound. These connections are provided indirectly via the Charter Oak Bridge and the Wilbur Cross Highway through East Hartford. I-84 Interchange 51 connects I-84 to I-91 northbound. Interchange 52 connects I-84 to I-91 southbound. The interchange is signed as Interchange 32A and 32B on I-91. The I-84 eastbound on-ramp from I-91 southbound and the I-84 westbound on-ramp from I-91 northbound both leave I-91 as left-hand exits, which do not meet driver expectancy.

Interchanges 51 and 52 consist of six directional ramps. The ramps were assessed for compliance with the minimum design speed of 40 mph for direct connection ramps. Of the six ramps, only the westbound on-ramp from I-91 southbound (Interchange 52) meets the minimum design speed for a direct connection ramp. The I-84 eastbound off-ramp to I-91 northbound (Interchange 51) meets design criteria for 30 mph. The limiting design element is the stopping sight distance controlled by the inside bridge parapet where the ramp flies over I-84 and I-91. The horizontal curve radius meets criteria for 35 mph. All other geometric features meet criteria for the minimum direct connection design speed of 40 mph. The I-84 eastbound off-ramp to I-91 southbound (Interchange 52) meets design criteria for 25 mph. The limiting design element is the stopping sight distance controlled by the inside bridge parapet where the ramp crosses over Columbus Boulevard. The horizontal curve radius meets criteria for 30 mph. The eastbound on-ramp from I-91 southbound (Interchange 52) meets design criteria for 20 mph. The limiting design element is the stopping sight distance controlled by the inside bridge parapet where the ramp is carried above I-91 northbound. The horizontal curve radius is sufficient for 25 mph.

The I-84 westbound off-ramp to I-91 northbound (Interchange 51) meets design criteria for 25 mph. The limiting design element is the stopping sight distance controlled by the inside bridge parapet where the ramp crosses the Connecticut River. The horizontal curve radius meets design criteria for 30 mph. The I-84 westbound on-ramp from I-91 northbound (Interchange 51) meets design criteria for 25 mph. The limiting design element is the stopping sight distance controlled by the I-91 substructure elements where the ramp passes underneath I-91 southbound. The horizontal curve radius meets design criteria for 30 mph. All ramps have either posted speed limit signs or ramp advisory speed warning signs. See Table 2-29, page 2-130, for further information.

The ramp widths were evaluated against the CTHDM minimum overall width of 26 feet (with a 12 foot travel lane, 4 foot left shoulder and 10 foot right shoulder). Four of the six ramps have shoulder width deficiencies, which are detailed in Table 2-28, page 2-130. In many locations, the narrow shoulder widths contribute to stopping sight distance deficiencies due to the reduced horizontal offsets to the bridge parapets.

Acceleration and deceleration lengths were assessed based on the controlling geometric criteria. The eastbound off-ramp to I-91 northbound (Interchange 51) departs I-84 as an auxiliary lane drop. Therefore, sufficient deceleration distance is provided. The ramp merges with the westbound off-ramp before joining I-91 northbound as a lane addition. Therefore, sufficient acceleration length is provided. The eastbound off-ramp to I-91 southbound (Interchange 52) departs I-84 as an auxiliary lane drop. Therefore, sufficient deceleration length is provided. The ramp merges with a local street on-ramp before joining I-91 as a lane addition. Therefore, sufficient acceleration length is provided. The eastbound on-ramp from I-91 southbound (Interchange 52) departs I-91 with a parallel-type deceleration lane which does not meet CTDOT’s current policy. Sufficient deceleration distance to the 20 mph curve is provided. However, if mainline vehicles do not enter the deceleration lane at the beginning, the deceleration length would be severely deficient due to the significant speed differential between the mainline and the ramp. The ramp bifurcation is on a bridge structure where the gore nose is protected with an impact-attenuating barrel array, which is often hit by vehicles. The ramp enters I-84 as an auxiliary lane which extends to Interchange 53. Therefore, sufficient acceleration distance is provided.

The I-84 westbound off-ramp to I-91 northbound (Interchange 51) departs I-84 as an auxiliary lane drop. Therefore, sufficient deceleration distance is provided. The ramp merges with the I-84 eastbound off-ramp before joining I-91 northbound as a lane addition. Therefore, sufficient acceleration length is provided. The I-84 westbound on-ramp from I-91 northbound (Interchange 51) departs I-91 as an auxiliary lane drop. Therefore, sufficient deceleration distance is provided. The ramp enters I-84 as an auxiliary lane which extends to Interchange 46. Therefore, sufficient acceleration length is provided. The westbound on-ramp from I-91 southbound departs I-91 as an auxiliary lane drop. Therefore, sufficient deceleration length is provided. The ramp enters I-84 as an auxiliary lane which extends to the Interchange 47 off-ramp. Therefore, sufficient deceleration length is provided.

2.6 Existing Structural Conditions

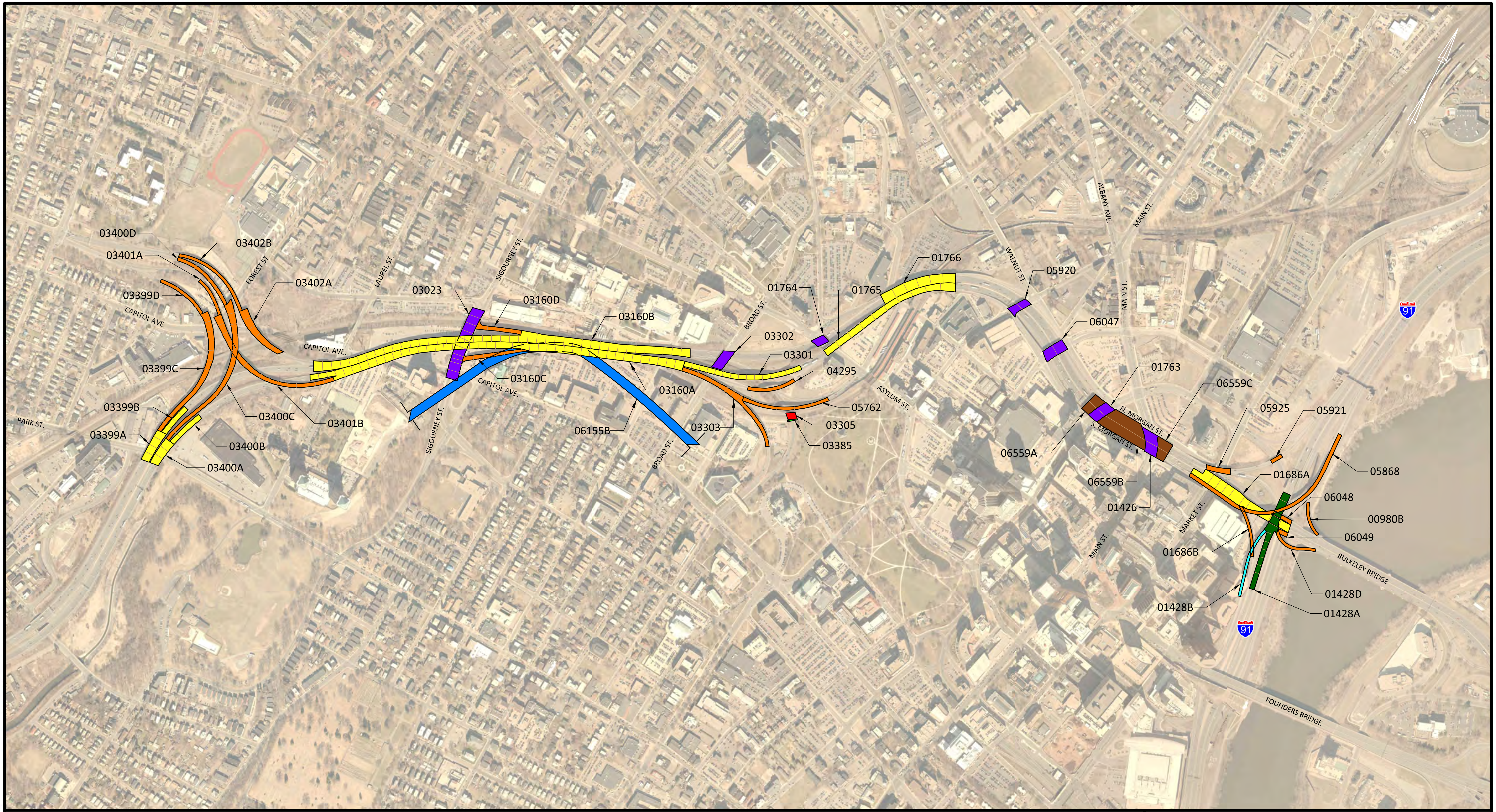
The existing condition of the structures within the Project Study Corridor was assessed and documented utilizing 2011-2013 bridge inspection reports.

2.6.1 General Description of Bridges

A total of 45 bridges in the Corridor from Park Street to I-91 Interchange, have been assessed in this report. These bridges carry or underpass the I-84 mainline, I-91 mainline, ramps, local city streets and The Hartford Line/CT*fastrak*. A detail summary of bridges within the Corridor is included in Appendix A.1. The Hartford Line runs roughly parallel to the I-84 through the Project Study Corridor. The rail line crosses from the north to the south side of the highway near Flower Street and crosses again from south to north near Church Street.

Most of the highway bridges in the Corridor were built in the 1960s and many have undergone rehabilitation since. Some bridges were constructed during a series of improvement projects in the 1980s. Typically, the highway bridges in the corridor have concrete decks with steel multi-girder superstructures simply supported on reinforced concrete piers, and almost all of the bridges have bituminous concrete overlay with membrane waterproofing. The old simply supported design of these bridges required deck joints at every substructure unit. It is important to note that these deck joints are located in the most vulnerable position on any bridge. Situated at surface level, these joints have been subjected to the impact and vibration of traffic and have been exposed not only to the effects of natural elements such as water, dirt, and UV rays, but also to those of chemicals such as deicing salts and petroleum derivatives. All the aforementioned external effects have contributed to deck joint leakages underneath these structures causing severe rust and section loss at beam ends. In addition to having deck joints at all substructure units, some of these bridges have other problematic details such as pin and hangers and steel pier caps, which also show severe rusting and section losses due to deck joint leakages.

Figure 2-55, following, illustrates the location and identification numbers of the bridges in the corridor. Table 2-30, page 2-149, shows general information regarding the year built and rehabilitation projects. A detailed report of the bridge condition assessment is included in Appendix A.1.



FEATURE CARRIED

I-84 Mainline	Railroad	I-91 Mainline
I-84 Ramps	Pedestrian	I-91 Ramps
City Streets	Park River Conduit	Platform

Not to Scale

The I-84 Hartford Project

Bridge Location Map

Date: 06/27/2014 | Drawn By: TSC | Fig. No: 2-55

Table 2-30: Bridge Construction and Rehabilitation Data

Bridge No.	No. of Spans	Original Construction Project No.	Year Construction Completed	Rehabilitation Project No.	Year Rehabilitation Construction Completed
00980B	2	63-153	1964	-	-
01426	2	-	1963	-	-
01428A	13	-	1961	-	-
01428B	11	-	1961	63-375	1993
01428D	5	63-158, 63-162	1961	-	-
01686A	14	63-133, 63-162	1961	63-675	-
01686B	8	63-116	1961	-	-
01763	2	63-136	1964	63-364	
01764	1	63-167	1966	63-364	1984
01765	10	63-137, 63-167	1966	63-364, 63-479, 63-565	1984, 1995, 2000
01766	6	63-137	1964	63-364, 63-375, 63-590	1984, 1993, 2006
03023	11	63-159	1964	63-338, 63-624	1982, 2007
03160A	44	63-138	1965	63-304, 63-393, 63-488, 63-527, 63-648	1975, 1990, 1993, 2000, 2011
03160B	42	63-138	1965	63-304, 63-393, 63-488, 63-527, 63-648	1975, 1990, 1993, 2000, 2011
03160C	6	63-138	1965	63-304, 63-393, 63-527, 63-648	1975, 1990, 2000, 2011
03160D	4	63-138	1965	63-304, 63-393, 63-527, 63-648	1975, 1990, 2000, 2011
03301	15	63-175	1966	63-648	2011
03302	1	63-175	1966	63-364	1984
03303	15	63-175	1966	63-409, 63-648	1989, 2011
03305	1	-	1966	63-670	Underway
03385	1	-	1966	-	-
03399A	4	63-141	1969	155-145	2000
03399B	4	63-141	1969	155-145	2000
03399C	14	63-141, 63-192	1969	155-145, 63-622	2000, 2011
03399D	6	63-192	1969	155-145	2000
03400A	3	63-141	1969	155-145	2000
03400B	4	63-141	1969	155-145	2000
03400C	15	63-141, 63-192	1969	155-145, 63-638	2000, 2011

Table 2-30(ctd.): Bridge Construction and Rehabilitation Data

Bridge No.	No. of Spans	Original Construction Project No.	Year Construction Completed	Rehabilitation Project No.	Year Rehabilitation Construction Completed
03400D	7	63-192	1969	155-145	2000
03401A	5	63-192	1969	155-145	1988, 2000
03401B	16	63-141, 63-192	1969	63-304, 155-145, 63-627	1975, 2000, 2011
03402A	6	63-141, 63-192	1969	155-145	2000
03402B	10	63-192	1969	155-145	2000
04295	3	63-307	1980	-	-
05762	5	-	1987	63-409	1989
05868	9	63-375	1993	63-639	1998, 2012
05920	2	63-136	1964	63-375	1993
05921	1	63-375	1993	-	-
05925	2	63-375	1993	-	-
06047	2	63-375	1993	-	-
06048	3	63-375	1993	-	1976
06049	2	63-375	1993	-	-
06559A	2	63-474	1996	-	-
06559B	2	63-474	1996	-	-
06559C	2	63-474	1996	-	-

2.6.2 Existing Structural Conditions

In 1968, the Federal-Aid Highway Act directed the states to maintain an inventory of federal-aid highway bridges. According to National Bridge Inspection Standards (NBIS) today, condition ratings are used to describe an existing bridge compared with its condition if it was new. Each bridge component is assigned a condition rating based on inspection findings. These inspection ratings are based on the materials and physical condition of the deck, superstructure and the substructure. General condition ratings range from 0 (failed condition) to 9 (excellent). Bridge condition assessments are defined in Table 2-31, below.

Table 2-31: NBIS Condition Rating Scale

Code	Descriptions
9	Excellent Condition – No maintenance or rehabilitation concerns
8	Very Good Condition – No maintenance or rehabilitation concerns. No problems noted.
7	Good Condition – Potential exist for minor maintenance. Some minor problems noted.
6	Satisfactory Condition – Potential exist for major maintenance. Structural elements shown minor deterioration.
5	Fair Condition – Potential exist for minor rehabilitation. All primary structural elements are sound but may have minor section loss*, cracking, spalling or scour.

Table 2-31 (ctd.): NBIS Condition Rating Scale

Code	Descriptions
4	Poor Condition – Potential exist for major rehabilitation. Advance section loss, deterioration, spalling, or scour.
3	Serious condition – Rehabilitation or repair required immediately. Loss of section, deterioration, spalling, or scour have seriously affected primary structural components. Local failures possible. Fatigue cracks in steel or shear cracks in concrete may be present.
2	Critical Condition – Need for immediate repairs or rehabilitation is urgent. Advance deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored it may be necessary to close the bridge until corrective action is taken.
1	"Imminent" Failure Condition – Bridge is closed to traffic but corrective action may put back in light service. Major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structure stability.
0	Failed Condition – Bridge is out of service and is beyond corrective action.

* The term "section loss" is defined in The Bridge Inspector's Reference Manual (BIRM) Publication No. FHWA NHI 03-001 as the loss of a (bridge) member's cross-sectional area usually by corrosion or decay. A "spall" is a depression in a concrete member resulting from the separation and removal of a volume of the surface concrete. Spalls can be caused by corroding reinforcement, friction from thermal movement, and overstress. The term "scour" refers to the erosion of streambed or bank material around bridge supports due to flowing water.

In addition to the individual component ratings, an overall Structural Evaluation has been established for each bridge in NBIS. Structural Evaluation is an appraisal rating that describes an overall rating of the bridge structure. This is dependent on the separately rated conditions of the structural components (deck, superstructure, and substructure) and the load carrying capacity of the bridge. This is the truest measure in the NBIS of the structural fitness of a bridge.

Table 2-32, below, shows Condition Ratings and Overall Structural Evaluation for each bridge in the I-84 Corridor according to 2011-2013 inspection reports. Figure 2-56, page 2-154, shows Structural Evaluation of each bridge in the corridor. For a detail condition assessment of the bridges, see Appendix A.1

Table 2-32: Bridge Condition Ratings and Overall Structural Evaluation

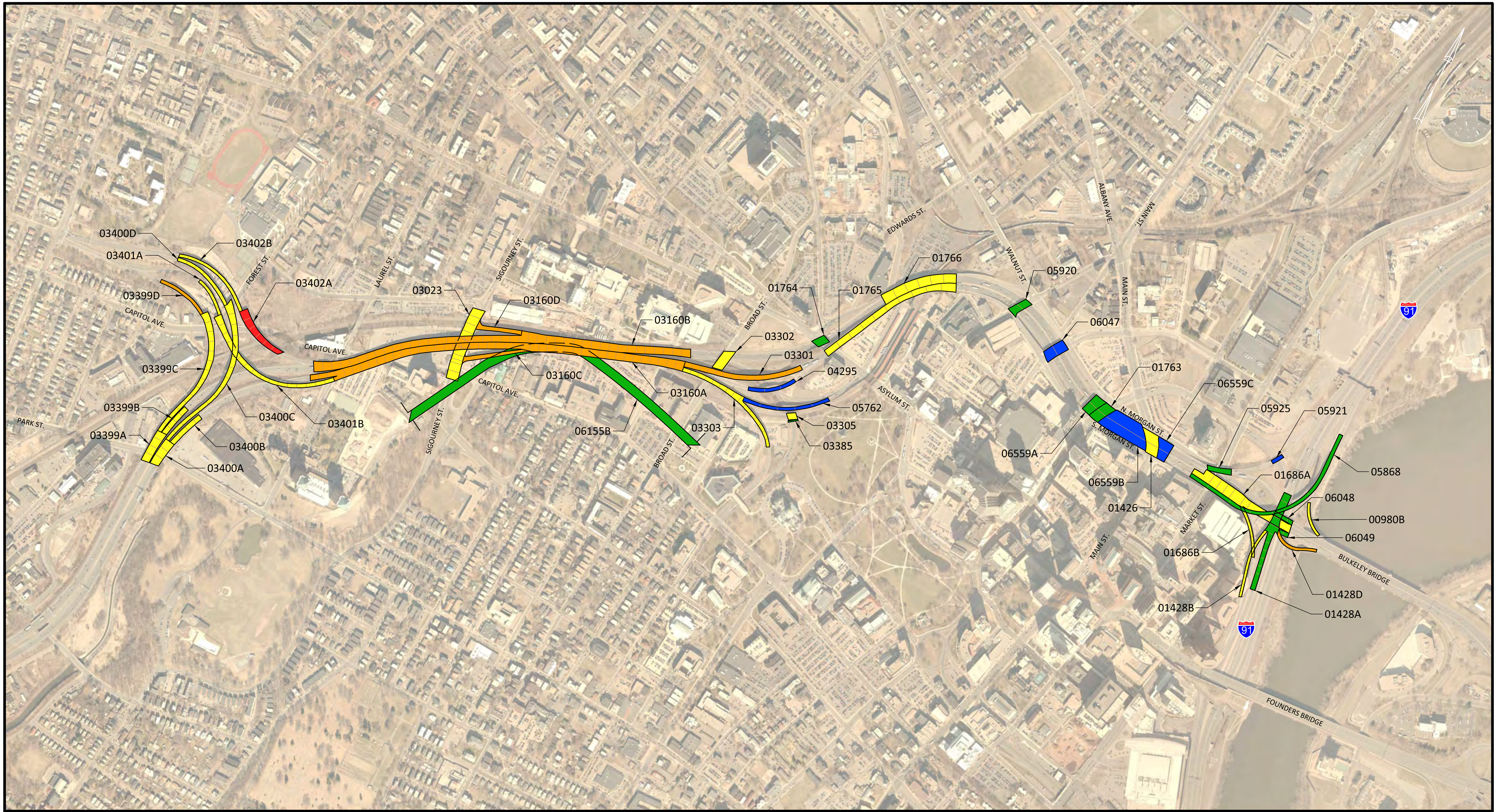
Bridge No.	Feature Carried/Crossed	# of Spans	Length	Deck Area	Deck	Superstructure	Substructure	Culvert	Structural Evaluation
00980B	I-84 TR 826 over Connecticut River	2	263	6,970	6	5	6	N	5
01426	US Route 44 EB and Main Street over I-84 and Morgan Street Ramp	2	205	22,038	6	6	5	N	5

Table 2-32 (ctd.): Bridge Condition Ratings and Overall Structural Evaluation

Bridge No.	Feature Carried/Crossed	# of Spans	Length	Deck Area	Deck	Superstructure	Substructure	Culvert	Structural Evaluation
01428A	I-91 SB over Ramp D & F, I-84, US Route 44	13	951	40, 988	7	6	6	N	6
01428B	I-91TR 839 over I-91 – 153, I-84 – 825, US Route 44 EB	11	769	21,147	7	5	6	N	5
01428D	I-91 TR 840 over I-91 NB, US Route 44 EB, Railroad and Connecticut River	5	408	12,924	7	5	4	N	4
01686A	I-84 over Market Street and I-91 NB	14	870	74,552	5	5	5	N	5
01686B	I-84 TR 825 over US Route 44 EB and Columbus Boulevard	8	525	13,916	4	5	5	N	5
01763	Trumbull Street over I-84 and Access Ramps I-91	2	189	17,483	6	6	6	N	6
01764	Asylum Street over I-84 WB	1	85	7,692	6	6	6	N	6
01765	I-84 EB over Amtrak and Local Roads	10	1271	83,895	4	5	6	N	5
01766	I-84 WB over Amtrak and Local Roads	6	810	62,377	4	5	6	N	5
03023	Sigourney Street over Capitol Avenue, Amtrak, and Aetna Parking Lot	11	654	70,000	5	5	5	N	5
03160A	I-84 EB over Amtrak and Local Roads	44	3252	225,464	6	4	5	N	4
03160B	I-84 WB over Aetna Parking Lot, Amtrak, and Local Roads	42	3177	209,469	6	4	5	N	4
03160C	I-84 WB on ramp over Aetna Parking Lot	6	415	13,860	7	4	5	N	4
03160D	I-84 EB off-ramp 115 over Amtrak and Aetna Parking Lot	4	307	10,910	7	4	5	N	4
03301	I-84 EB over Broad Street, I-84 Ramp 191, and Parking Lot	15	974	46,256	6	4	5	N	4
03302	Broad Street over I-84 WB and I-84 Ramp 191	1	128	10,560	6	6	5	N	5
03303	I-84 EB Ramp 190 over Broad Street and Amtrak	15	1131	39,700	6	5	5	N	5
03305	Amtrak over I-84 Ramp 191 and I-84 WB on-ramp from Capitol Avenue	1	90	4,973	7	5	6	N	5
03385	Pedestrian Walkway over I-84 Ramp 191	1	78	858	7	6	6	N	6
03399A	I-84 WB over Park Street	4	296	25,130	6	5	5	N	5
03399B	I-84 WB over Parking Lot	4	296	14,060	6	5	6	N	5
03399C	I-84 WB TR 824 over Capitol Avenue and Amtrak	14	1187	55,028	4	5	5	N	5
03399D	I-84 TR 824 over Parking Lot	6	458	12,595	5	4	5	N	4
03400A	I-84 EB over Park Street and Parking Lots	3	226	20,254	6	5	5	N	5

Table 2-32 (ctd.): Bridge Condition Ratings and Overall Structural Evaluation

Bridge No.	Feature Carried/Crossed	# of Spans	Length	Deck Area	Deck	Superstructure	Substructure	Culvert	Structural Evaluation
03400B	I-84 EB over Parking Lot	4	339	16,136	6	5	6	N	5
03400C	I-84 TR 823 over Capitol Avenue, Forest Street, and Amtrak	15	1439	62,908	4	6	5	N	5
03400D	I-84 TR 823 over Parking Lot	7	599	16,473	4	5	5	N	5
03401A	SR 503 EB over Parking Lot	5	342	9,405	6	5	5	N	5
03401B	SR 503 EB over Capitol Avenue, Laurel Street, Forest Street, and Amtrak	16	1337	56,281	5	5	5	N	5
03402A	SR 503 WB over Capitol Avenue and Amtrak	6	500	27,075	5	3	3	N	3
03402B	SR 503 WB over Forest Street and Parking Lot	10	756	20,790	6	5	5	N	5
04295	I-84 EB On-Ramp 186 over I-84 Exit 48 On-Ramp	3	290	9,193	7	7	7	N	7
05762	I-84 EB Ramp 299 (off-ramp to Asylum Street) over I-84 WB Ramp 191	5	603	16,824	7	7	7	N	7
05868	W-N Turning Roadway over I-84/I-91 Ramps and Connecticut Southern Railroad	9	1726	58,136	7	7	6	N	6
05920	High Street over I-84 and on-off-ramps for Trumbull Street	2	180	12,510	7	7	6	N	6
05921	I-84 TR 841 over I-91 Ramp 186	1	106	3,583	7	7	7	N	7
05925	I-84/91 TR 841/858 over US Route 44 WB and Market Street	2	211	9,242	7	7	6	N	6
06047	Ann Uccello Street over I-84 and Ramps	2	206	19,879	7	7	7	N	7
06048	US Route 44 WB over I-91 NB, C-D Roadway and Ramps	3	154	5,359	7	6	6	N	6
06049	US Route 44 EB over I-91 NB, I-91 Collector and S-W Roadway	2	132	5,082	7	7	6	N	6
06559A	Hartford Platform West over I-84	2	179	15,834	7	7	6	N	6
06559B	Hartford Platform over I-84	2	175	67,375	7	7	6	N	6
06559C	Hartford Platform East over I-84	2	175	15,925	7	7	7	N	7
			Total Deck Area (sf.):	**1,501,113**					



NBI APPRAISAL RATING

- Very Good(8)
- Good(7)
- Satisfactory(6)
- Fair(5)
- Poor(4)
- Serious(3)

Not to Scale

The I-84 Hartford Project

Existing
Bridge Conditions
Map

Date: 06/27/2014	Drawn By: TSC	Fig. No: 2-56

3.0 Future (2040) Transportation Conditions

Future traffic and structural bridge conditions within the I-84 Hartford Project Area have been analyzed to identify the needs and deficiencies which the Project will address moving forward. This assessment builds on the Existing Conditions summarized in Chapter 2.0, projecting traffic volumes and structural bridge conditions to the Project's design year, 2040.

3.1 Future (2040) Traffic Data

An important component of the Project is to project traffic data out to the design year, 2040. This chapter describes the future traffic conditions within the study area, development steps of the Future No-Build Scenario Travel Demand Model (TDM), documentation of the traffic forecast process, and application of TDM results to other software such as Vissim, Synchro, and HCS.

It should be noted that the Future No-Build Scenario represents future conditions expected in the study area assuming year 2040 land-use, employment and housing levels currently identified by the City of Hartford and the Capitol Region Council of Governments (CRCOG). It assumes only limited improvements to the transportation system – typically only those that are programmed in either the Regional or the City of Hartford's Transportation Improvement Plan and have committed funding.

3.1.1 Methodology

Like most traffic forecasts, the CRCOG Model is a traditional daily four-step travel demand model with trip generation, trip distribution, mode choice, and traffic assignment that reflects population and employment projections and future land use development. These projections are used to predict traffic growth and to show how the transportation network will be impacted by this growth. In order to develop a calibrated future network, several steps were taken to ensure validity of the model.

To start the process, CDM Smith updated the CRCOG Daily Model with a time-of-day module to support the I-84 viaduct project and the I-84 value pricing pilot program study. The intent of the time-of-day implementation was to provide period-level traffic forecasts while maintaining as much of the basic CRCOG model structure as possible. The steps taken to develop the four periods using purpose-specific time-of-day (diurnal) factors are described in Appendix A.2.9, Technical Memorandum.

Next, using the updated CRCOG Time-of-Day Model, Cambridge Systematics developed the I-84 TransCAD subarea model to assist in future year demand analyses and to provide refined AM and PM peak period trip table demand estimates for the existing (2012) and future (2040) microscopic simulations. It should be noted that Cambridge Systematics performed their calibration process on the extracted subarea model for both the base year and the future year of 2040. Appendix A.2.10 includes the technical memorandum that provides background on the development of the base year (2012) existing conditions subarea origin-destination (OD) demand tables and the accompanying base year subarea assignment model. Similarly, Appendix A.2.11 includes the technical memorandum that provides background on the development of the 2040 no-build existing conditions subarea OD demand tables and the accompanying 2040 no-build subarea assignment model. Both memoranda describe in great detail the traffic forecast's development from the various traffic data sources, identification of any anomalies or significant variations between the forecasts, and planned improvements to the transportation system within the region.

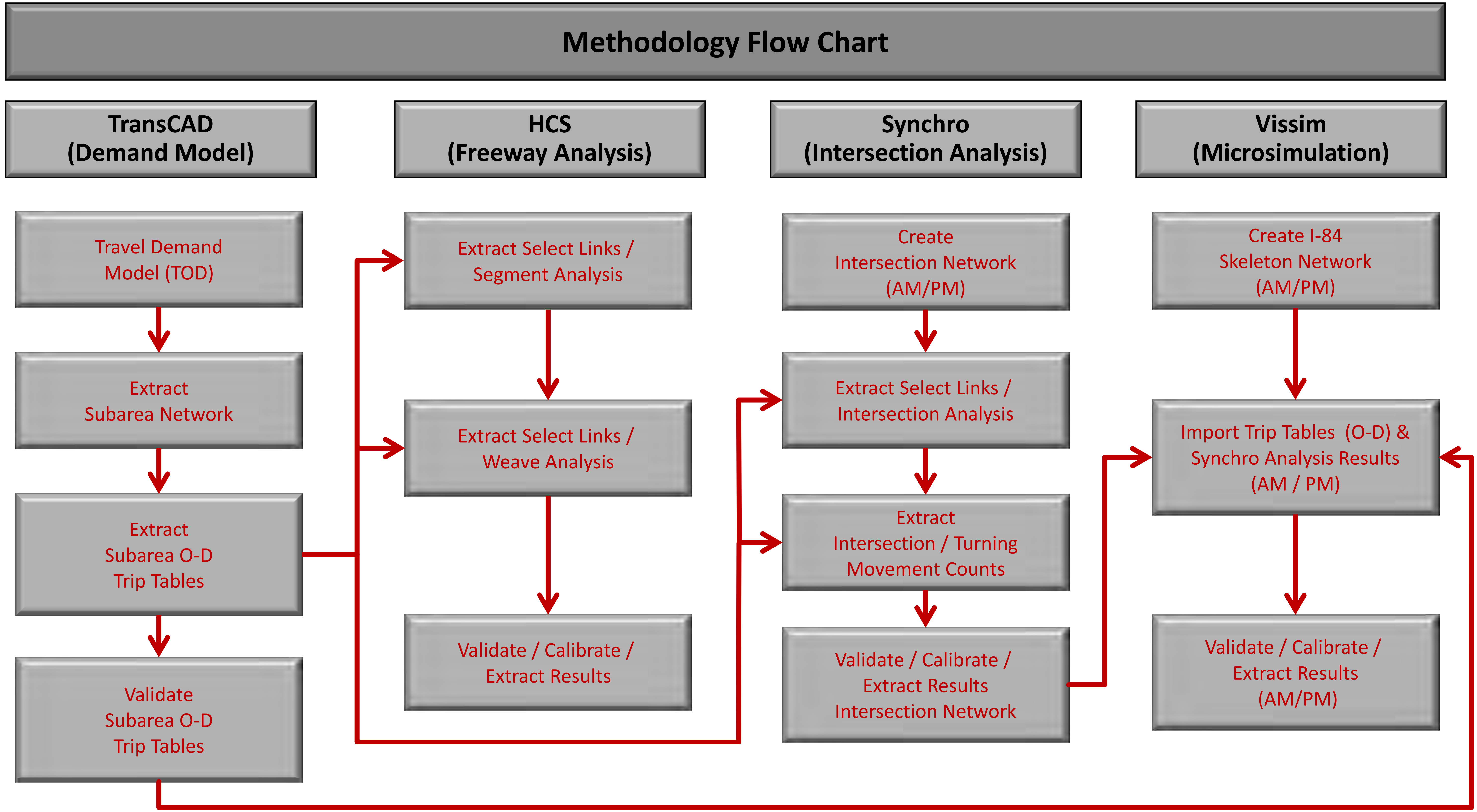
The TDM's main function is to produce long-range traffic forecasts, which are then used in a variety of ways, including supporting the analysis of alternatives, regional capacity needs, and congestion issues. The results of these analyses are important not only in identifying potential highway network needs, but also in providing inputs for further analysis of traffic flows, including intersection performance on arterial and collector roadways. Figure 3-1, following, illustrates the interaction between the TDM, HCS, Synchro, and Vissim. Each program is used to establish a baseline condition against which future conditions can be evaluated and provides different analysis elements within the Traffic Analysis Area.

3.1.2 Volumes

Based on forecast traffic growth in the study area, daily and peak hour traffic volumes were developed for the mainline, on- and off-ramps, weaving sections, and key intersections under study. Morning and evening peak hour volumes were used to evaluate the operating conditions based on these forecast traffic demands. These projected volumes account for potential development in the region, as well as growth expected elsewhere in the state. A detailed analysis of these roadway segments is summarized in following sections. Table 3-1 illustrates the overall pattern of traffic growth crossing the Connecticut River and the accuracy of calibration to traffic count data. During the AM and PM peak, the average annual growth rate is 0.3%.

Table 3-1: AM and PM Traffic Volume Comparison at CT River Crossings

Roadway	Direction	AM				PM			
		Count Profile Volume	2012 TDM Volume	2040 TDM Volume	AAPC	Count Profile Volume	2012 TDM Volume	2040 TDM Volume	AAPC
I-84-Bulkeley Bridge	Westbound	12,700	12,500	13,200	0.21%	14,500	14,300	15,600	0.31%
I-84-Bulkeley Bridge	Eastbound	8,500	8,400	9,100	0.29%	18,700	18,600	19,700	0.20%
Rt. 2-Founders Bridge	Westbound	6,600	6,400	7,000	0.33%	3,700	3,100	3,300	0.23%
Rt. 2-Founders Bridge	Eastbound	1,000	1,000	1,400	1.08%	6,900	6,900	8,300	0.65%
Rts. 5/15 -Charter Oak Bridge	Westbound	6,000	6,600	7,400	0.41%	6,200	7,300	8,200	0.43%
Rts. 5/15-Charter Oak Bridge	Eastbound	4,000	4,100	4,600	0.41%	8,800	8,900	9,900	0.36%
Total Traffic		**38,700**	**39,000**	**42,800**	**0.33%**	**58,700**	**59,000**	**64,900**	**0.34%**



The I-84 Hartford Project

Methodology Flow Chart

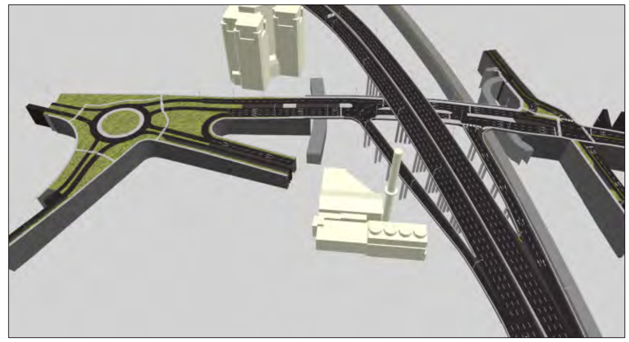
Date: 6/27/2014	Drawn By: TranSystems	Figure No: 3-1

3.2 Future (2040) Traffic Operations

The future traffic operations have been evaluated for the design year of 2040, using the future traffic volumes development process illustrated in Section 3.1.

3.2.1 Vissim (Microsimulation)

The modeling approach detailed in Section 2-4: Existing Traffic Conditions was also used for the 2040 future conditions no-build scenario to create Vissim AM peak and PM peak models. The origin-destination matrices for the 2040 no-build models were generated by the Travel Demand Model through extraction of trip tables as explained in Figure 3-1, page 3-3.



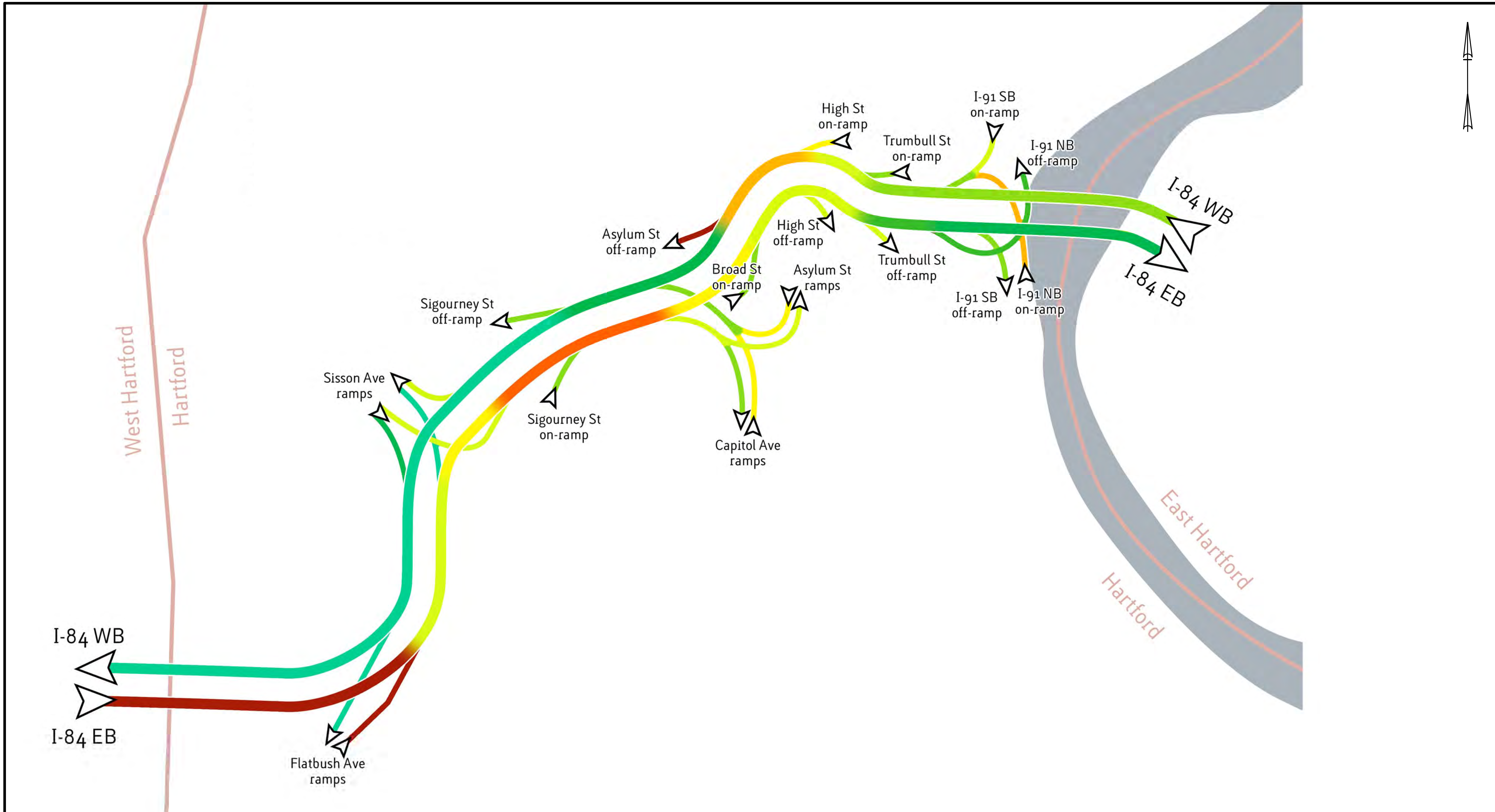
Screenshot of Vissim Modeled Roadway: Changes to Russ Street/Park Terrace/ Sigourney St. Intersection/Roundabout

Several modifications to the Vissim model roadway geometry were required to preserve the integrity of the study itself. These changes reflect future committed or in-construction geometry changes to 2040 Vissim networks:

- Conversion of the 4-way intersection at Russ Street, Park Terrace, and Sigourney Street into a modern roundabout;
- Reversal of the direction of flow on Union Place, to operate in the southbound direction only;
- Reversal of the direction of flow on High Street between Church Street and Asylum Street, to operate in the northbound direction only;
- Lane use changes on Asylum Street, Spruce Street, and High Street;
- Widening and lane use changes on Broad Street, Asylum Avenue, and Farmington Avenue;
- Alignment changes at Hawthorn Street, Sigourney Street, and Aetna Drive; and
- Reconfiguration and capacity improvement of the interchange between I-91 and CT 15.

The following sections show the Vissim simulation results for the 2040 AM and PM peak hours. These results include the traffic conditions for the I-84 corridor and those adjacent at-grade intersections that significantly affect mainline operations.

Average speeds for I-84 in Hartford in the morning and afternoon peaks are shown in Figure 3-2, following, and Figure 3-3, page 3-6, respectively. Note that speeds were collected lane-by-lane in 100-foot segments; while these diagrams summarize average speeds along a segment, more detailed data is also available. Speeds for the entire corridor are provided in Appendix A.2.14. Detailed Vissim results are provided in Appendix A.2.15.



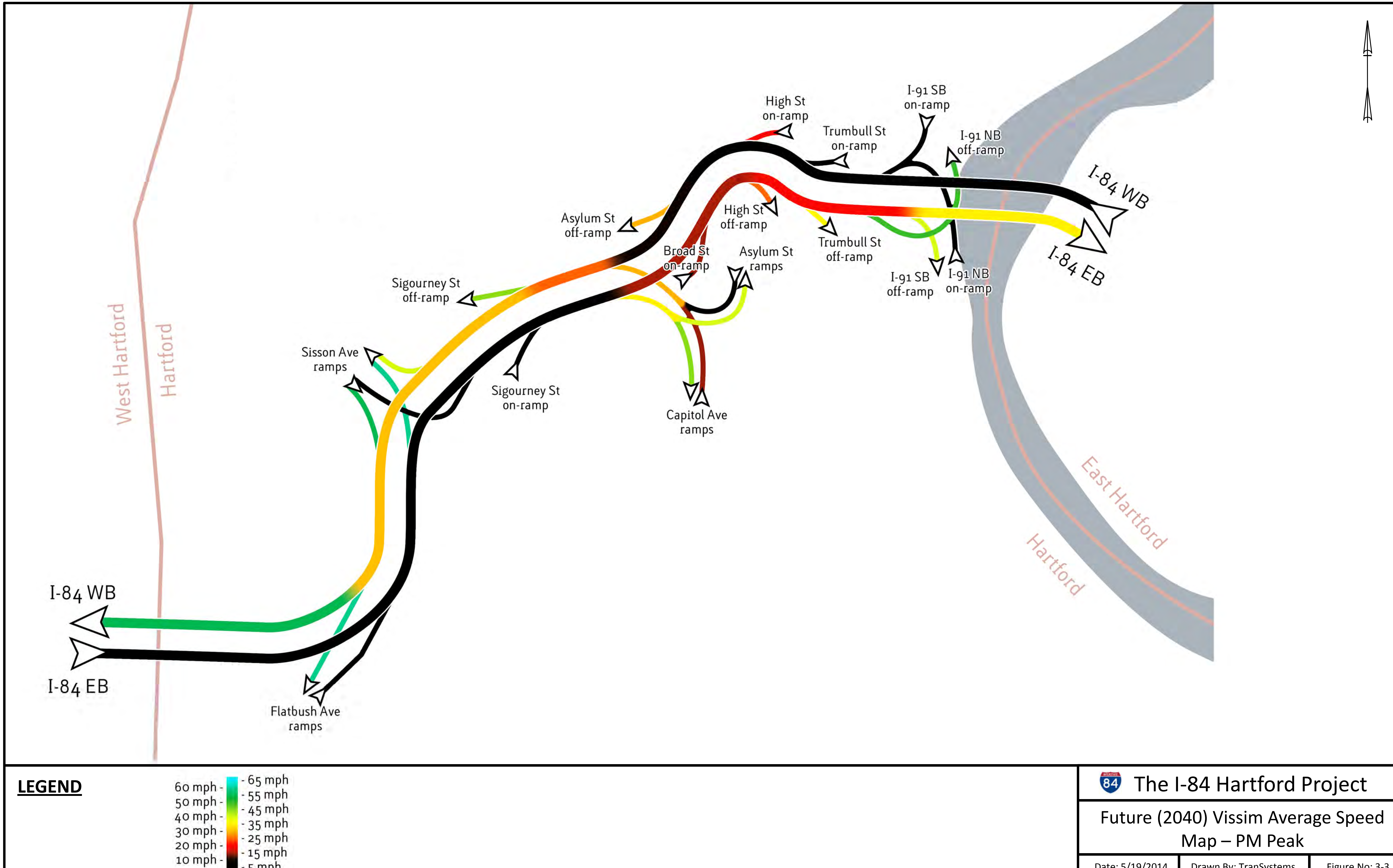
LEGEND

60 mph - - 65 mph
50 mph - - 55 mph
40 mph - - 45 mph
30 mph - - 35 mph
20 mph - - 25 mph
10 mph - - 15 mph
- 5 mph

The I-84 Hartford Project

Future (2040) Vissim Average Speed Map – AM Peak

Date: 5/19/2014	Drawn By: TranSystems	Figure No: 3-2



The I-84 Hartford Project

Future (2040) Vissim Average Speed Map – PM Peak

Date: 5/19/2014	Drawn By: TranSystems	Figure No: 3-3

In the morning peak, eastbound traffic flows slightly slower than 2012 existing. Similarly, the average speeds were lowest west of the Flatbush Ave on-ramp with average speed range of 15-20 mph. The weave section between the Sigourney Street on-ramp and Exits 48A and 48B exhibits an average speed of 25 mph. Past this point, the speeds improve slightly to 35-45 mph until the recovery point of uncongested speeds after the Trumbull Street off-ramp, where speeds reach 55 mph and higher. Westbound, traffic improves substantially between 2012 and 2040. This is a direct result of the realignment and optimization of traffic and signal timings on Asylum Street intersections. In the existing conditions model, the Asylum Street off-ramp queue backs up into the rightmost lane of freeway, causing congestion that extends past the I-91 interchange. With the improvements to the local road network, the freeway experiences significantly less congestion and delay.

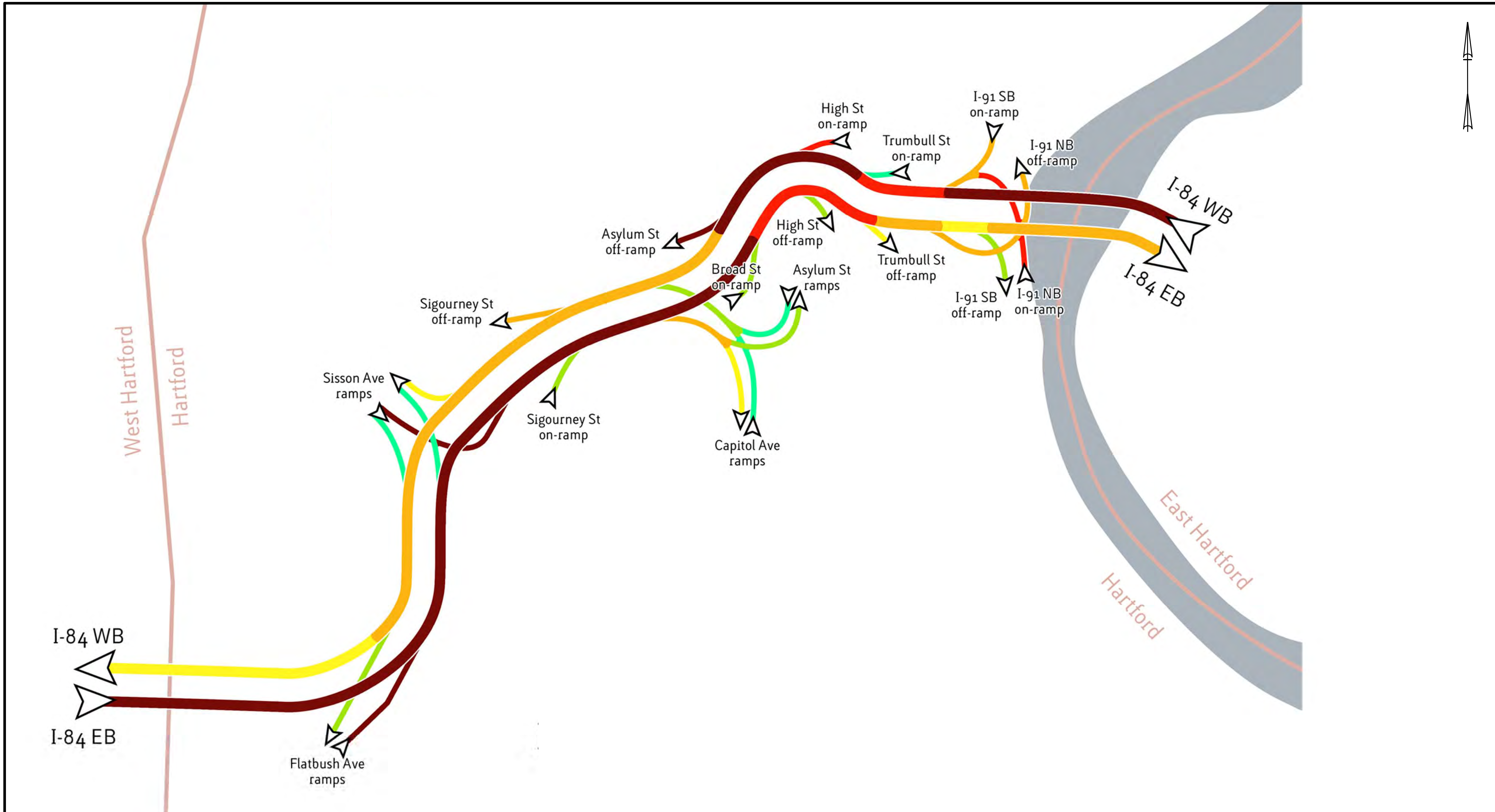
In the afternoon, average speeds are slower than in the morning for both directions. Eastbound traffic is backed up from West Hartford through Hartford, only improving marginally after crossing the Connecticut River with speeds of 35 mph. Westbound traffic is heavy throughout East Hartford and Hartford, only beginning to improve past the Sigourney St off-ramp (Exit 47). Free flow conditions are experienced west of Flatbush Avenue off Ramp (Exit 45), though it is relevant to note that the simulation area does not continue past this point. Downstream congestion would almost certainly degrade speeds in this area, as was noted in the field.

Density on I-84 through the study area was also analyzed in Vissim. This density was then used to calculate Level or Service (LOS). The AM and PM LOS results for I-84 in Hartford are shown in Figure 3-4, following, and Figure 3-5, page 3-9, respectively. LOS values for the entire corridor are provided in Appendix A.2.15.

In the morning peak, both directions of I-84, as well as several ramps, experience heavy congestion. I-84 eastbound operates at LOS F from West Hartford easterly to the Broad Street on-ramp, and then alternates between LOS E and C across the Connecticut River and into East Hartford. Westbound, traffic operates at LOS F from the East Hartford town line westerly to the Asylum Street off-ramp, and improves marginally thereafter, reaching LOS C after the Flatbush Avenue off-Ramp (Exit 45).

The afternoon peak brings greater levels of traffic congestion. Both directions through Hartford operate at LOS F. Along with the mainline, several ramps are influenced by this congestion. The on-ramps from I-91, in particular, are heavily congested during both peak periods. The Flatbush Avenue on-ramp and Sisson Avenue on-ramp to I-84 eastbound experience significant congestion due to heavy volumes on the freeway. Similarly, in the westbound direction, heavy congestion and weaving on the freeway cause congestion on the High Street on-ramp.

With the future no-build model complete, proposed alternatives can now be compared to determine their impact on traffic flow.



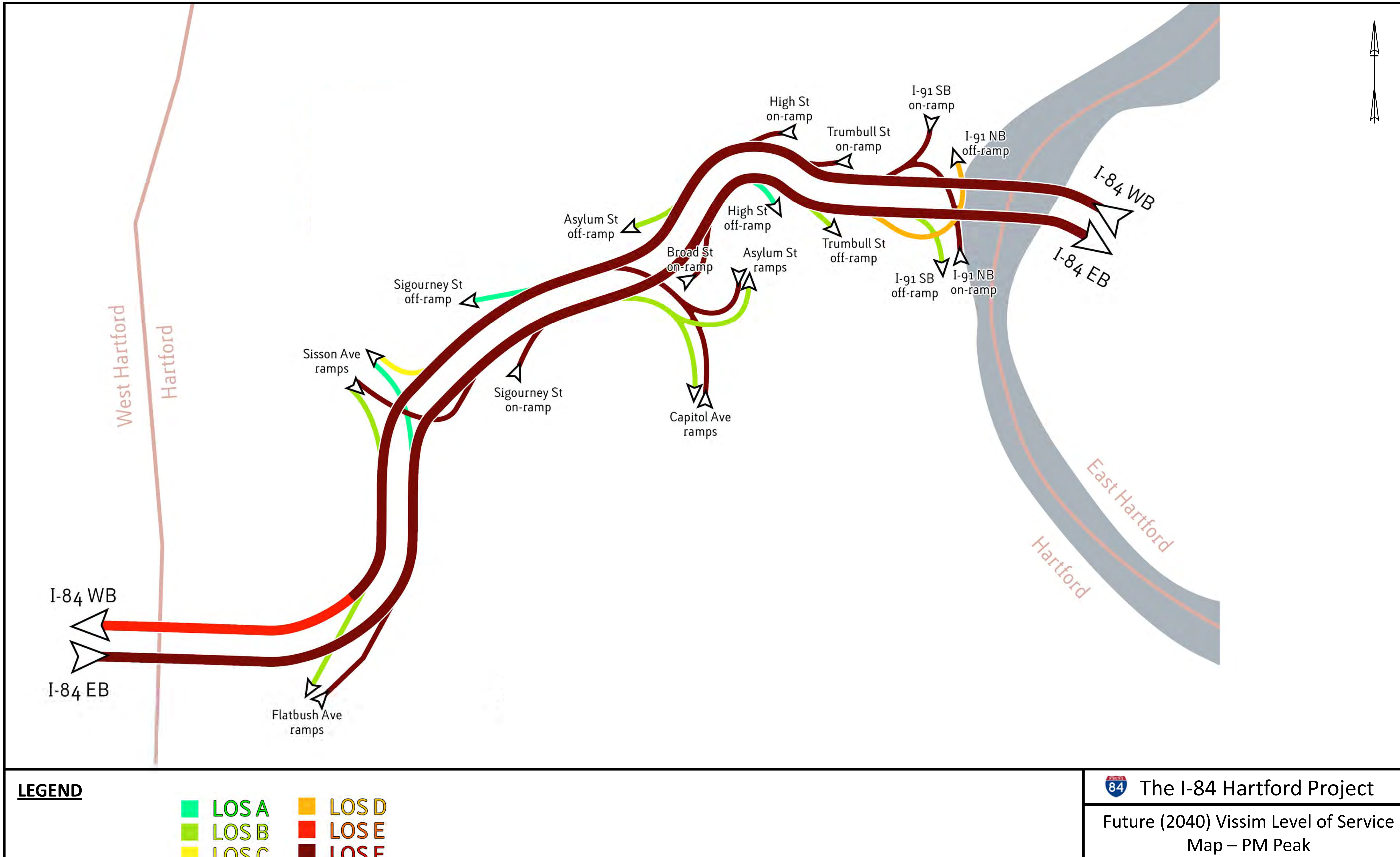
LEGEND

- LOS A
- LOS B
- LOS C
- LOS D
- LOS E
- LOS F

The I-84 Hartford Project

Future (2040) Vissim Level of Service Map – AM Peak

Date: 5/19/2014	Drawn By: TranSystems	Figure No: 3-4



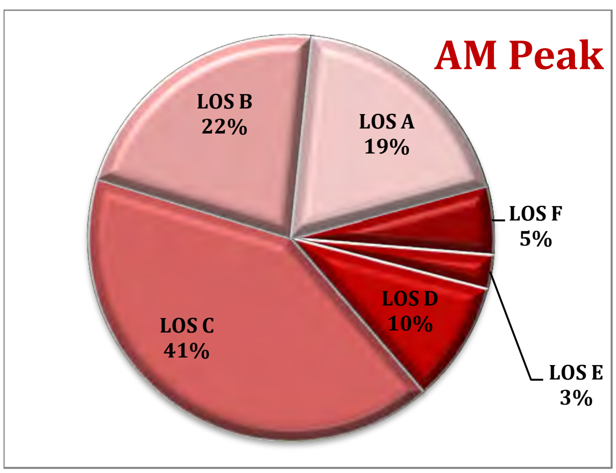
The I-84 Hartford Project		
Future (2040) Vissim Level of Service Map – PM Peak		
Date: 5/19/2014	Drawn By: TranSystems	Figure No: 3-5

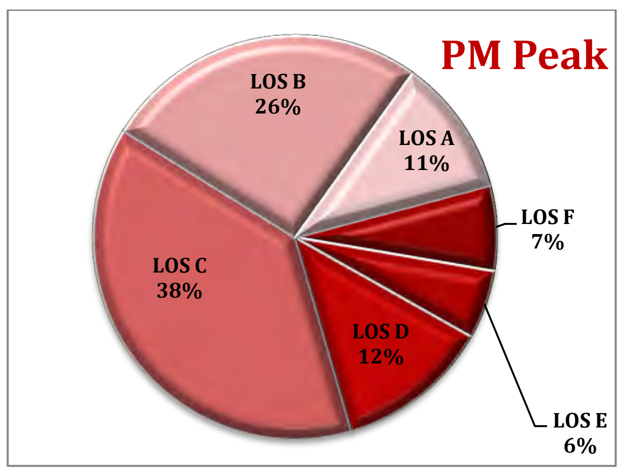
3.2.2 Synchro (Intersection Analysis)

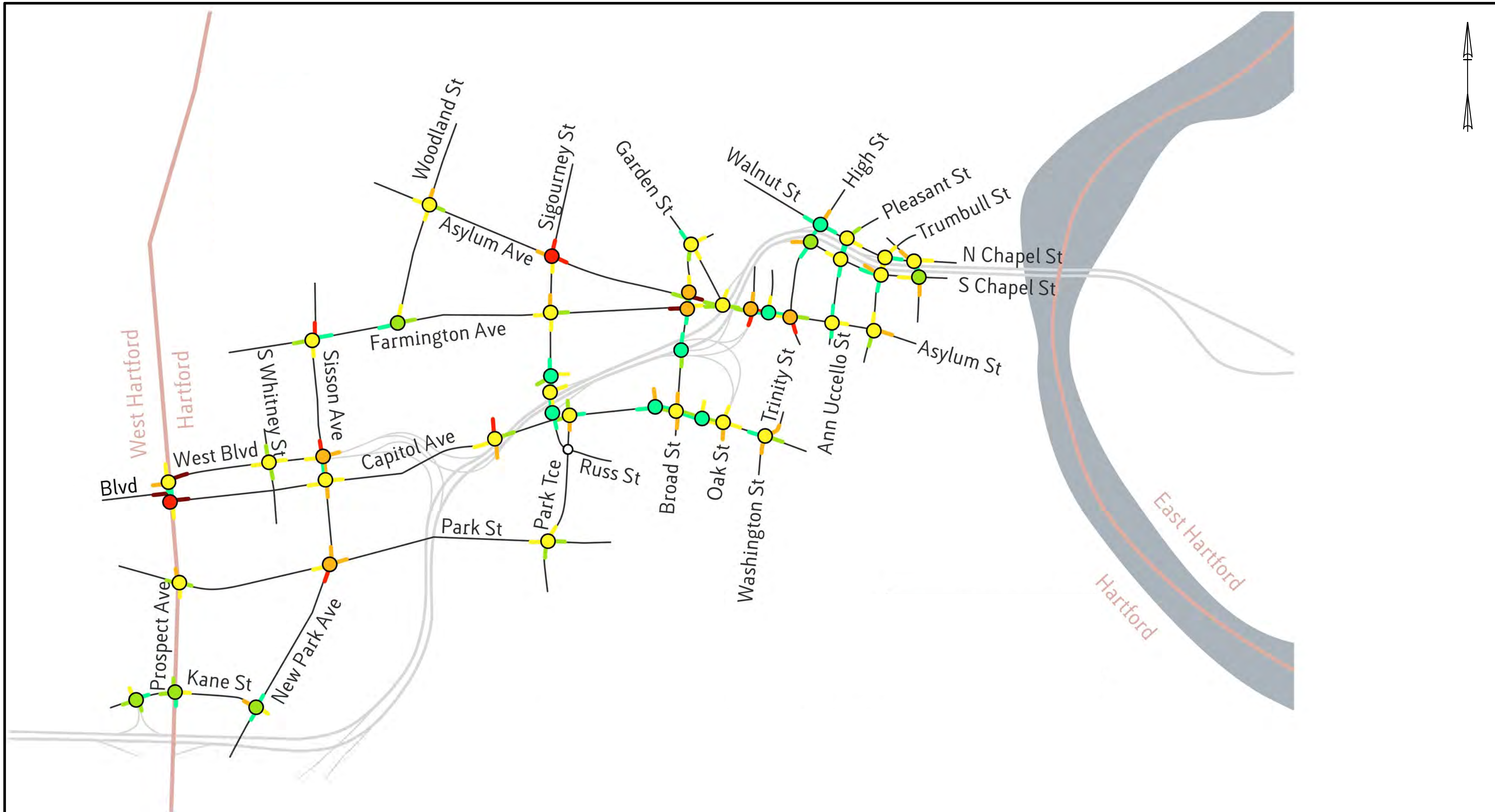
The results of the intersection analysis under 2040 traffic conditions are summarized in Appendix A.2.13 for all signalized intersections in the study area. The tables and figures encompass the intersections that were evaluated for the 2040 future conditions morning and evening peak hour levels of service with and without optimized traffic signal times. Partial results of the intersection LOS results are also presented graphically in Figure 3-7, following, for the AM Peak and Figure 3-8, page 3-12, for the PM Peak. All signal timings for the future conditions analysis have been optimized in Synchro to account for the City of Hartford's impending signal system upgrades. The following paragraphs summarize the expected 2040 operating conditions using Synchro.

Overall, under 2040 conditions, the operating LOS of most intersections is expected to deteriorate from existing conditions due to increased volumes. At all intersections where there will be volume increases, longer delays and higher volume to capacity (v/c) ratios are expected. Note that the count of signalized intersections changes from 75 to 73 in 2040 due to the realignment of one intersection and the redesign of another to a roundabout. Figure 3-6, below, shows that the number of signalized intersections with LOS E or F during the AM peak hour is expected to increase from 4% under existing conditions to 8% under 2040 conditions. In PM peak hour, there is a similar increase from 10% to 13% with LOS of E or F. The percent of signalized intersections with LOS E or F increases due to the increased number of congested intersections rather than the removal of intersections, as further explained following the figures and tables.

Figure 3-6: Summary of Synchro Optimized Intersection Peak Hour Results







LEGEND

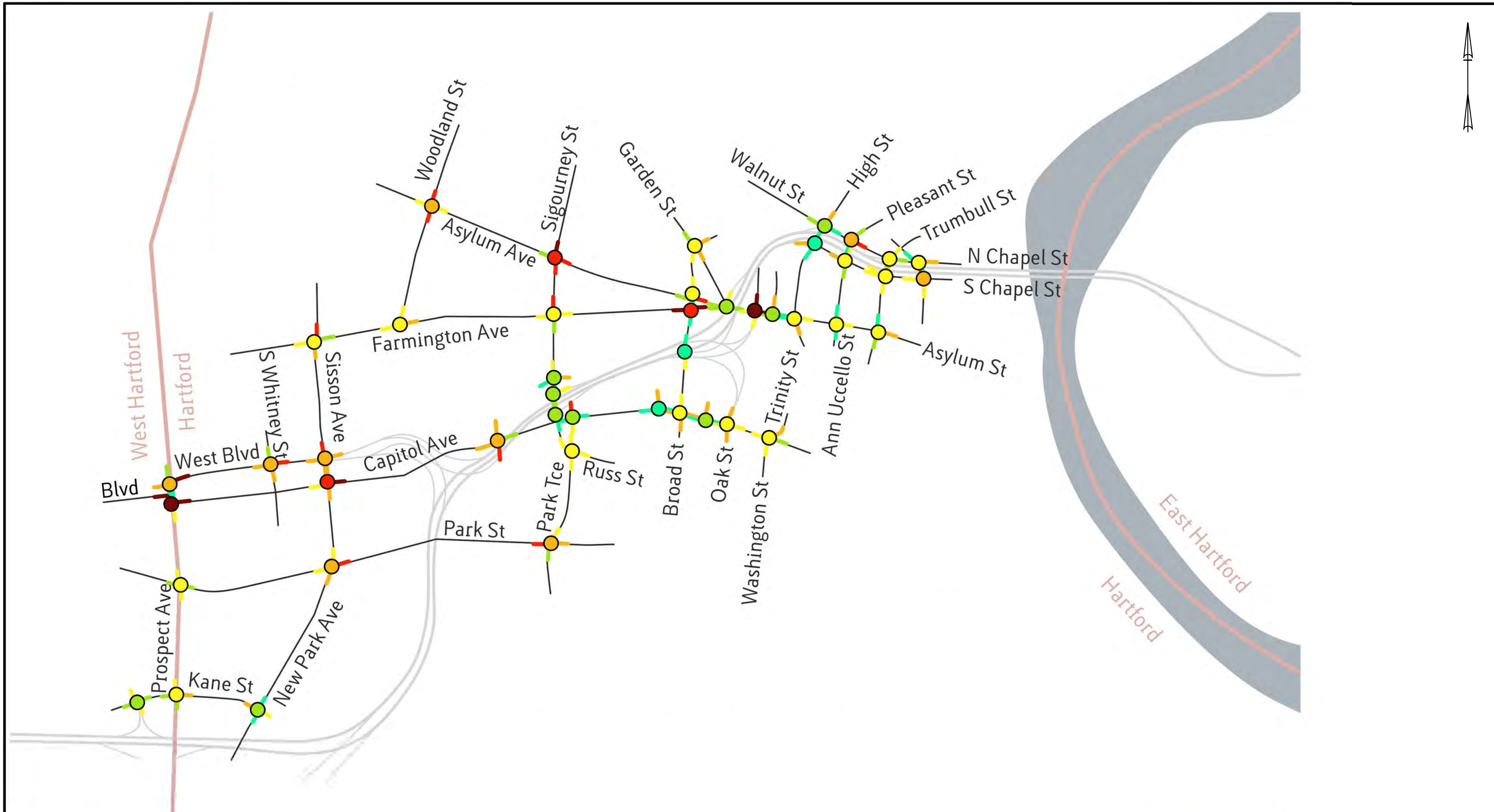
LOS A
LOS B
LOS C
LOS D
LOS E
LOS F

Intersection LOS
Approach LOS

The I-84 Hartford Project

Future (2040) Synchro Intersection Level of Service Map – AM Peak

Date: 6/27/2014	Drawn By: TranSystems	Figure No: 3-7



LEGEND

LOS A
LOS B
LOS C
LOS D
LOS E
LOS F

Intersection LOS
Approach LOS

The I-84 Hartford Project

Future (2040) Synchro Intersection Level of Service Map – PM Peak

Date: 6/27/2014	Drawn By: TranSystems	Figure No: 3-8

Table 3-2, below, illustrates partial results for selected key intersections that are directly impacted by operations on I-84. Only intersections 67 & 68 have one or more approaches with a LOS lower than E; the other three intersections perform at LOS A through LOS C.

Table 3-2: Summary of Selected Synchro Future (2040) Conditions – Intersection Analysis Results

Intersection/Direction	AM Peak Hour		PM Peak Hour	
	LOS	Approach Delay (sec/veh)	LOS	Approach Delay (sec/veh)
Sigourney St & I-84 Eastbound On-Ramp				
Northbound - Sigourney St	A	7.9	B	13.4
Southbound - Sigourney St	A	2.6	A	8.0
Overall	A	4.4	B	10.5
Sigourney St & I-84 Westbound Off-Ramp				
Northbound - Sigourney St	C	30.2	B	17.6
Southbound - Sigourney St	B	10.9	B	12.9
Westbound - I-84 EB Off Ramp	C	30.6	B	19.6
Overall	C	26.8	B	16.0
Asylum Ave & Garden St & I-84 Westbound Off-Ramp				
Southbound - I-84 Westbound Off Ramp	C	26.5	C	32.6
Eastbound - Asylum Ave & Farmington Ave	B	12.4	B	10.4
Westbound - Asylum St	B	16.3	B	16.7
Overall	C	20.2	B	19.2
Broad St/Cogswell St & Asylum Ave				
Northbound - Broad St	A	4.9	A	8.9
Southbound - Cogswell St	C	23.0	C	25.2
Eastbound - Asylum Ave	B	10.6	B	18.0
Westbound - Asylum Ave	F	84.8	D	39.7
Overall	D	35.0	C	24.3
Broad St & Farmington Ave				
Northbound - Broad St	A	9.0	B	11.4
Southbound - Broad St	B	13.1	B	18.6
Eastbound - Farmington Ave	F	157.1	F	101.5
Westbound - Farmington Ave	C	29.8	E	62.7
Overall	D	46.2	E	58.4

Out of the 73 signalized intersections analyzed for 2040 traffic conditions, 18 intersections are expected to experience saturated conditions during at least one of the peak hours, and nine of the intersections will operate at a LOS E or F during both peak hours. An estimated 16 signalized intersections are projected to be significantly over capacity, with a volume-to-capacity (v/c) ratio in excess of 1.2 during the PM peak hour for a least one of the approaches. When v/c ratios significantly exceed 1.0, the intersection cannot process the traffic demands placed upon it and will fail (LOS F), causing significant delays. During the AM peak hour, nine locations have one approach with a V/C ratio in excess of 1.2 or LOS F. Of the 16 intersections reviewed where I-84 ramps intersect with the local streets, 12 intersections during the AM peak hour and 16 during the PM peak hour are expected to operate under LOS A through C. Only one signal, the intersection of Asylum Avenue with the I-84 eastbound off-ramp and Spruce Street, performs with V/C ratios higher than 1.2.

It should be noted there are several exceptions to the general trend of worsening intersection performance. Where traffic volumes did not exceed capacity limits, the optimized signal timings used in the 2040 analysis improved performance of several intersections overall. Also, due to the reconstruction of Park Terrace at Russ Street from a signalized intersection to a roundabout, two nearby intersections improve their performance: Park Terrace at Capitol Avenue improves from LOS D to LOS B and Sigourney Street at I-84 eastbound on-ramp also shows improvement from LOS B to LOS A. The latter signal also benefits from roadway improvements related to the CT*fastrak* project, which reconstructed both Sigourney Street and Hawthorn Street.

In addition to these improvements, changes to other roadway segments had similar impacts on Synchro's intersection analysis. In the 2040 TDM, two roads reverse their direction of operation: High Street and Union Place. High Street from Asylum Street to Church Street will change its flow of direction from southbound-only to northbound-only, and Union Place will operate only in southbound direction in future years. In addition to the change of traffic direction on these two streets, lane arrangements have changed on Asylum Street from Spruce Street to High Street. The net results of these changes, along with the optimization of traffic signal timings, has improved the performance of these intersections as well as their neighbors.

Finally, the reconfiguration of Broad Street between the I-84 eastbound on-ramp and Cogswell Street has resulted in major operational changes, including the improvement of the on-ramp itself and better traffic flow between the two closely spaced intersections to the north. These differences are critical to traffic flow on I-84 in 2040.

3.2.3 HCS (Freeway Analysis)

The procedures and criteria used to evaluate the future conditions were based on the methodology presented in the Highway Capacity Manual, similar to the analyses completed for the 2012 Existing Conditions. Level of Service (LOS) values for intersections and roadway segments can range from A to F, with LOS A representing the best operational conditions. LOS F represents congested conditions. A detailed description of the LOS methodology and criteria is provided in Section 2.4. The full results of the freeway segment analysis under 2040 traffic conditions are summarized in Appendix A.2.12.

When comparing 2012 to 2040, the LOS of mainline segments through the corridor remains the same or gets worse within Hartford in both directions. The traffic through I-84 Hartford in 2040 was determined to range between LOS C and LOS F for both peak periods, with the majority of segments operating at LOS E or worse. For this study, freeway operations of LOS D or better were considered acceptable; however, in this instance, the segment's operating at LOS D had short length and was adjacent to LOS E/F segments. In such conditions, it can be assumed that HCS does not properly reflect real-world operations and the LOS for these segments would be worse.

3.3 Future (2040) Structural Conditions

Accurate prediction of the future condition of bridge components is an important part of any bridge management system. Past bridge inspection data and information on repairs and/or retrofits were used to provide a baseline for predicting the future condition of bridge components in the Project Study Corridor. These future condition ratings are crucial for the Project's no-build alternative.

To predict the future condition, historical bridge condition ratings were used to create scatterplots depicting ratings over time. Deterioration curves were drawn using known ratings and a trend line was established for each bridge. These trend lines or curves were then projected forward to the design year, 2040. From the curve values, engineering judgment was made to determine what level of bridge rehabilitation or replacement would be required to keep the bridges in fair or better condition (Rating of '5' or above).

The number of previous rehabilitation projects was considered in order to determine each bridge's ability to be effectively rehabilitated in the future. For instance, if the existing rating of a bridge is '4' (poor) and the bridge has already undergone multiple rehabilitation projects, it is likely that substantial replacement will be required by 2040. Table 3-3, below, shows programmed rehabilitation projects, projected condition ratings for 2040, and anticipated future projects for the corridor based on the deterioration curves. Figure 3-9, page 3-20, shows which bridges would need to be replaced or rehabilitated by 2040. See Appendix A.1 for further details, including the condition rating curves used for future condition assessment.

It is important to note that rehabilitations in the corridor have cost $60 million since 2005 and an additional $63 million is planned to be spent by 2018. It is anticipated that additional funding will be required in future years to keep these bridges in fair condition (rating '5').

Table 3-3: Programmed and Proposed Rehabilitation/Replacement Projects

Bridge No.	Current Needs/Programmed Rehabilitation Projects	2040 Deck Rating	2040 Superstructure Rating	2040 Substructure Rating	2040 Rehabilitation/Replacement Recommendations
00980B	None	4.5	4.3	5.0	General Maintenance
01426	None	5.9	5.1	4.2	General Maintenance
01428A	None	6.0	5.2	5.2	General Maintenance
01428B	None	6.0	4.1	5.2	General Maintenance
01428D	Project 63-653 will increase the condition ratings of all major components in 2015.	5.7	4.3	4.5	General Maintenance
01686A	This bridge is scheduled for rehabilitation on List 27, although no specific project has been initiated.	5.0	4.0	4.5	General Maintenance

Table 3-3 (ctd.): Programmed and Proposed Rehabilitation/Replacement Projects

Bridge No.	Current Needs/Programmed Rehabilitation Projects	2040 Deck Ratings	2040 Superstructure Rating	2040 Substructure Ratings	2040 Rehabilitation/Replacement Recommendations
01686B	Project 65-654 will increase the condition ratings of all components in 2016.	4.7	4.8	4.3	General Maintenance
01763	None	5.9	4.4	5.3	General Maintenance
01764	None	5.9	4.5	4.0	General Maintenance
01765	General Rehabilitation required. No project has been established. Increased condition ratings (deck and superstructure to a 6) have been applied to year 2017.	3.5	3.3	3.7	Substantial Replacement will be required.
01766	General Rehabilitation required. No project has been established. Increased condition ratings (deck and superstructure to a 6) have been applied to year 2017	3.6	3.5	3.8	Substantial Replacement will be required.
03023	None	3.1	4.5	3.9	Deck Replacement will be required.
03160A	Project 63-616 Rehabilitation project -- intent is to bring superstructure condition rating to a 5 and address outstanding deficiencies.	3.2	1.5	1.8	Substantial Replacement will be required.
03160B	Project 63-616 Rehabilitation project -- intent is to bring superstructure condition rating to a 5 and address outstanding deficiencies.	3.2	1.4	1.7	Substantial Replacement will be required.
03160C	Project 63-616 Rehabilitation project -- intent is to bring superstructure condition rating to a 5 and address outstanding deficiencies.	5.7	1.5	2.7	Substantial Replacement will be required.

Table 3-3 (ctd.): Programmed and Proposed Rehabilitation/Replacement Projects

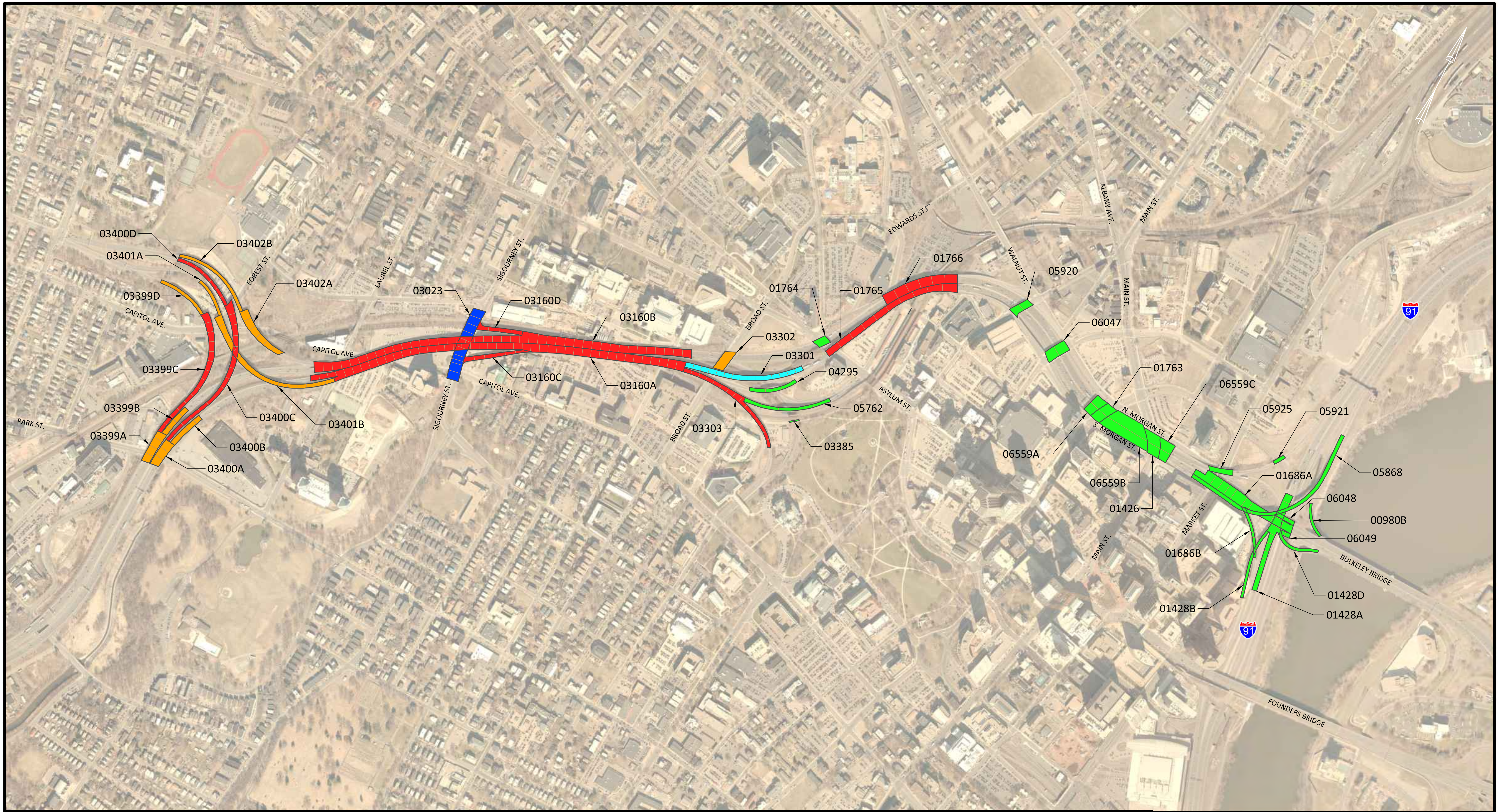
Bridge No.	Current Needs/Programmed Rehabilitation Projects	2040 Deck Ratings	2040 Superstructure Rating	2040 Substructure Ratings	2040 Rehabilitation/Replacement Recommendations
03160D	Project 63-616 Rehabilitation project -- intent is to bring superstructure condition rating to a 5 and address outstanding deficiencies.	6.1	2.1	2.7	Substantial Replacement will be required.
03301	Project 63-616 Rehabilitation project -- intent is to bring superstructure condition rating to a 5 and address outstanding deficiencies.	4.5	1.9	3.4	Superstructure Replacement will be required prior to 2040.
03302	None	5.3	3.7	2.5	General Rehabilitation will be required prior to 2040.
03303	Project 63-616 Rehabilitation project -- intent is to bring superstructure condition rating to a 5 and address outstanding deficiencies.	5.0	2.2	2.5	Substantial Replacement will be required.
03385	None	N/A	4.3	4.7	General Maintenance
03399A	None	3.3	2.3	3.7	General Rehabilitation will be required prior to 2040 (See Note A).
03399B	None	3.8	2.3	3.7	General Rehabilitation will be required prior to 2040 (See Note A).
03399C	None	3.9	1.4	2.2	Substantial Replacement will be required.
03399D	Project 63-695 is planned for general rehabilitation expected to increase deck, superstructure, and substructure rating to a 6 in 2016.	3.9	3.4	3.3	General Rehabilitation will be required prior to 2040.
03400A	None	3.4	2.3	2.3	General Rehabilitation will be required prior to 2040 (See Note B).
03400B	None	5.0	2.3	4.1	General Rehabilitation will be required prior to 2040 (See Note A).

Table 3-3 (ctd.): Programmed and Proposed Rehabilitation/Replacement Projects

Bridge No.	Current Needs/Programmed Rehabilitation Projects	2040 Deck Ratings	2040 Superstructure Rating	2040 Substructure Ratings	2040 Rehabilitation/Replacement Recommendations
03400C	General Rehabilitation required. No project has been established. Increased condition ratings have been applied to year 2018.	3.4	2.2	2.3	Substantial Replacement will be required.
03400D	Project 63-694 is planned for general rehabilitation expected to increase deck, superstructure, and substructure rating to a 6 in 2016.	4.4	2.2	2.3	Substantial Replacement will be required.
03401A	None	4.9	3.5	4.3	Superstructure Rehabilitation will be required prior to 2040.
03401B	None	3.8	3.5	2.5	General Rehabilitation will be required prior to 2040.
03402A	Project 63-695 is planned for general rehabilitation expected to increase superstructure and substructure rating to a 5 in 2016.	3.4	3.1	3.3	General Rehabilitation will be required prior to 2040.
03402B	None	4.1	3.9	3.2	General Rehabilitation will be required prior to 2040.
04295	None	5.4	5.7	5.7	General Maintenance
05762	None	7.0	5.8	5.8	General Maintenance
05868	None	6.3	6.1	5.3	General Maintenance
05920	None	5.0	5.1	5.3	General Maintenance
05921	None	6.1	6.3	5.6	General Maintenance
05925	None	5.6	5.6	5.5	General Maintenance
06047	None	5.8	5.8	5.5	General Maintenance
06048	None	5.2	4.6	4.4	General Maintenance
06049	None	5.5	5.5	5.1	General Maintenance
06559A	None	5.9	5.6	5.5	General Maintenance
06559B	None	5.9	5.6	5.5	General Maintenance
06559C	None	5.9	5.6	5.5	General Maintenance

Note A: Superstructure rehabilitation is expected to increase rating prior to 2040. No previous superstructure rehabilitations have been performed.

Note B: Superstructure and substructure rehabilitations expected to increase ratings sufficiently prior to 2040. No previous superstructure or substructure rehabilitations have been performed.



Legend

- Deck Replacement
- Superstructure Replacement
- General Rehabilitation
- General Maintenance
- Substantial Replacement

The I-84 Hartford Project

Future (2040) Bridge Rehabilitation/Replacement Recommendations

Date: 06/27/2014	Drawn By: TSC	Fig. No: 3-9

 Not to Scale

4.0 Existing Social, Economic and Environmental Conditions

The Existing Social, Economic, and Environmental Conditions within the I-84 Hartford Project Area have been analyzed to identify the needs and deficiencies that the Project will address. The future impacts of an alternative, both positive and negative, are based on this assessment of existing conditions. Each of the elements analyzed below were evaluated within the Social, Economic, and Environmental Study Area (the Study Area, for the duration of this section). The Study Area comprises an area the length of the Project Study Corridor and extending approximately half a mile north and south of I-84. See Figure 4-1, following, for an illustration of the Social, Economic, and Environmental Study Area and key features within the Study Area. See the Study Areas Map, page 1-3, for further location information.

4.1 Land Use

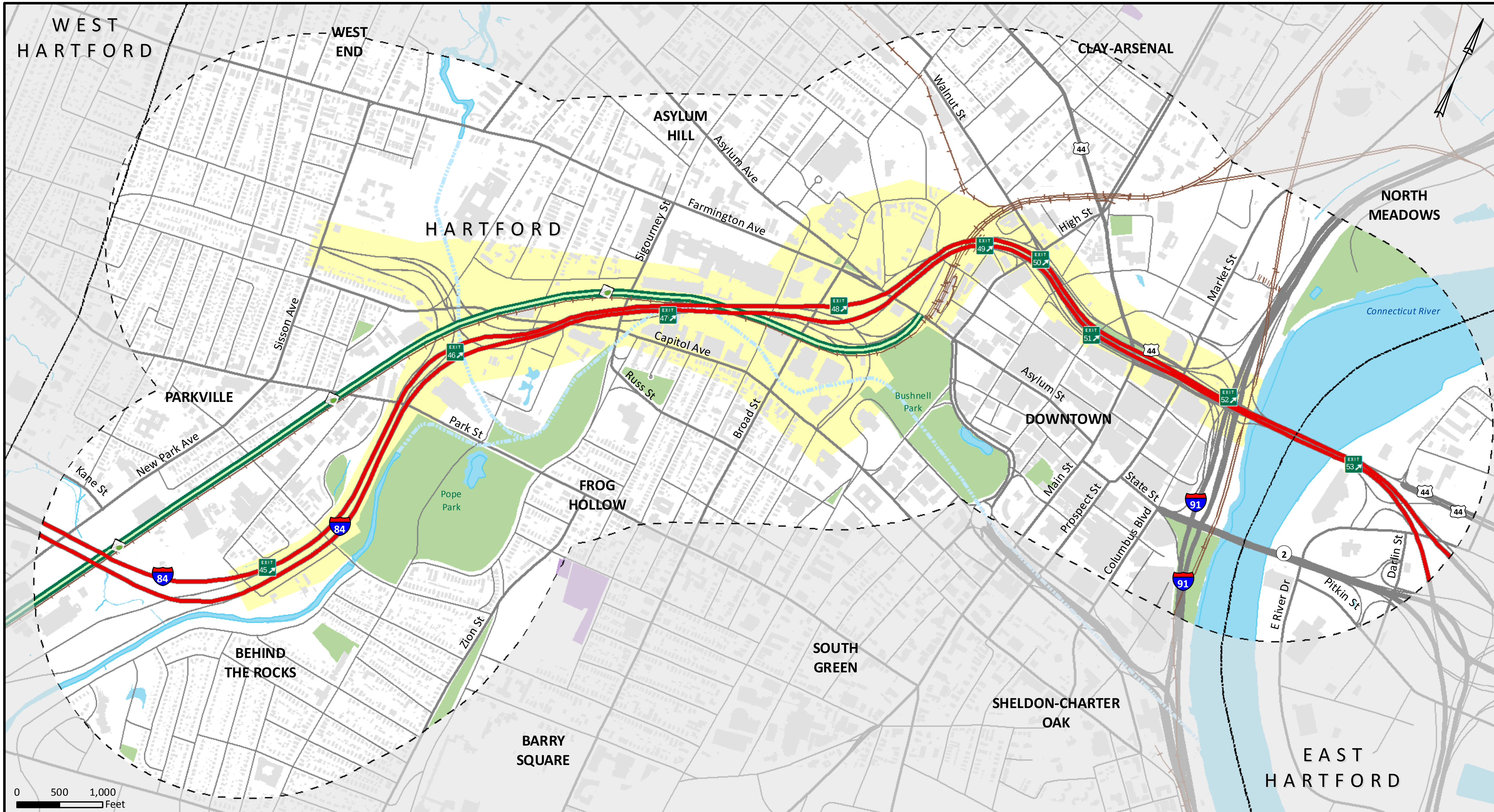
City of Hartford Land Use data and classifications were consulted for the land use evaluation. Land uses in the Study Area are characterized by a diversity of types: primarily residential (low, medium, and high density), office, retail, light industrial, education, government, and transportation/parking. Generally speaking, residential uses are located at the periphery of the Study Area, while the inner band of uses along I-84 is comprised of light industrial, green space (Pope Park and Bushnell Park), office, governmental, and transportation/parking. Land use is presented graphically in Figure 4-2, page 4-3.

4.1.1 New Park Avenue to Park Street

West of I-84, this area exhibits a large concentration of active light industrial and office uses with one large retail component (Stop and Shop Plaza). East of I-84, there are organized neighborhoods of single and multi-family housing between Flatbush Avenue and Zion Street. Near Park Street, I-84 divides Pope Park, a large neighborhood park of 71 acres, into sections east and west of the highway. Park Street is an active retail street between Prospect and Sisson Avenues.

4.1.2 Park Street to Asylum Avenue

West of I-84, the area between Park Street and Farmington Avenue is primarily residential. The I-84 Interchange 46 ramps cross above Capitol Avenue just south of Hartford High School. The Mark Twain and Harriet Beecher Stowe houses (see Section 4.9: Historic and Archaeological Resources) are on Farmington Avenue. East of I-84 includes a mix of retail (old Caldor shopping plaza) and residential areas around Russ and Broad Streets. Three major land uses within this area include the Aetna corporate campus to the west and the State Capitol and Bushnell Park to the east.



LEGEND

- I-84 Exit
- CT Fastrak Station
- I-84
- Project Corridor
- Interstate Highway
- US Highway
- Major Road
- Local Road
- Railroad
- CT Fastrak
- Study Area
- City Boundary
- Park River Conduit
- Building Footprint
- Cemetery
- Park
- Water

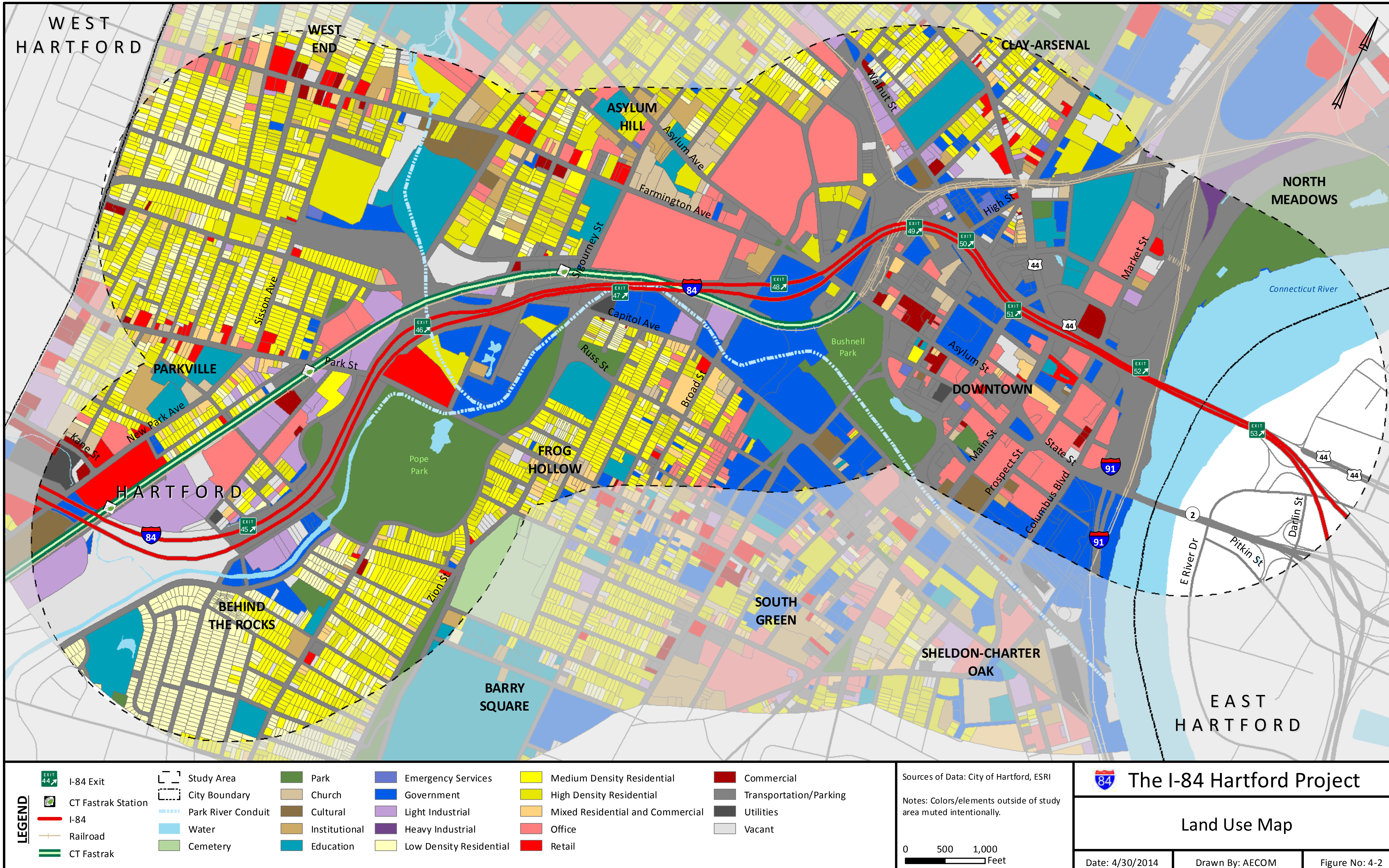
Sources of Data: City of Hartford, ESRI, CT DEEP, National Register of Historic Places, CDOT, US Census Bureau 2010

Notes: Colors/elements outside of study area muted intentionally.

The I-84 Hartford Project

Study Area Map

Date: 4/29/2014	Drawn By: AECOM	Figure No: 4-1


WEST HARTFORD
WEST END
ASYLUM HILL
CLAY-ARSENAL
NORTH MEADOWS
PARKVILLE
DOWNTOWN
FROG HOLLOW
HARTFORD
BEHIND THE ROCKS
SOUTH GREEN
BARRY SQUARE
SHELDON-CHARTER OAK
EAST HARTFORD
Walnut St
Asylum Ave
Farmington Ave
High St
Market St
Sigourney St
Sisson Ave
Capitol Ave
Park St
Russ St
Broad St
Asylum St
Main St
State St
Prospect St
Columbus Blvd
New Park Ave
Kane St
Zion St
E River Dr
Pitkin St
Darlin St
Bushnell Park
Pope Park
Connecticut River
LEGEND
I-84 Exit
CT Fastrak Station
I-84
Railroad
CT Fastrak
Study Area
City Boundary
Park River Conduit
Water
Cemetery
Park
Church
Cultural
Institutional
Education
Emergency Services
Government
Light Industrial
Heavy Industrial
Low Density Residential
Medium Density Residential
High Density Residential
Mixed Residential and Commercial
Office
Retail
Commercial
Transportation/Parking
Utilities
Vacant
Sources of Data: City of Hartford, ESRI
Notes: Colors/elements outside of study area muted intentionally.
0 500 1,000 Feet
The I-84 Hartford Project
Land Use Map
Date: 4/30/2014
Drawn By: AECOM
Figure No: 4-2

4.1.3 Asylum Avenue to I-91

This area is comprised of Asylum Hill, Clay Arsenal, the North Meadows, and Downtown. Large office land uses such as The Hartford corporate complex are north of Asylum Avenue, transitioning to residential uses along Albany Avenue (US 44) in the Clay Arsenal neighborhood. Union Station sits directly adjacent to I-84 with Downtown extending east to I-91 and the Connecticut River. Downtown consists primarily of office and government uses, but also has a variety of retail and commercial land uses with the XL Center sports arena and convention center centrally located at Trumbull and Church Streets.

4.1.4 CT*fastrak*

The CT*fastrak* dedicated bus network between New Britain and Downtown Hartford began service in March 28, 2015. CT*fastrak* is an exclusive two-lane guideway for buses that also built 10 new transit stations. Parcels along the Amtrak rail corridor have been converted for this use. Three of the eleven stations and stops are within the Study Area: Parkville, Sigourney Street, and Union Station. The guideway runs parallel to the train tracks on the west side of I-84 between Kane Street and Sigourney Street but shifts to the east side of I-84 at Flower Street. The guideway terminates at Union Station where passengers will be able to make connections to local shuttle buses or continue to downtown destinations. For further information on CT*fastrak*, see Section 2.1.4: Bus Transportation.

4.2 Zoning

Table 4-1, below, and Figure 4-3, on page 4-6, present the 14 different zoning classifications adopted by the City of Hartford within the Study Area, and their intended purposes. The zoning map was last updated by the City of Hartford in 2008.

In general, the Study Area is zoned for a mix of commercial or business activity. A number of the zones are structured to encourage a mix of complementary uses and designed to foster neighborhood cohesion and a sustainable downtown. The remaining areas are zoned for primarily residential uses at varied densities as well as some mixing of uses with residential. There is a single sizeable area zoned industrial at the southwestern edge of the Study Area.

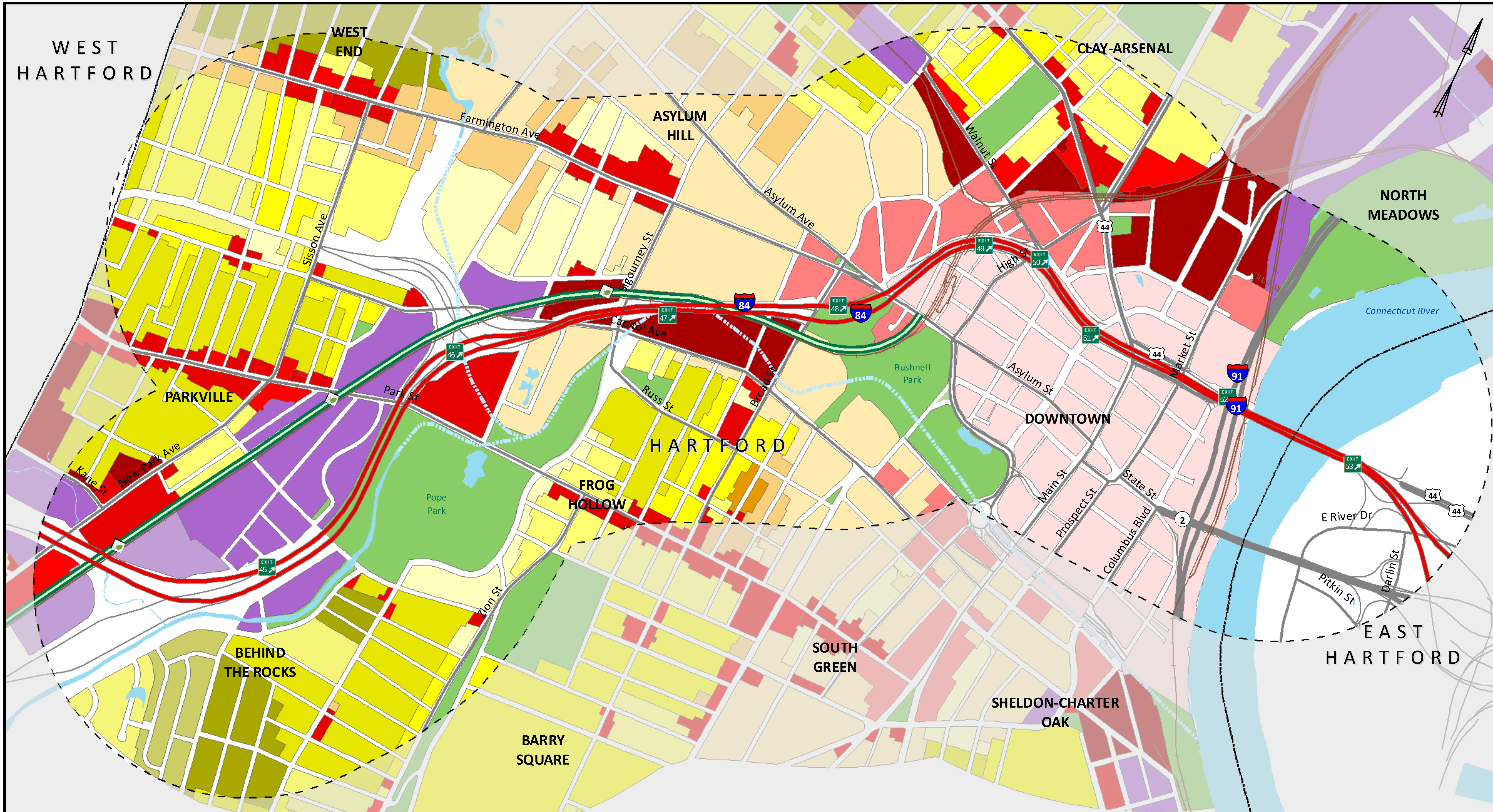
Table 4-1: Zoning Districts within the Study Area

Zoning District	Primary Purposes
B-1	Downtown Development District; mixed retail, office and residential development compatible with the character of the downtown area and conforming to the Downtown development plan.
B-2	Downtown Perimeter District; development that will provide sensitive transitions in the scale, use and intensity from the B-1 downtown development district to surrounding residential areas.
B-3	Business District (general-linear business) to provide for linear, "strip" or "shoestring" commercial streets by the concentration of shopping areas.

Table 4-1 (ctd.): Zoning Districts within the Study Area

Zoning District	Primary Purposes
C-1	Commercial District; locations for uses such as storage warehouses, wholesalers, laboratories, computer centers and display rooms and offices of equipment manufacturers where the equipment is medium or large in size.
I-1	Industrial District; heavy industrial district intended as an area for the location of the city incinerator, automobile wrecking yards and similar uses.
I-2	Industrial District; medium to heavy industry characterized by a minimum of noise, odor, glare, and pollution, and by moderate traffic upon the public streets; it is intended to support continuation of clustered areas of this type of industry.
RO-1	Residence-Office District (300 PPA*); financial, insurance, government, personal services and other similar offices together with multiple residence structures, boardinghouses and rooming houses.
RO-2	Residence-Office District (225 PPA*); Similar to RO-1 with lower permissible persons per acre.
R-1	Residence District (150 PPA*); high density, multiple-family residential structures on the perimeter of the downtown development district, on Asylum Hill, and in other areas which are desirable sites for this use because of proximity to employment, parks, commerce, transportation, etc.
R-2	Residence District (high density, 100 PPA*); relatively high density multiple-family residential structures.
R-3	Residence District (medium density, 75 PPA*); similar to R-2 but outside the Asylum Hill and central areas and with lower residential density permitted.
R-4	Residence District (three-family); similar to R-2 with lower residential density permitted and allowing for new forms of medium density multiple residences; to encourage new and modern construction but limiting the conversion of older structures.
R-5	Residence District (one- and two-family); low density residential; minimum lot size of 7000 square feet.
R-6	Residence District (one-family); single-family with minimum lot size of 6000 square feet.
R-7	Residence District (one-family); single-family with minimum lot size of 7500 square feet.
R-8	Residence District (one-family); Low-density areas of single-family residences with minimum lot area of 12,000 square feet.
P	Public Property and Cemetery District; Public parks and recreational uses such as skating rinks, public swimming pools, and zoos. Large cemeteries and expressways and highways are included in this district.

*PPA = Persons Per Acre



LEGEND

I-84 Exit	Interstate Highway	Park River Conduit	B-1	B-4	I-2	R-2	R-5	R-8
CT Fastrak Station	US Highway	Water	B-2	C-1	P	R-3	R-6	RO-1
I-84	Major Road		B-3	I-1	R-1	R-4	R-7	RO-2
Study Area	Railroad							RO-3
City Boundary	CT Fastrak							

Sources of Data: City of Hartford, ESRI

Notes: Colors/elements outside of study area muted intentionally.

0 500 1,000 Feet

The I-84 Hartford Project

Zoning Map

Date: 4/29/2014 | Drawn By: AECOM | Figure No: 4-3

4.3 Neighborhoods

City of Hartford neighborhood data and classifications, Hartford's *One City One Plan* plan of conservation and development (POCD), and a visual assessment were consulted for the neighborhoods evaluation. Portions of eight neighborhoods are located within the Study Area: Behind the Rocks, Parkville, Frog Hollow, the West End, Asylum Hill, Downtown, Clay Arsenal, and North Meadows. These neighborhoods are shown graphically on Figure 4-4, following. Numerous planning and development initiatives are ongoing within these neighborhoods related to complete streets, planning, zoning, economic development, revitalization, small business development, housing, marketing, licensing, and policy-making. Some are well known - such as the ongoing iQuilt Partnership and Intermodal Triangle initiatives in Downtown - while others are smaller and more neighborhood specific. The complete list of initiatives can be found in the City of Hartford Department of Development Services, *Project Updates Report*, 2013 as well as Chapter 13 of the *One City One Plan* POCD, adopted in June 2010. A brief description of each neighborhood as it relates to the Study Area follows.

4.3.1 Behind the Rocks

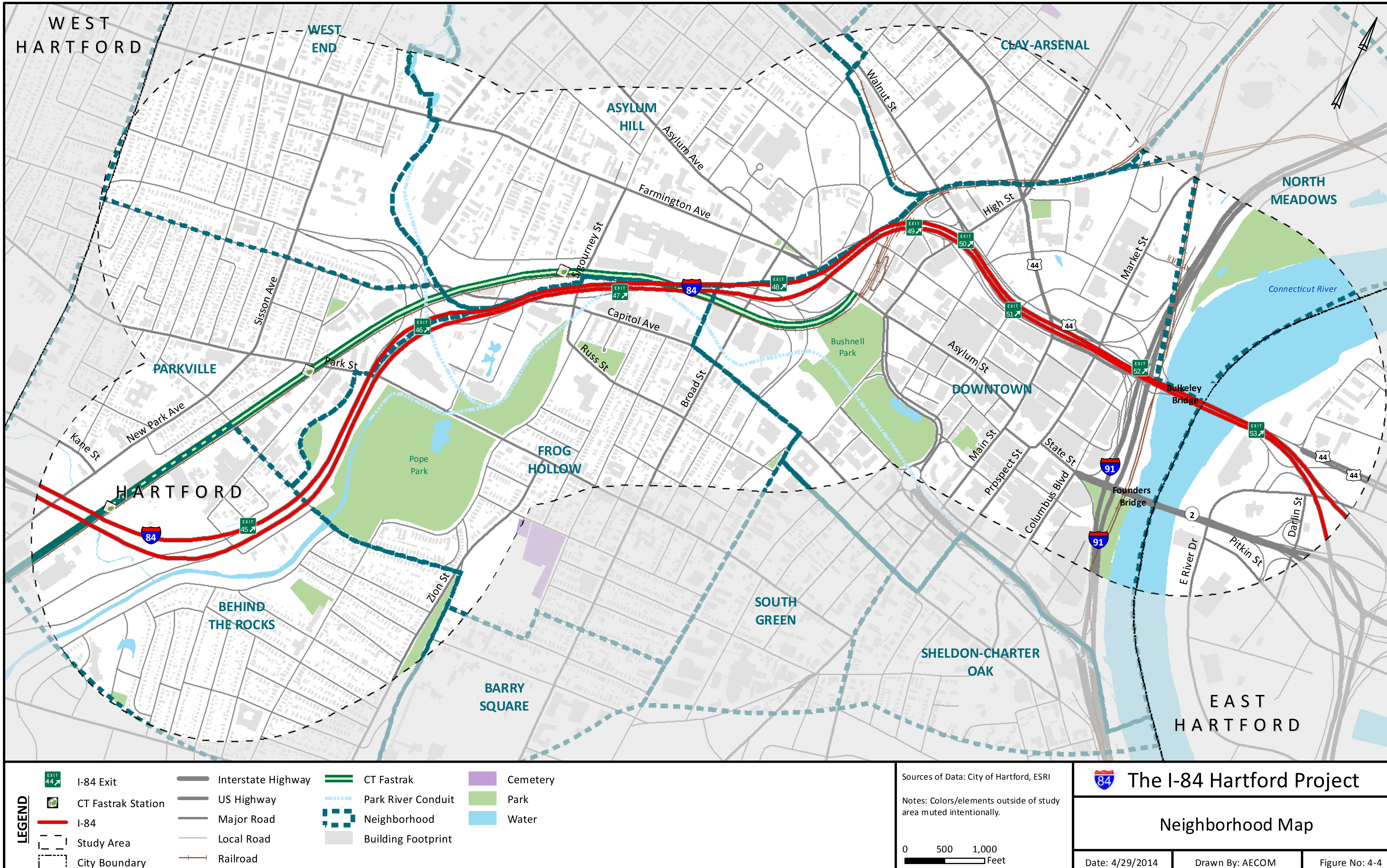
Located at the southwestern limits of the Study Area, approximately 90% of Behind the Rocks is within the Study Area. The neighborhood is characterized by extensive residential blocks south of Hamilton Street and west of Zion Street and by light industrial/office uses west of I-84. Behind the Rocks encompasses the Interchange 45 (Flatbush Avenue) ramps which run parallel to the South Branch of the Park River; the latter is contained in a man-made concrete channel, surrounded by green space.

4.3.2 Parkville

Located at west of I-84, approximately 90% of Parkville is located within the Study Area. Parkville is defined by the retail uses along Park Street (a multitude of shops, restaurants, and small local businesses) surrounded by clearly defined residential neighborhoods south of Capitol Avenue. A light industrial area with a design center, restaurant, offices, and emerging residential component exists near the railroad line and I-84. Parkville is also home to the offices of Hartford's Real Art Ways, a long-standing cultural institution in the city.

4.3.3 Frog Hollow

South of I-84, approximately 75% of Frog Hollow is located within the Study Area. Pope Park is the central defining feature of Frog Hollow. The neighborhood is bounded to the north by Downtown at Capitol Avenue and extends south to Hamilton Street. Frog Hollow includes a number of governmental uses surrounded by residential neighborhoods around Russ and Broad Streets (as well as the Billings Forge Community Works, a well-known not-for-profit job training center). Extensive surface parking lots exist both behind government offices along Capitol Avenue as well as underneath I-84. Based on interviews with stakeholders, the neighborhood is disconnected between the adjacent Parkville and Asylum Hill, with the expansive presence of I-84 and its ramps a contributing factor, as noted in Appendix A.3.1.


WEST HARTFORD
WEST END
ASYLUM HILL
CLAY-ARSENAL
NORTH MEADOWS
PARKVILLE
DOWNTOWN
FROG HOLLOW
HARTFORD
BEHIND THE ROCKS
SOUTH GREEN
SHELDON-CHARTER OAK
BARRY SQUARE
EAST HARTFORD
Connecticut River
Bushnell Park
Pope Park
Bulkeley Bridge
Founders Bridge
Walnut St
Asylum Ave
Farmington Ave
High St
Market St
Sigourney St
Capitol Ave
Sisson Ave
Park St
Russ St
Broad St
Asylum St
Main St
Prospect St
State St
Columbus Blvd
New Park Ave
Kane St
Zion St
E River Dr
Pitkin St
Darlin St
LEGEND
I-84 Exit
CT Fastrak Station
I-84
Study Area
City Boundary
Interstate Highway
US Highway
Major Road
Local Road
Railroad
CT Fastrak
Park River Conduit
Neighborhood
Building Footprint
Cemetery
Park
Water
Sources of Data: City of Hartford, ESRI
Notes: Colors/elements outside of study area muted intentionally.
0 500 1,000 Feet
The I-84 Hartford Project
Neighborhood Map
Date: 4/29/2014
Drawn By: AECOM
Figure No: 4-4

4.3.4 West End

Towards the northwest of the Study Area, approximately 50% of the West End neighborhood is located within the Study Area. This area includes the Interchange 46 (Sisson Avenue) ramps, extensive residential neighborhoods west of Sisson Avenue, and the Farmington Avenue retail corridor with a variety of shops, restaurants, gas stations, and small businesses. Hartford Public High School straddles the border of the West End and Asylum Hill neighborhoods and is in close proximity to the I-84 and Interchange 46 ramp overpasses over Capitol Avenue and the railroad.

4.3.5 Asylum Hill

North of I-84, approximately 60% of Asylum Hill is located within the Study Area. Asylum Hill is centered on Farmington and Asylum Avenues. Residential and commercial neighborhoods (including the Mark Twain and Harriet Beecher Stowe houses on Farmington Avenue) give way to larger uses towards downtown. The Hartford Financial Services Hartford campus fronts onto Asylum Avenue with nearby multi-family residential buildings and large surface parking areas behind it. The Aetna corporate campus is located between I-84 and Farmington Avenue between Sigourney and Flower Streets. Flower Street was closed to vehicular and pedestrian traffic in 2013. Based on stakeholder interviews, the neighborhood feels disconnected from neighboring Frog Hollow and Downtown partly due to the lack of connectivity across I-84 and its ramps.

4.3.6 Downtown

Approximately 90% of Downtown is located within the Study Area. Downtown extends from Union Station, the State Capitol, and Bushnell Park on the west to the Connecticut River to the east, Capitol Avenue to the south and the area known as North Park to the north of I-91. Asylum Avenue becomes Asylum Street after crossing I-84 and is the main spine through Downtown, intersecting Main Street near the historic Old State House, the landmark Travelers Tower, and the Wadsworth Atheneum. The XL Center sports, entertainment, retail, and residential complex sits in the middle of Downtown surrounded by a variety of office and commercial uses. Towards the river, large office buildings at Constitution Plaza and the iconic Phoenix Mutual Life Insurance Building along State Street give way to the Connecticut Science Center and the Mortensen Riverfront Plaza which reaches across I-91 and steps down to the water below the Founders Bridge (Route 2 over the Connecticut River). South of State Street, the Adriaen's Landing development district sits next to the Connecticut Convention Center. Downtown also includes commercial/light industrial lands north of I-84, dominated by large surface parking lots and large industrial office buildings around Windsor, Trumbull, and Pleasant Streets.

4.3.7 Clay Arsenal

In the northern sections of the Study Area, approximately 40% of Clay Arsenal is located within the Study Area. This area includes lower Albany Avenue (US Route 44), lined by a variety of small businesses below apartments, and Walnut Street, which hosts a number of automotive establishments and other light industrial uses. A mix of single- and multi-family residential neighborhoods lies between these two primary corridors and around the Thomas Quirk Middle School. A portion of Main Street also runs through Clay Arsenal with a mix of small retail businesses and multi-family housing developments.

4.3.8 North Meadows

Approximately 40% of the North Meadows is located within the Study Area. The North Meadows is situated next to the Connecticut River, more or less parallel to I-91. The North Meadows is comprised of Riverside Park, which includes a recently constructed boat house and community center facility at the edge of the river. Large trees, lawn areas, pathways, a gazebo, a boat launch area, and a parking lot are also part of the Riverside Park facilities. A large pedestrian bridge connects North Meadows to North Park and the Market Street area across I-91.

4.4 Community Resources and Institutions

There is a rich diversity of community resources and institutions in the Study Area. These include schools, churches, and parks that offer community gathering places and contribute to a community sense of place and cohesion. They also include community government and safety facilities such as government offices, police and fire stations, as well as major cultural destinations and entertainment venues. These resources are illustrated in Figure 4-5, following, and listed in Table 4-2, page 4-12. A complete listing is provided in Appendix A.3.5.

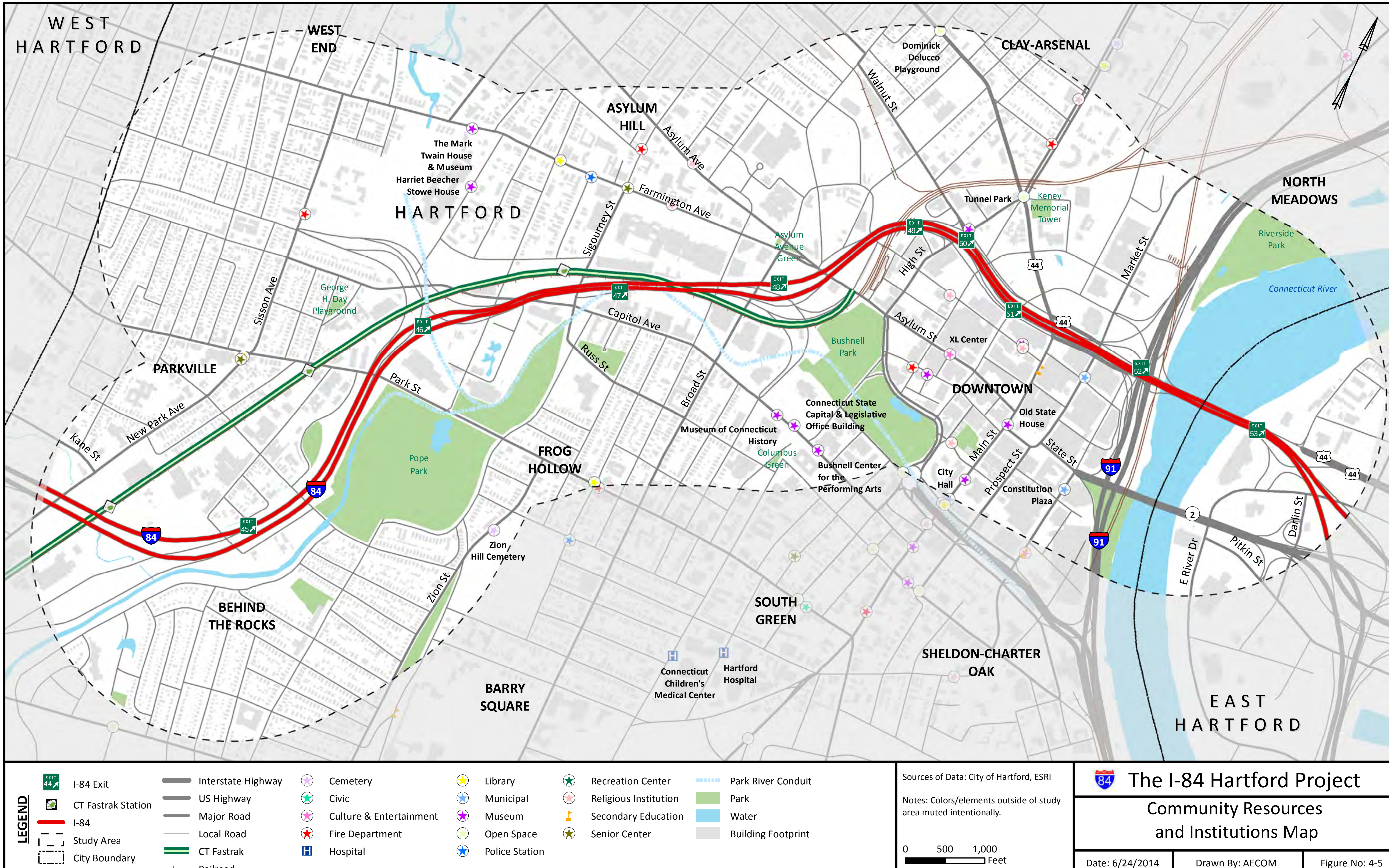
Notable individual community resources and institutions in the Study Area include:

- the State Capitol and State Legislative Office Building, located adjacent to Bushnell Park on Capitol Avenue;
- Trinity College, located slightly southwest of the Study Area, which has been active in fostering revitalization and stability in the neighborhoods surrounding the campus; and
- two large entertainment venues in Downtown: the XL Center and the Connecticut Convention Center.

The variety and number of resources is indicative of the Hartford urban core as both a destination and cultural hub, as well as being composed of a number of cohesive neighborhoods defined in part by a distinctive collection of community assets as described in Section 4.3 above.

Interviews were conducted with a number of the institutions and organizations located in and around the Study Area. The following is a summary of existing conditions and travel patterns associated with each. For further information, see Stakeholder Interview Summaries, Appendix A.3.1

- The churches attract a large amount of visitors from outside the city. Emmanuel Church estimates that 80% of its parishioners are from the suburbs (mainly West Hartford, Farmington, and Glastonbury) and travel in for services.
- The Cathedral of Saint Joseph hosts more than 100,000 visitors each year, with 1,500 per week at mass. The cathedral also hosts concerts, community events, graduations and weddings.
- Trinity Episcopal has a more local congregation, with a large percentage of the Burmese community living in the Laurel Street/South Marshall neighborhood that walk to the church. There is also a large Indian community from the Union Station area that attends the church.


WEST HARTFORD
WEST END
ASYLUM HILL
CLAY-ARSENAL
NORTH MEADOWS
HARTFORD
PARKVILLE
FROG HOLLOW
DOWNTOWN
BEHIND THE ROCKS
BARRY SQUARE
SOUTH GREEN
SHELDON-CHARTER OAK
EAST HARTFORD
The Mark Twain House & Museum
Harriet Beecher Stowe House
Dominick Delucco Playground
Tunnel Park
Keney Memorial Tower
Riverside Park
Connecticut River
Asylum Avenue Green
George H. Day Playground
Bushnell Park
XL Center
Connecticut State Capital & Legislative Office Building
Museum of Connecticut History
Columbus Green
Bushnell Center for the Performing Arts
Old State House
City Hall
Constitution Plaza
Pope Park
Zion Hill Cemetery
Connecticut Children's Medical Center
Hartford Hospital
Walnut St
Asylum Ave
Farmington Ave
Sigourney St
Sisson Ave
Capitol Ave
Russ St
Broad St
Park St
New Park Ave
Kane St
Zion St
High St
Asylum St
Market St
Main St
Prospect St
State St
E River Dr
Pitkin St
Darlin St
EXIT 45
EXIT 46
EXIT 47
EXIT 48
EXIT 49
EXIT 50
EXIT 51
EXIT 52
EXIT 53
84
91
44
2
LEGEND
EXIT 44 I-84 Exit
CT Fastrak Station
I-84
Study Area
City Boundary
Interstate Highway
US Highway
Major Road
Local Road
CT Fastrak
Railroad
Cemetery
Civic
Culture & Entertainment
Fire Department
Hospital
Library
Municipal
Museum
Open Space
Police Station
Recreation Center
Religious Institution
Secondary Education
Senior Center
Park River Conduit
Park
Water
Building Footprint
Sources of Data: City of Hartford, ESRI
Notes: Colors/elements outside of study area muted intentionally.
0 500 1,000 Feet
The I-84 Hartford Project
Community Resources and Institutions Map
Date: 6/24/2014
Drawn By: AECOM
Figure No: 4-5

- Hartford Hospital is an 867-bed facility and has the second busiest operating room in the Northeast. An average of 10,000 people comes through the front lobby daily. The hospital is located just to the south of the Study Area.
- The St. Francis Hospital complex is located just to the north of the Study Area.
- Ambulances for area hospitals currently look to the main roads/boulevards in and out of the city for alternate routes during high traffic periods on area highways. Roads currently used are New Britain Avenue, Farmington Avenue, Asylum Avenue, and Albany Avenue. Patients are sometimes routed to New Britain General Hospital due to traffic in Hartford.

Table 4-2: Community Resources and Institutions within the Study Area

Community Resource or Institution Type	Number within the Study Area
Cemetery	1
Colleges, Universities and other Secondary Educational Facilities	1
Culture and/or Entertainment Venue	4
Government	4
Fire Departments	4
Libraries	3
Municipal	3
Museums	12
Parks, Plazas, and Other Open Space	8
Police Station/Substation	1
Recreation Center	1
Religious Institution	6
Senior Centers	2

4.5 Demographics

Demographic characteristics considered for the Study Area include residents, their employment, and housing. Consequently, the analysis of existing conditions for demographics addresses the following: population, housing, income and employment, and commute patterns.

2010 US Census Bureau data were used to determine the demographic aspects of the Study Area. Census Tracts and Block Groups located were mapped to reflect variations in these aspects across the Study Area. The block groups within the Study Area are illustrated in Appendix A.3.4. A number of the block groups extend substantially beyond the Study Area limits, therefore, in order to best represent the Study Area traits, any block group that falls partially within, but is 75% or more outside the Study Area, was eliminated from the demographic data tabulations.

Since the 2010 Census does not provide population and housing data at the same level of data as the 2000 Census, this analysis contained herein supplements data from the 2010 Census with data contained in the 2009 American Community Survey (ACS), the 2011 ACS updates, and information from the Connecticut Economic Resource Center (CERC). The ACS contains Census data that has been updated via surveys (yielding sample data) and projections of trends from both the 2000 and 2010 US Census forward.

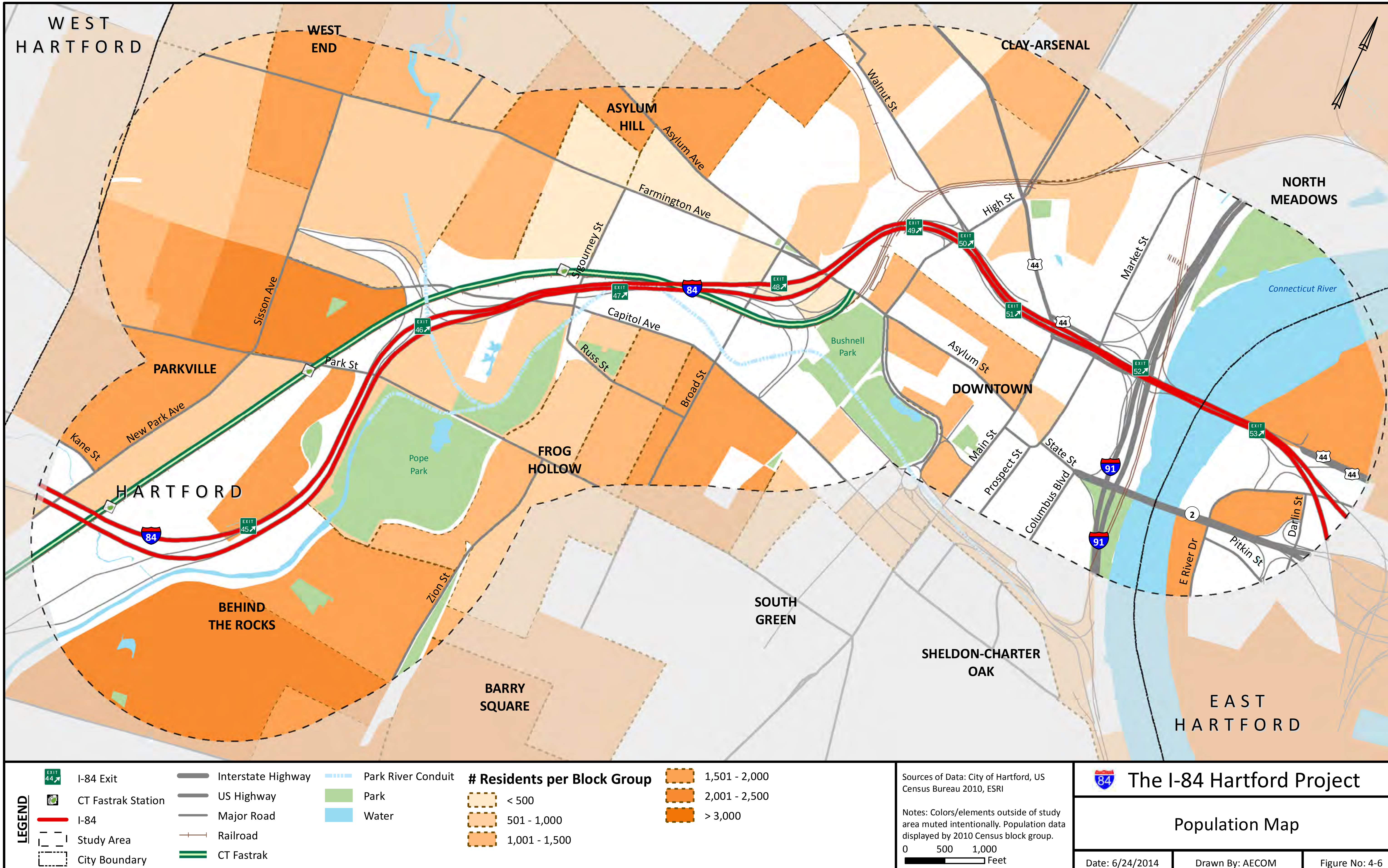
4.5.1 Population Characteristics

As the Study Area stretches across the core of the City of Hartford, population characteristics are quite diverse. Table 4-3, below, indicates the distribution of the Study Area population by age and ethnicity. The total population of the Study Area, 33,757 people, represents approximately 26.5% of the total population of the City of Hartford (127,775 people). The data indicates a substantial portion of the population (nearly 62%) is of employment age, falling between the ages of 18 and 59. In terms of ethnicity within the Study Area, there were a number of responses. It is typically assumed that there is some human error on the respondee's end in choosing multiple ethnicities. The Study Area is predominantly comprised of minority ethnicities with approximately 33% self-identifying as White. Of the total population, almost 48% are Hispanic, 30% African American, and 28% self-identified as Other Race. The Other Race category includes all other responses not included in the White, Black or African American, American Indian or Alaska Native, Asian, and Native Hawaiian or Other Pacific Islander race categories. Please note that, for the US Census, Hispanic is considered a separate category, and so the percentages do not add up to 100%.

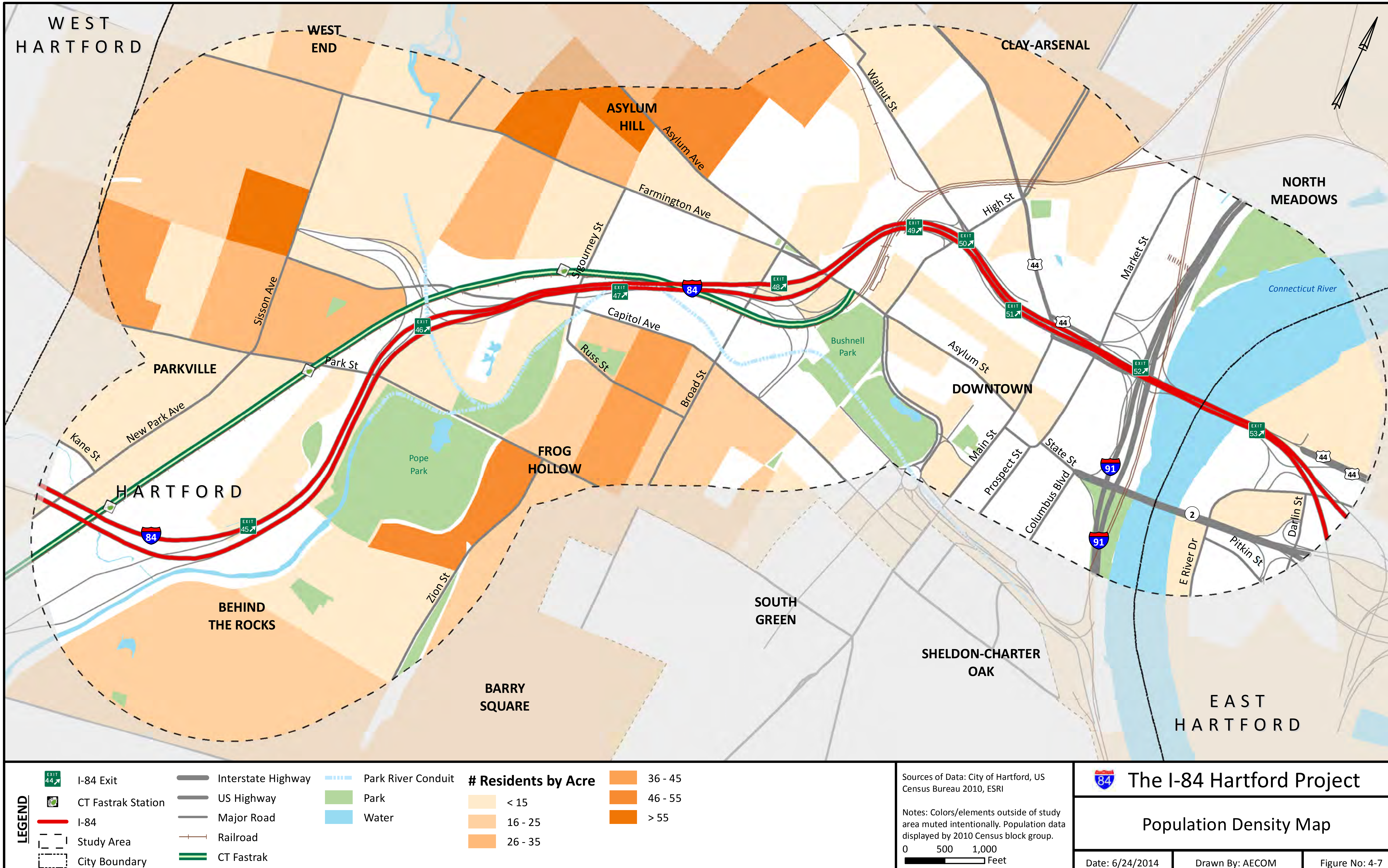
Table 4-3: Study Area Population Characteristics

	Total	Percent (%)
Population	**33,757 people**	**100%**
<5 years	2,669	7.9%
5-17 years	5,879	17.4%
18-59 years	20,854	61.8%
60-79 years	3,720	11.0%
80 years and over	635	1.9%
White	11,039	32.7%
African-American	10,171	30.1%
American Indian, Eskimo or Aleut/ Alaska Native	511	1.5%
Asian or Pacific Islander	1,333	3.9%
Other (single use)	9,497	28.1%
Two or more races	2,412	7.1%
Hispanic or Latino	16,177	47.9%

The distribution of the resident population within the Study Area is illustrated in Figure 4-6, following, and Figure 4-7, page 4-15. The density graphic indicates that the population per Census block group is highest at the eastern and western edges of the Study Area. These are predominantly residential neighborhoods with a diversity of housing from single-family to three-family to multi-family complexes. The population is least dense in the center of the Study Area and west of Hartford's downtown core. This is an area predominantly of commercial, entertainment and office uses, typical of an urban downtown with a comparatively limited number of residential units.



WEST HARTFORD
WEST END
ASYLUM HILL
CLAY-ARSENAL
NORTH MEADOWS
PARKVILLE
HARTFORD
FROG HOLLOW
DOWNTOWN
BEHIND THE ROCKS
BARRY SQUARE
SOUTH GREEN
SHELDON-CHARTER OAK
EAST HARTFORD
Walnut St
Asylum Ave
Farmington Ave
High St
Sigourney St
Sisson Ave
Capitol Ave
Market St
Connecticut River
Bushnell Park
Asylum St
Park St
Russ St
Broad St
New Park Ave
Kane St
Pope Park
Main St
Prospect St
State St
Columbus Blvd
Zion St
E River Dr
Pitkin St
Darlin St
LEGEND
I-84 Exit
CT Fastrak Station
I-84
Study Area
City Boundary
Interstate Highway
US Highway
Major Road
Railroad
CT Fastrak
Park River Conduit
Park
Water
Residents per Block Group
< 500
501 - 1,000
1,001 - 1,500
1,501 - 2,000
2,001 - 2,500
> 3,000
Sources of Data: City of Hartford, US Census Bureau 2010, ESRI
Notes: Colors/elements outside of study area muted intentionally. Population data displayed by 2010 Census block group.
0 500 1,000 Feet
The I-84 Hartford Project
Population Map
Date: 6/24/2014
Drawn By: AECOM
Figure No: 4-6



WEST HARTFORD
WEST END
ASYLUM HILL
CLAY-ARSENAL
NORTH MEADOWS
PARKVILLE
DOWNTOWN
FROG HOLLOW
HARTFORD
BEHIND THE ROCKS
SOUTH GREEN
SHELDON-CHARTER OAK
BARRY SQUARE
EAST HARTFORD
Asylum Ave
Farmington Ave
Walnut St
High St
Market St
Sigourney St
Sisson Ave
Capitol Ave
Park St
Russ St
Broad St
Asylum St
Main St
Prospect St
State St
Columbus Blvd
New Park Ave
Kane St
Zion St
E River Dr
Pitkin St
Darlin St
Pope Park
Bushnell Park
Connecticut River
LEGEND
I-84 Exit
CT Fastrak Station
I-84
Study Area
City Boundary
Interstate Highway
US Highway
Major Road
Railroad
CT Fastrak
Park River Conduit
Park
Water
Residents by Acre
< 15
16 - 25
26 - 35
36 - 45
46 - 55
> 55
Sources of Data: City of Hartford, US Census Bureau 2010, ESRI
Notes: Colors/elements outside of study area muted intentionally. Population data displayed by 2010 Census block group.
0 500 1,000 Feet
The I-84 Hartford Project
Population Density Map
Date: 6/24/2014
Drawn By: AECOM
Figure No: 4-7

4.5.2 Housing

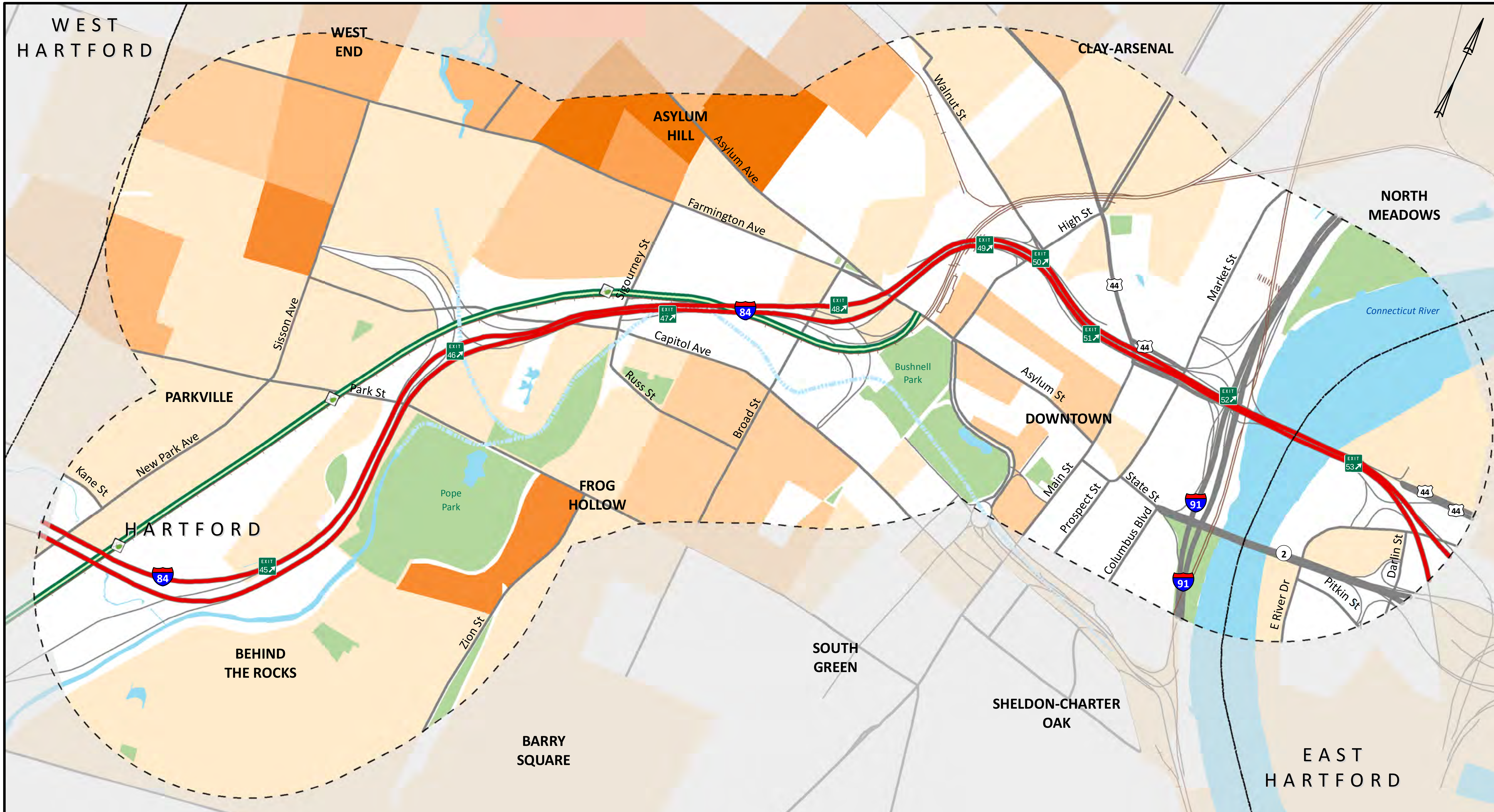
Table 4-4, below, provides data on housing characteristics in the Study Area. It indicates that the majority (83%) of housing units are occupied. The Study Area also contains a fair number of vacant housing units; however, the 17% vacancy rate within the Study Area is comparable to the nearly 16% vacancy rate within the City of Hartford as a whole.

The average household size in the Study Area is slightly larger for the owner-occupied units than for the renter-occupied units. At an average of 2.23 persons per household or more overall, this data suggests, in consideration of the population age distribution, that the Study Area has a substantial number of families with school age children or younger. It is also notable that 40% of the households in the Study Area have no vehicle and can be considered dependent on transit to meet their overall transportation needs.

Table 4-4: Study Area Housing Characteristics

	Total	Percent (%)
Housing Units	**18,357**	**100%**
Occupied	15,219	82.9%
Vacant	3,138	17.1%
Occupied Housing Units	**15,219**	**100%**
Owner-occupied	2,407	15.8%
Renter-occupied	12,812	84.2%
Vehicles Available		
None	6,109	40.1%
1-2 Vehicles	8,573	56.3%
3 or more Vehicles	537	3.5%
Household Size - Person Per Housing unit (pph)		
Occupied Housing Units	2.23 pph	-
Owner-occupied housing units	2.80 pph	-
Renter-occupied housing units	2.21 pph	-

The housing distribution in the Study Area largely mirrors that of the population distribution and is shown in Figure 4-8, following and Figure 4-9, page 4-18. There are clusters of vacant units as shown in Figure 4-9, with the densest cluster occurring in the northeast portion of the Study Area.



LEGEND

I-84 Exit	Interstate Highway	Park River Conduit
CT Fastrak Station	US Highway	Park
I-84	Major Road	Water
Study Area	Railroad	
City Boundary	CT Fastrak	

 # Housing Units by Acre

< 10	21 - 25
11 - 15	26 - 30
16 - 20	> 30

Sources of Data: City of Hartford, US Census Bureau 2010, ESRI

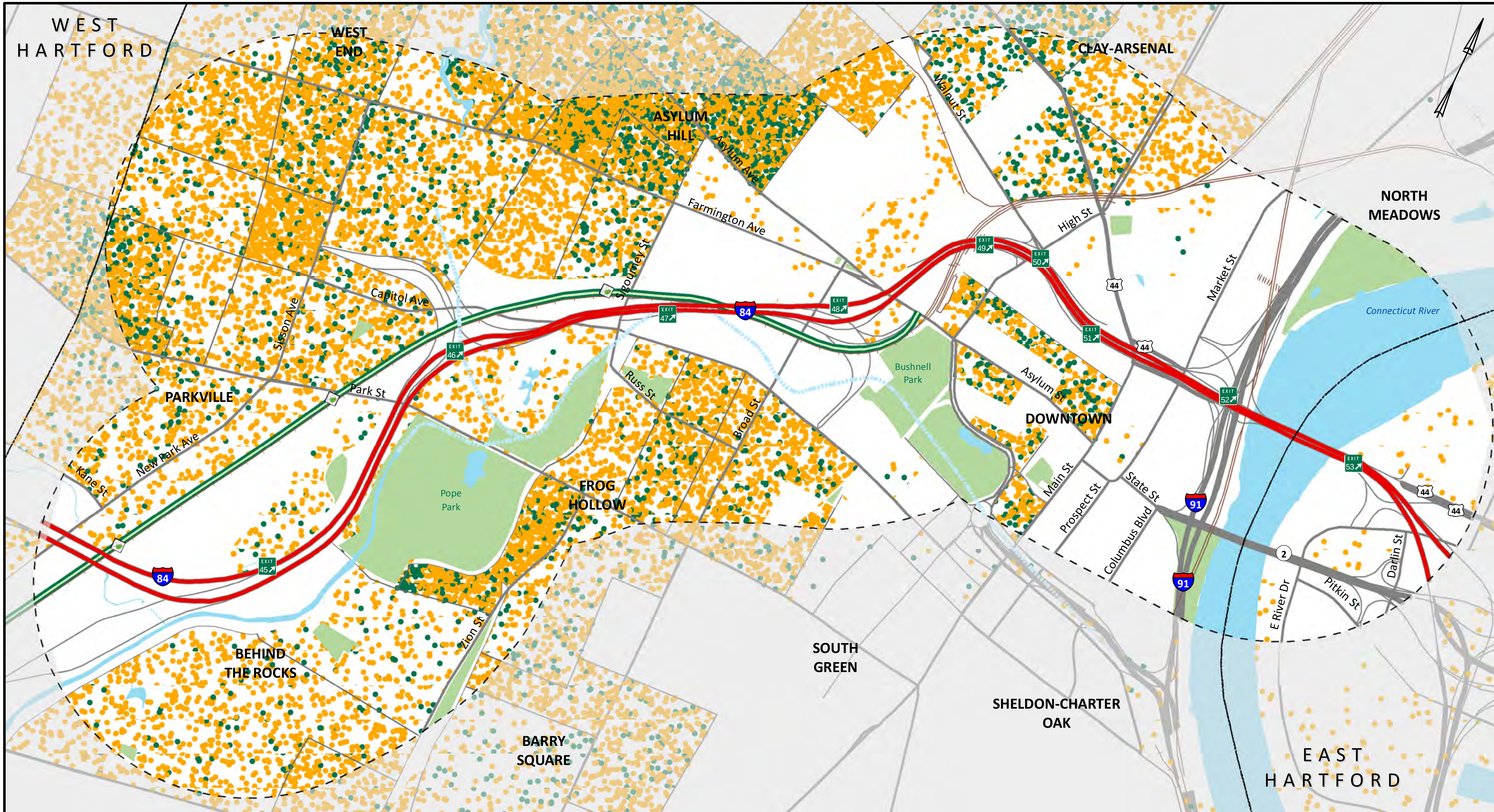
Notes: Colors/elements outside of study area muted intentionally. Population data displayed by 2010 Census block group.

0 500 1,000 Feet

The I-84 Hartford Project

Housing Unit Density Map

Date: 6/24/2014	Drawn By: AECOM	Figure No: 4-8



LEGEND

- I-84 Exit
- CT Fastrak Station
- I-84
- Study Area
- City Boundary
- Interstate Highway
- US Highway
- Major Road
- Railroad
- CT Fastrak
- Park River Conduit
- Park
- Water
- 1 Dot = 1 Housing Unit
- Vacant Housing Unit
- Occupied Housing Unit

Sources of Data: City of Hartford, US Census Bureau 2010, ESRI

Notes: Colors/elements outside of study area muted intentionally. Population data displayed by 2010 Census block group.

0 500 1,000 Feet

The I-84 Hartford Project

Housing Unit Occupancy Map

Date: 6/24/2014	Drawn By: AECOM	Figure No: 4-9

4.5.3 Income and Employment

Income and employment data for the Study Area is shown below in Table 4-5. Comparative data for the Study Area in the context of the City of Hartford, Hartford County, and State of Connecticut is shown in Table 4-6, also below. The Study Area households have a median income of $28,339 annually which is somewhat lower than the City of Hartford as a whole, less than half of that in Hartford County and the State of Connecticut as a whole. Similarly, the Study Area has approximately 34% of households and population below the poverty level as compared with 30% for the City of Hartford as a whole. This is substantially higher than the Hartford County and the State of Connecticut. Also, similarly, the unemployment rate among those of employment age is at 18% for the Study Area and is comparable to that for the City as a whole, but notably higher than the state-wide average.

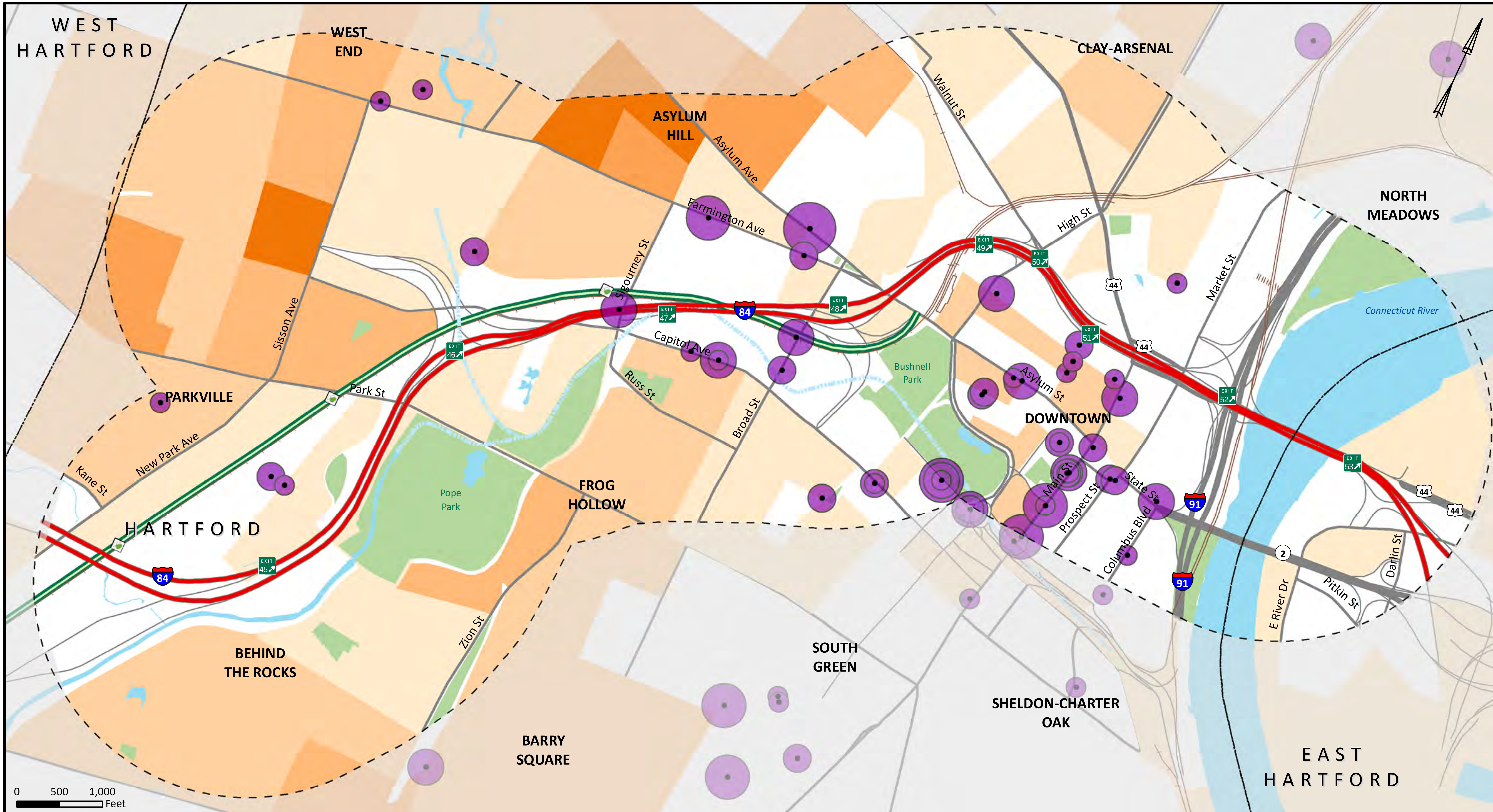
Table 4-5: Study Area Income and Employment Characteristics

Economic Characteristics	Total	Percent (%)
Households Total	**15,219**	**100%**
Median household income in the past 12 months (in 2010 inflation-adjusted dollars)	$28,339	N/A
Households with income in the past 12 months below poverty level	5,179	34%
Total Population (for whom poverty status is determined)	**33,275**	**100%**
Individual income in the past 12 months below poverty level	12,001	36%
Population 16+ years; In labor force; Civilian labor force	**16,656**	**100%**
Employed	13,720	82%
Unemployed	2,936	18%

Table 4-6: Comparative Income and Employment Characteristics

Comparative Characteristics	Study Area	City of Hartford	Hartford County	State of Connecticut
Median household income	$28,339	$29,017	$62,590	$67,740
Individual income below poverty level	36%	30%	11%	10%
Unemployed	18%	18%	9%	9%

Figure 4-10, following, illustrates the distribution of employed persons and major employers within the Study Area. The distribution of employed persons aligns for the most part with the overall population distribution. There is a relatively high concentration of employers located in downtown Hartford directly south of and including the census block groups encompassing the main I-84 viaduct structures.



LEGEND

- I-84 Exit
- CT Fastrak Station
- I-84
- Study Area
- City Boundary
- Interstate Highway
- US Highway
- Major Road
- Railroad
- CT Fastrak
- Park River Conduit
- Water
- Park

 # Employed Residents by Acre

- < 5
- 6 - 10
- 11 - 15
- 16 - 20
- 21 - 25
- > 25

# of Employees by Employer Location

- 249
- 250 - 499
- 500 - 999
- 1,000 - 4,999
- > 5,000
- Employer Location

Sources of Data: City of Hartford, US Census Bureau 2010, CT Labor Market Information, ESRI

Notes: Colors/elements outside of study area muted intentionally. Population data displayed by 2010 Census block group for population aged 16 and over.

The I-84 Hartford Project

Employment Density in Relation to Major Employers Map

Date: 6/24/2014	Drawn By: AECOM	Figure No: 4-10

4.5.4 Commute Patterns

Table 4-7, below, presents origin and destination data for the City of Hartford, produced by the Connecticut Economic Resource Center (CERC) (2011). Table 4-8, following, presents means of travel to work for the U.S. Census block groups within the Study Area, prepared by the 2011 American Community Survey (ACS).

The data indicates that among Hartford residents over 50% work in Hartford. In addition, more workers commuted into Hartford to work than commuted from Hartford out to other communities. Regardless, West Hartford, which lies directly adjacent to the City, has the greatest number of commuters in each direction among nearby communities. Interviews conducted with major employers within the Study Area provided some additional information about commuting patterns.

- The Travelers insurance company reported that many of its employees commute from West Hartford using local streets (Farmington Avenue, Asylum Avenue, and Capitol Avenue). The company believes that the commute has improved for employees due to increased flex time, telecommuting, and staggered shifts. Approximately 23% of its 6,000 Hartford employees take the bus to work.
- Hartford Hospital employs approximately 8,000 people who work varying shifts. About half of the staff, or 4,000 people, work between 7 AM and 5 PM. The nursing staff works 12-hour shifts, and there is often congestion on local roadways adjacent to the hospital at 7 PM due to shift changes. Many of the employees travel from locations east of the Connecticut River.
- Aetna (formerly Aetna Insurance Company) estimates 4,500 employees travel by car to its campus and utilize on-campus parking. While most employees traveling from the east use I-84, many employees from West Hartford and Bloomfield use Farmington Avenue or Albany Avenue to avoid highway congestion.
- The Hartford (insurance company) currently has 6,000 employees at its Downtown campus. Approximately 2,500 employees live within Hartford County, and approximately 50% of those 2,500 live along the I-84 corridor in Hartford, West Hartford, East Hartford, and surrounding towns. Up to 40% of all employees do some level of telecommuting.

Table 4-7: Commuting Patterns – Origins and Destinations

Commuters Into Hartford From	Number	Hartford Residents Commuting To	Number
Hartford	14,661	Hartford	14,661
West Hartford	7,687	West Hartford	2,981
Manchester	5,223	East Hartford	1,949
East Hartford	5,174	Bloomfield	1,854
Windsor	3,613	Farmington	1,680
New Britain	3,494	Windsor	1,433
Wethersfield	3,463	Manchester	1,404
Glastonbury	3,392	New Britain	1,104
Newington	3,369	Newington	1,024
Total	**50,076**	**Total**	**28,090**

According to the 2011 ACS, approximately 66% of workers commuting to Hartford used automobiles, whether traveling alone or carpooling, while nearly 21% of workers took public transportation. The remaining 13% traveled by other means, including walking, bicycling, motorcycle, taxicab, or, alternatively, worked from home. Whether using any of these modes of travel, 44% of workers traveled between 15 and 30 minutes to get to work while almost 23% traveled 30 minutes or more to work.

Table 4-8: Mode of Transportation to Work

Transportation to Work	Total	Percent (%)
Mode of Transportation to Work	**13,158**	**100%**
Drove alone or carpooled	8,657	65.8%
Public transportation	2,713	20.6%
Bicycle	272	2.1%
Walked	1,152	8.8%
Other means (including taxi, motorcycle)	50	0.4%
Worked at home; no commute	314	2.4%
Commute Times	**12,844**	**100%**
Less than 15 minutes (travel time to work)	4,186	32.6%
15 to 29 minutes	5,682	44.2%
30 to more minutes	2,976	23.2%

4.6 Business Activity and Major Employers

For this analysis, major employers are considered to be those who employ 100 or more people. Data on major employers was compiled from the 2011 ACS and supplemented with local plans and studies discussing local business activity, as well as interviews with some of the major employers within the Study Area. Table 4-9, following, lists a sample of the major employers by employment sector in the Study Area. Figure 4-10, page 4-20, presents the distribution of employers across the Study Area.

The data indicates that much of the employment in the Study Area is in insurance, medical, education, and government sectors, with the State of Connecticut among the largest employers overall. While the largest insurance companies generally have the majority of their employees at their offices in the Study Area, some percentage are also working from satellite office campuses in nearby communities. In late 2015, United Technologies Corp. is planning to move all its employees from the Hartford headquarters to nearby Farmington.

Table 4-9: Sample of Major Employers by Sector

Employer	Range of Employees
Financial/Insurance	
Aetna Inc.	1,000 - 4,999
Travelers	5,000 - 9,999
Hartford	5,000 - 9,999
Lincoln National Life Ins Co	500 - 999
ING Investment Management	250 - 499
Construction/Manufacturing/Wholesale	
United Technologies Corp.	500 - 999
Government	
State of CT - DEEP	1,000 - 4,999
Bureau of Materials Management	500 - 999
Leisure & Hospitality	
XL Center	500 - 999
WCCT Television/Broadcasting	500 - 999
Hilton-Hartford	250 - 499
Marriott-Downtown	100 - 249
Other Services/Retail	
Marshall's Department	250 - 499
Walmart/Sam's Club	100 - 249
Professional and Business Services	
Shipman & Goodwin LLP	500 - 999
Hartford Steam Boiler	250 - 499
Cantor Colburn LLP	100 - 249
Day Pitney LLP	100 - 249
Cornerstone Advisors	100 - 249
Ernst & Young	100 - 249
Trade, Transportation, Utilities	
Connecticut Light & Power Co.	250 - 499

Source: Connecticut Labor Market Information,
http://www1.ctdol.state.ct.us/lmi/EmpSearchTopList.asp

Jobs in the Study Area are concentrated in downtown Hartford as is common in urban cities. As Figure 4-10, page 4-20, illustrates, however, some large employers clustered west of the downtown as well.

4.7 Population and Employment Trends

For both historical trends and projections of population, there are a range of sources available for varied (or slightly different) geographies that encompass the study area. The data sources reviewed included the Capitol Region Council of Governments (CRCOG), the Connecticut Economic Resource Center (CERC), and the Connecticut State Data Center (CSDC). The 2011 ACS (used above to assess other demographic characteristics) does not offer population projections. Each source speaks to a distinct geographic area, and the projection methodologies and time frames considered vary somewhat.

Population trends to 2020 are shown in Table 4-10 below using CERC data. Between 1990 and 2012, the data indicates a minor loss of population in the city of Hartford as compared with less than 1 percent growth in Hartford County and the State of Connecticut as a whole. Future population projections show a positive average annual growth rate. It is projected between 2010 and 2020 that the City of Hartford population will grow 0.15% annually on average. Hartford County is anticipated to observe an average annual growth of 0.46%, which is slightly less than State's projection.

Table 4-10: Population Trends

	1990	2000	2010	2011	2012	2020	Average Annual Growth Rate (1990-2012)	Average Annual Growth Rate (2010-2020)
City of Hartford	139,739	121,578	124,760	124,817	124,879	126,656	-0.51%	0.15%
Hartford County	851,783	857,183	880,467	890,588	893,504	922,085	0.22%	0.46%
State of CT	3,287,116	3,405,565	3,511,137	3,558,172	3,572,213	3,690,997	0.38%	0.50%

The CERC annual growth rate projections of population coincide with forecasts from other sources. A summary of the average annual growth rates anticipated via these sources for the City of Hartford are summarized as follows:

- CERC: 0.15 % annual growth between 2010 and 2020
- CSDC: 0.07% annual growth between 2010 and 2025
- CRCOG: 0.11% annual growth between 2010 and 2040

The growth in population in Hartford is expected to be stronger over the coming decade than it has been since 1990. The recent resurgence in housing development projects in the City of Hartford supports this finding. The following graphs depict the variations in these population growth trends for the City of Hartford, Hartford County, and the State of Connecticut. Table 4-11, following, illustrates the population projections available for the City of Hartford by source. By projecting intermediate years, the

CSDC predicts a slight decline in the City's population between 2020 and 2025; however, between 2010 and 2025, the average annual growth is both positive and in line with the CRCOG and CERC projections.

Table 4-11: City of Hartford - Population Projections over Time by Source

	CERC	CSDC	CRCOG
1990	139,739	-	-
2000	121,578	-	-
2010	124,760	124,775	124,701
2011	124,817	-	-
2012	124,879	-	-
2015	-	125,999	-
2020	126,656	126,656	-
2025	-	126,185	-
2040	-		128,692
Average Annual Growth (2010-2020)	0.15%	0.15%	-
Average Annual Growth (2010-2025)	-	0.07%	-
Average Annual Growth (2010-2040)	-	-	0.11%

Table 4-12, below, illustrates the population projections available for Hartford County by source. A summary of the average annual growth rates projected for Hartford County are summarized as follows:

- CERC: 0.46 % annual growth between 2010 and 2020
- CSDC: 0.31% annual growth between 2010 and 2025
- CRCOG: 0.39% annual growth between 2010 and 2040

Table 4-12: Hartford County - Population Projections over Time by Source

	CERC	CSDC	CRCOG
1990	851,783	-	-
2000	857,183	-	-
2010	880,467	894,014	893,924
2011	890,588	-	-
2012	893,504	-	-
2015	-	910,924	-
2020	922,085	925,492	-
2025	-	936,810	-
2040	-	-	1,003,157
Average Annual Growth (2010-2020)	0.46%	0.35%	-
Average Annual Growth (2010-2025)	-	0.31%	-
Average Annual Growth (2010-2040)	-	-	0.39%

Table 4-13, following, illustrates the population projections available for the State of Connecticut by source. CRCOG does not have state-wide population projections. A summary of the average annual growth rates projected for the State are summarized as follows:

- CERC: 0.50 % annual growth between 2010 and 2020
- CSDC: 0.31% annual growth between 2010 and 2025

Table 4-13: State of Connecticut - Population Projections over Time by Source

	CERC	CSDC
1990	3,287,116	-
2000	3,405,565	-
2010	3,511,137	3,574,097
2011	3,558,172	-
2012	3,572,213	-
2015	-	3,644,545
2020	3,690,997	3,702,469
2025	-	3,746,181
2040	-	-
Average Annual Growth (2010-2020)	0.50%	0.35%
Average Annual Growth (2010-2025)	-	0.31%
Average Annual Growth (2010-2040)	-	-

Table 4-11 through Table 4-13, page 4-25 and above, show growth in the upcoming years on the city, county, and state-wide level. The projected populations are relatively close. At the county level, the average annual growth rate is less than 0.50%: CERC projects 0.46% and CSDS projects 0.35% between 2010 and 2020. The state-wide population values for CERC and CSDC differ by approximately 0.3% in 2020. All sources project growth on an average annual basis over the next decade.

The CRCOG projections noted above are based on data for the agency's Traffic Analysis Zones used for transportation planning purposes. This data was also used to generate the traffic projections for this study, based on an annual projected growth rate of 0.11% growth. Overall, the data suggests that while the population of the City of Hartford, and comparably the study area, may rise overall somewhat over time up to the 2040 design year, as a whole it can also be anticipated to remain essentially stable.

Employment trends are more difficult to predict given the changes in the national economy in recent years. Varied sources of employment projections over the past decade suggest that job growth may be anticipated to continue. These information sources have found the following:

- Every two years, the State of Connecticut's Department of Labor (CTDOL) creates ten year industry employment forecasts. The CTDOL projects an average annual growth rate of 0.95% for employment between 2012 and 2022 in north central Connecticut, including Hartford.
- In Hartford County, CRCOG projects 0.42% job growth on an average annual basis between 2010 and 2040.

- The Urban Land Institute projected in 2007 that the Hartford MSA (Metropolitan Statistical Area) had the potential to gain 12,540 new jobs between 2007 and 2017.
- The City of Hartford's comprehensive Plan of Conservation and Development, the One City One Plan (2010), indicated a 4% growth rate in jobs between 2001 and 2008 and anticipated continued growth.
- The US Census showed an employment growth rate of 11.6% over 10 years between 2000 and 2010 for Hartford.
- The March, 2013 Manpower Employment Outlook Survey (Manpower Group) for the Hartford-West Hartford-East Hartford, CT MSA found that employers expect to hire at a continuing pace during 2013 and 2014. Fifteen percent of the companies interviewed said from April to June 2013, they planned to hire more employees, while 6% expect to reduce staff. Another 77% expect to maintain their current workforce levels.

Interviews conducted in 2013 with Study Area major employers may provide one of the clearest indications of near-term employment change potential for the Study Area. Several said they anticipate future employment growth for their business in downtown Hartford as follows:

- The University of Connecticut has committed to locating a satellite campus in downtown Hartford in the near future and is initiating design for the new campus. The site will provide space for 3,500 staff and students.
- Infinity Hall, a new concert venue, will be located adjacent to the Connecticut Convention Center, continuing the infill development program in the area surrounding the Connecticut Convention Center.
- The Hartford Financial Services is in the process of selling its Simsbury location and most of those employees will be relocated to the Hartford offices.

In addition, the new Hartford Yard Goats minor league baseball stadium is scheduled to open for the start of the 2016 baseball season at the intersection of Main Street and Trumbull Street. Initial job estimates indicate that over 500 jobs will be created to operate the ballpark on top of jobs to construct the ballpark.[1]

4.8 Environmental Justice and Title VI

Environmental Justice must be addressed to ensure that federal transportation funds are used in manner that does not result in disproportionately high and adverse human health or environmental impacts to minority and low-income populations and ensures that minority and low-income populations are included in the planning and decision making processes for transportation services and projects. Environmental justice populations are defined by various thresholds at the federal, state, regional, and local levels, based on demographic and socioeconomic statistics.

[1] In Brailsford & Dunlavey, "New Ballpark Planning Study" from April 2014.

The Capitol Region Council of Governments (CRCOG) 2002 report on Environmental Justice and Transportation Planning summarizes the guiding principles and history of environmental justice regulations as follows:

“Environmental justice is not a new concept. It has its roots in Title VI of the Civil Rights Act of 1964. Title VI bars intentional discrimination as well as disparate impact discrimination. In 1994, President Clinton took this one step further by issuing Executive Order 12898, *"Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,"* commanding all Federal agencies to implement environmental justice.”

Civil Rights Act of 1964, Title VI “No person in the United States shall, on the ground of race, color, or national origin be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving federal financial assistance.”

Executive Order 12898, Environmental Justice “Each federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations.”

The US Department of Transportation (USDOT) also issued its *DOT Order to Address Environmental Justice in Minority Populations and Low-Income Populations* in 1997. It identified environmental justice as an “undeniable mission of the agency” along with safety and mobility. USDOT stresses three principles of environmental justice:

- To avoid, minimize, or mitigate disproportionately high and adverse human health and environmental effects, including social and economic effects, on minority populations and low-income populations.
- To ensure the full and fair participation by all potentially affected communities in the transportation decision-making process.
- To prevent the denial of, reduction in, or significant delay in the receipt of benefits by minority and low-income populations.

The Federal Highway Administration (FWHA) and the Federal Transit Administration (FTA) have been working with their State and local transportation partners to make sure that the principles of environmental justice are integrated into every aspect of their transportation programs. Title VI and environmental justice are more than a set of legal and regulatory obligations. Properly implemented, environmental justice principles and procedures improve all levels of transportation decision-making. This approach will:

- Make better transportation decisions that meet the needs of all people.
- Design transportation facilities that fit more harmoniously into communities.
- Enhance the public involvement process, strengthen community-based partnerships, and provide minority and low-income populations with opportunities to learn about and improve the quality and usefulness of transportation in their lives.

- Improve data collection, monitoring, and analysis tools that assess the needs of, and analyze the potential impacts on minority and low-income populations.
- Partner with other public and private programs to leverage transportation agency resources to achieve a common vision for communities.
- Avoid disproportionately high and adverse impacts on minority and low-income populations.
- Minimize and/or mitigate unavoidable impacts by identifying concerns early in the planning phase and providing offsetting initiatives and enhancement measures to benefit affected communities[2].

In 2012, USDOT issued an update to the 1997 DOT Order 5610.2[3] to reaffirm USDOT's commitment to environmental justice and clarify aspects of the original Order.

In 2013, CRCOG reevaluated the environmental justice populations in the region in light of the 2012 USDOT update and the availability of 2010 count data from the US Census Bureau. From the 2013 report,[4] minority groups comprise 33% of the population in the Capitol Region.[5] In the Study Area, the inverse is the case with 67% of people self-identifying as non-white or two or more races, as shown in Table 4-3: Study Area Population Characteristics, page 4-13. The City of Hartford is the center of the Capitol Region and contains 25% of the region's jobs and 16% of its population, but is composed of only 2% of the region's land area. Approximately 10% of the population in the Capitol Region is living below the poverty level (as defined by the US Census Bureau). In the Study Area, approximately 36% of the population is living below the poverty level, as shown Table 4-6: Comparative Income and Employment Characteristics, page 4-19. CRCOG also looks at two other elements of interest when identifying environmental justice populations – zero vehicle households and Limited English Proficiency (LEP). In the Capitol Region, 10% of households have no vehicle available and 8% of the population speaks English less than 'very well.' In the Study Area, approximately 40% of households have no vehicle available, as shown in Table 4-8: Mode of Transportation to Work, page 4-22. English proficiency of the Study Area is discussed further in Section 4.8.2: Environmental Justice in the Study Area.

Every year, the Connecticut Department of Economic Development compiles a list of 'distressed' municipalities. Distressed municipalities are defined based on per capita income; poverty status; unemployment rate; population, employment and income change; age of housing stock; and educational attainment. In 2014, Hartford is listed as the most distressed municipality in the State of Connecticut.[6]

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[2] CRCOG. *Environmental Justice & CRCOG's Transportation Planning Program*, December 2002. http://www.crcog.org/publications/TransportationDocs/E%20J/EJFinalReport_Hartford.pdf

[3] USDOT. *Department of Transportation Order 5610.2(a): Final DOT Environmental Justice Order*, 2012. http://www.fhwa.dot.gov/environment/environmental_justice/ej_at_dot/order_56102a/dot56102a.pdf

[4] CRCOG. *Atlas of Title VI Populations in the Capitol Region – 2010*, August 2013. http://www.crcog.org/publications/TransportationDocs/TitleVI-2011/TitleVIAtlas2013.pdf

[5] The CRCOG region is composed of 30 municipalities in central Connecticut.

[6] DECD Research, 2013, http://www.ct.gov/ecd/cwp/view.asp?a=1105&q=251248

4.8.1 Methodology

For this study, regional (CRCOG) thresholds of minority and low-income populations are used to identify and quantify environmental justice populations within the Study Area. USDOT has federal standards and thresholds for identifying environmental justice populations, but encourages local and regional developed definitions as long as they are at least inclusive of the federal standards.[7] Minority, low income, vehicle availability, and LEP populations are identified separately per federal guidelines.[8] The following are the environmental justice thresholds used for this study:

- Minority: 50% of U.S. Census block or more
- Low-Income: below poverty level, 150% of poverty level; 50% of block group or more
- Zero-Vehicle Households: 50% or more of block group
- Limited English Proficiency: 8% or more of block group speak English less than 'very well'

For the analysis of environmental justice populations, all blocks or block groups located within the Study Area, even if only partially, are included in the Study Area. Thus the analysis includes some population living outside, but immediately adjacent to, the Study Area.

Minorities include all non-white races. For this study, Census counts of 'white, not Hispanic' populations are subtracted from total population to get a count of minorities in the Study Area. The source of data is 2010 Census counts by block. Blocks where 50% or more of the population are minorities are identified as environmental justice populations. Block-level count information is not available for socioeconomic characteristics, so another dataset must be used for the other elements of the analysis.

'Low-income' as a component of environmental justice is not specifically defined in the USDOT Order, but the federal government does define annual income levels below which people are considered to be living in poverty. Poverty as defined by the US Census Bureau for 2011 is shown in Appendix A.3.4, Table A.3.4-1. Poverty status is determined by the age of the individual and the number of people living in a household. For this study, to approximate the CRCOG 150% of poverty level threshold, the individual poverty threshold of $11,139 was used in comparison to per capita income. 150% of the individual poverty threshold is $16,709. The source of data is US Census Bureau American Community Survey (ACS) 2007-2011 estimates by block group for the population for which poverty status is determined (as defined by the US Census Bureau). Low-income populations are also identified for block groups where 50% or more residents have incomes below the federal poverty level.

Vehicle availability is another component of the CRCOG environmental justice program. Occupied housing units by block group are used as the base unit of analysis and households without vehicles are identified through the use of ACS estimates.

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[7] FTA. *Circular 4702.1B: Title VI Requirements and Guidelines for Federal Transit Administration Recipients*, October 2012. http://www.fta.dot.gov/documents/FTA_Title_VI_FINAL.pdf and US Department of Health & Human Services. Poverty Guidelines, 2013. http://aspe.hhs.gov/poverty/index.cfm

[8] Texas Department of Transportation. *Identifying, Measuring, and Mitigating Environmental Justice Impacts of Toll Roads*, 2007. http://www.utexas.edu/research/ctr/pdf_reports/0_5208_1.pdf

The final component of the CRCOG environmental justice program is Limited English Proficiency (LEP). LEP populations are identified for the population aged 5 and over by block group. ACS estimates of population who speak English alone or English 'very well' are subtracted from the population total to get the count of people who speak English less than 'very well.'

4.8.2 Environmental Justice in the Study Area

Most of the blocks (87%) and block groups (81%) within the Study Area are home to 50% minorities or higher. More than half of the block groups have population living at less than 150% of the poverty level based on per capita income. However, only 7 block groups (17%) have more than 50% of population living below the federal poverty level. With regard to vehicle availability, 8 block groups (or 19% of Study Area block groups) have 50% or more of households without a vehicle available. Most of the block groups within the Study Area (88%) have populations with at least 8% limited English proficiency. Counts of blocks and block groups within the Study Area that are classified as containing environmental justice populations are listed in Table 4-14, below.

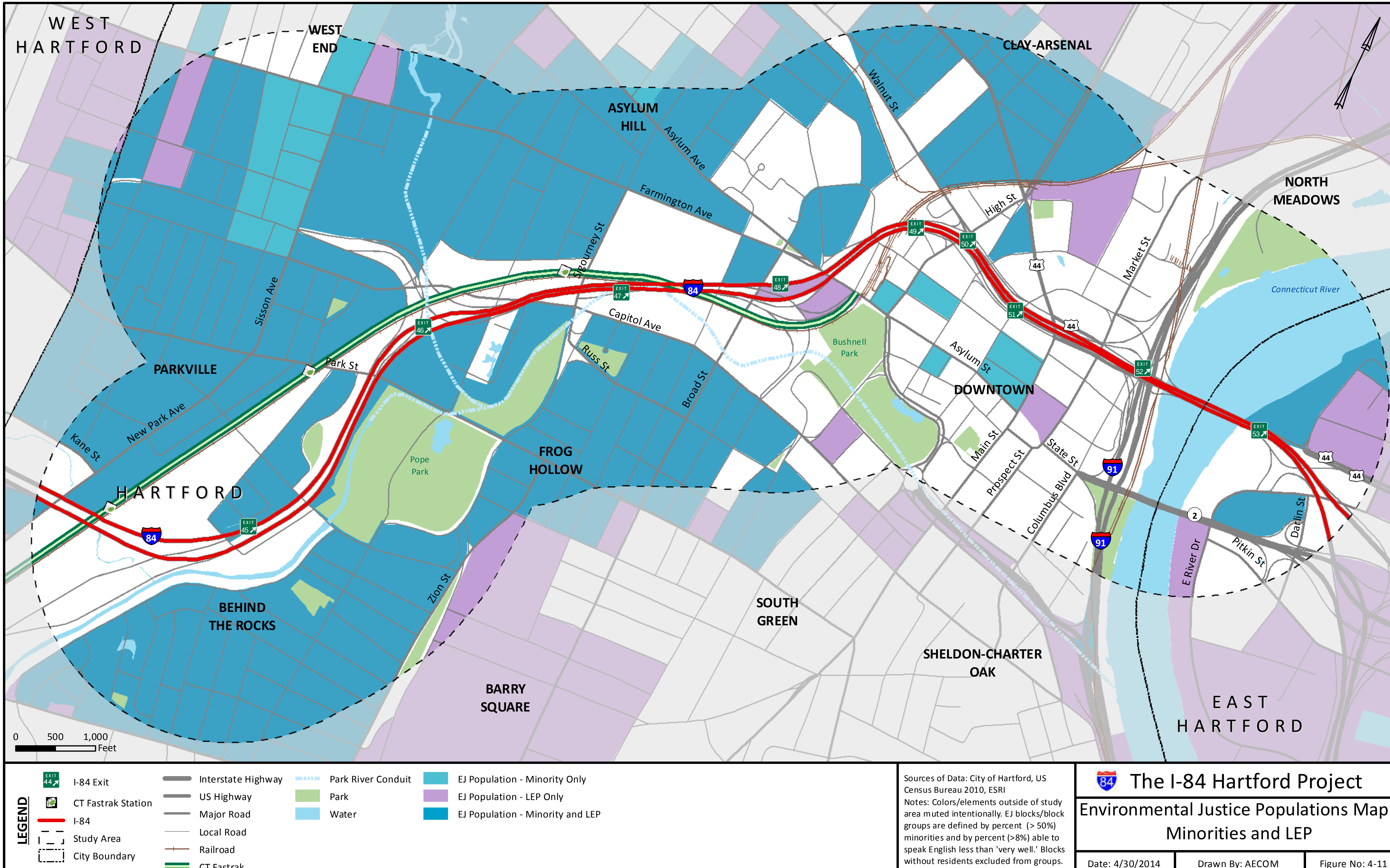
Table 4-14: Study Area Block and Block Group Counts of Environmental Justice Populations

Population Characteristic	# of Block Groups	%	# of Blocks	%
Study Area Total	**42**		**198**	
Minority - 50% or More	34	81%	173	87%
Population Living Below 150% Poverty Level	22	52%		
Population Living Below Poverty Level - 50% or More	7	17%		
Zero Car Households - 50% or More	8	19%		
LEP - 8% or More	37	88%		

Maps of the components of environmental justice populations within the Study Area are presented in Figure 4-11, following, and Figure 4-12, page 4-33. Minorities and LEP are shown together in Figure 4-11 and low-income populations and zero vehicle households are shown together in Figure 4-12.

4.8.3 Regional Context

The Study Area is comprised of approximately the same percentage of minorities as the City of Hartford as a whole, but a much higher percentage than the larger CRCOG region. The same can be said for the low-income, vehicle availability and LEP characteristics. Comparisons of the Study Area with the region and the City of Hartford as a whole are presented in Table 4-15, page 4-34. The Study Area totals for this analysis may differ slightly from those in other analysis due to how the data source has defined its boundaries. For the US Census block groups, a number of the block groups extend substantially beyond the Study Area limits, therefore, in order to best represent the Study Area traits, any block group that falls partially within, but is 75% or more outside the Study Area, was eliminated from the demographic data tabulations.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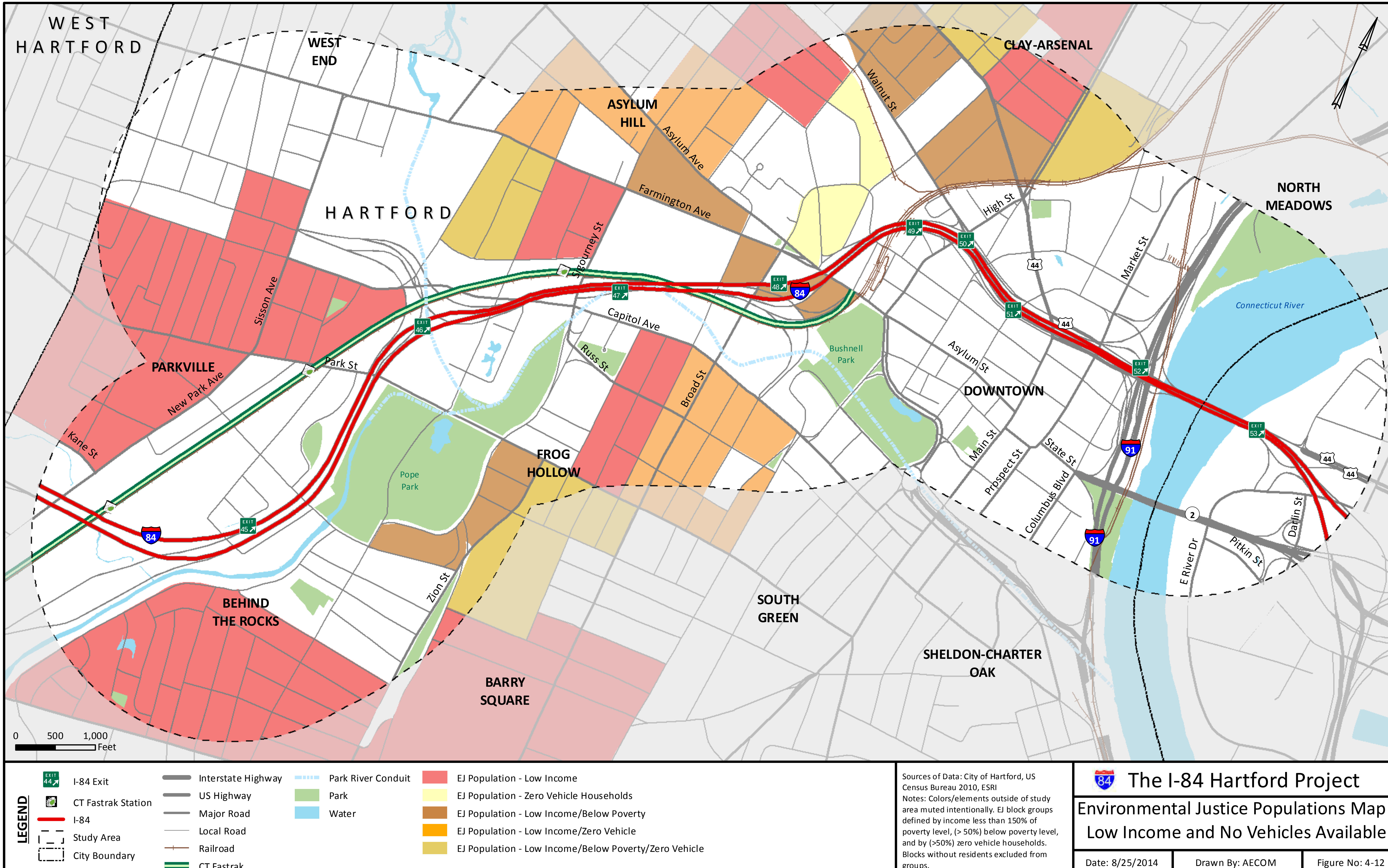
WEST END
ASYLUM HILL
CLAY-ARSENAL
NORTH MEADOWS
PARKVILLE
HARTFORD
FROG HOLLOW
DOWNTOWN
BEHIND THE ROCKS
SOUTH GREEN
SHELDON-CHARTER OAK
BARRY SQUARE
EAST HARTFORD
Connecticut River
Bushnell Park
Pope Park
Walnut St
Asylum Ave
Farmington Ave
High St
Market St
Sigourney St
Capitol Ave
Sisson Ave
Park St
Russ St
Broad St
Asylum St
New Park Ave
Kane St
Main St
Prospect St
State St
Columbus Blvd
Zion St
E River Dr
Pitkin St
Darlin St
0 500 1,000 Feet
LEGEND
I-84 Exit
CT Fastrak Station
I-84
Study Area
City Boundary
Interstate Highway
US Highway
Major Road
Local Road
Railroad
CT Fastrak
Park River Conduit
Park
Water
EJ Population - Minority Only
EJ Population - LEP Only
EJ Population - Minority and LEP
Sources of Data: City of Hartford, US Census Bureau 2010, ESRI
Notes: Colors/elements outside of study area muted intentionally. EJ blocks/block groups are defined by percent (> 50%) minorities and by percent (>8%) able to speak English less than 'very well.' Blocks without residents excluded from groups.
The I-84 Hartford Project
Environmental Justice Populations Map - Minorities and LEP
Date: 4/30/2014
Drawn By: AECOM
Figure No: 4-11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FROG HOLLOW
DOWNTOWN
BEHIND THE ROCKS
SOUTH GREEN
SHELDON-CHARTER OAK
BARRY SQUARE
Connecticut River
Bushnell Park
Pope Park
Walnut St
Asylum Ave
Farmington Ave
High St
Sigourney St
Sisson Ave
Capitol Ave
Park St
New Park Ave
Kane St
Russ St
Broad St
Asylum St
Market St
Main St
Prospect St
State St
Columbus Blvd
Zion St
E River Dr
Pitkin St
Darlin St
0 500 1,000 Feet
LEGEND
I-84 Exit
CT Fastrak Station
I-84
Study Area
City Boundary
Interstate Highway
US Highway
Major Road
Local Road
Railroad
CT Fastrak
Park River Conduit
Park
Water
EJ Population - Low Income
EJ Population - Zero Vehicle Households
EJ Population - Low Income/Below Poverty
EJ Population - Low Income/Zero Vehicle
EJ Population - Low Income/Below Poverty/Zero Vehicle
Sources of Data: City of Hartford, US Census Bureau 2010, ESRI
Notes: Colors/elements outside of study area muted intentionally. EJ block groups defined by income less than 150% of poverty level, (> 50%) below poverty level, and by (>50%) zero vehicle households. Blocks without residents excluded from groups.
The I-84 Hartford Project
Environmental Justice Populations Map - Low Income and No Vehicles Available
Date: 8/25/2014
Drawn By: AECOM
Figure No: 4-12

Table 4-15: Study Area Environmental Justice Comparison with the City of Hartford and CRCOG

Population Characteristic	Study Area Total*	%	City of Hartford Total*	%	CRCOG Region† (as a %)
Total Population	**47,412**		**151,000**		
Minorities	36,577	77%	117,773	78%	33%
Total Population for which Poverty Status is Determined	**43,182**		**142,004**		
Population Living Below Poverty	14,644	34%	41,180	29%	10%
Total Population 5 and Over	**44,271**		**141,072**		
Speak English less than very well	10,392	23%	27,230	19%	8%
Occupied Housing Units	19,437		55,907		
Zero-Car Households	7,219	16%	17,064	12%	10%

*Calculated from ACS block group 2007-2011 statistics
†From CRCOG Environmental Justice Report, 2013

The Study Area is home to a larger percentage of low-income persons, zero vehicle households and population with Limited English Proficiency than the City of Hartford as a whole, and much larger percentages of these environmental justice characteristics than the CRCOG region. The Study Area is home to approximately the same proportion of minorities as the City of Hartford as a whole and again, a much higher percentage than the larger region. Approximately 40% of the population in the Study Area speaks Spanish regardless of English proficiency.[10]

4.9 Historic and Archaeological Resources

The National Historic Preservation Act of 1966 (NHPA) was enacted to integrate consideration of historic resources into the early stages of project planning by a federal agency. Under Section 106 of NHPA, prior to the execution of a project, the federal agency or federally funded agency is required to consider the project's impact on any district, site, building, structure, or object that is included in, or eligible for inclusion in, the National Register of Historic Places (National Register). The Connecticut Environmental Policy Act of 1978 (CEPA) has similar requirements to consider the impacts of state funded or licensed projects on districts, sites, buildings, structures, or objects listed in or eligible for listing in the Connecticut State Register of Historic Places (State Register).

Other laws and guidelines also direct federal agencies to take into account important historic, cultural, and natural aspects of the nation's heritage, and to consider these resources in project planning and execution. These directives include, but are not limited to:

- National Environmental Policy Act of 1969 (NEPA) (42 USC 4321-4361)
- Executive Order (EO) 11593, Protection and Enhancement of the Cultural Environment
- The Historic Sites, Buildings, and Antiquities Act (16 USC 461)
- The Public Buildings Cooperative Use Act (40 USC 601a)
- The Antiquities Act (16 USC 431-433)

[10] ACS block group 2007-2011 statistics

- Archaeology and Historic Preservation Act of 1974
- Archaeological Resource Protection Act of 1979
- Native American Grave and Repatriation Act of 1990
- U.S. Department of Transportation Act of 1966, Section 4(f) (49 USC 303)

Historic and archaeological resources were evaluated within the Study Area and are illustrated in Figure 4-13, following. In addition, the archaeological site file search area has been defined and depicted as a one-mile radius around the Study Area, in accordance with the guidance found in the Connecticut Department of Economic and Community Development/State Historic Preservation Office's (SHPO) *Environmental Review Primer for Connecticut's Archaeological Resources*, illustrated in Figure 4-14, page 4-37. The area of concern includes portions of the City of Hartford and Towns of East and West Hartford.

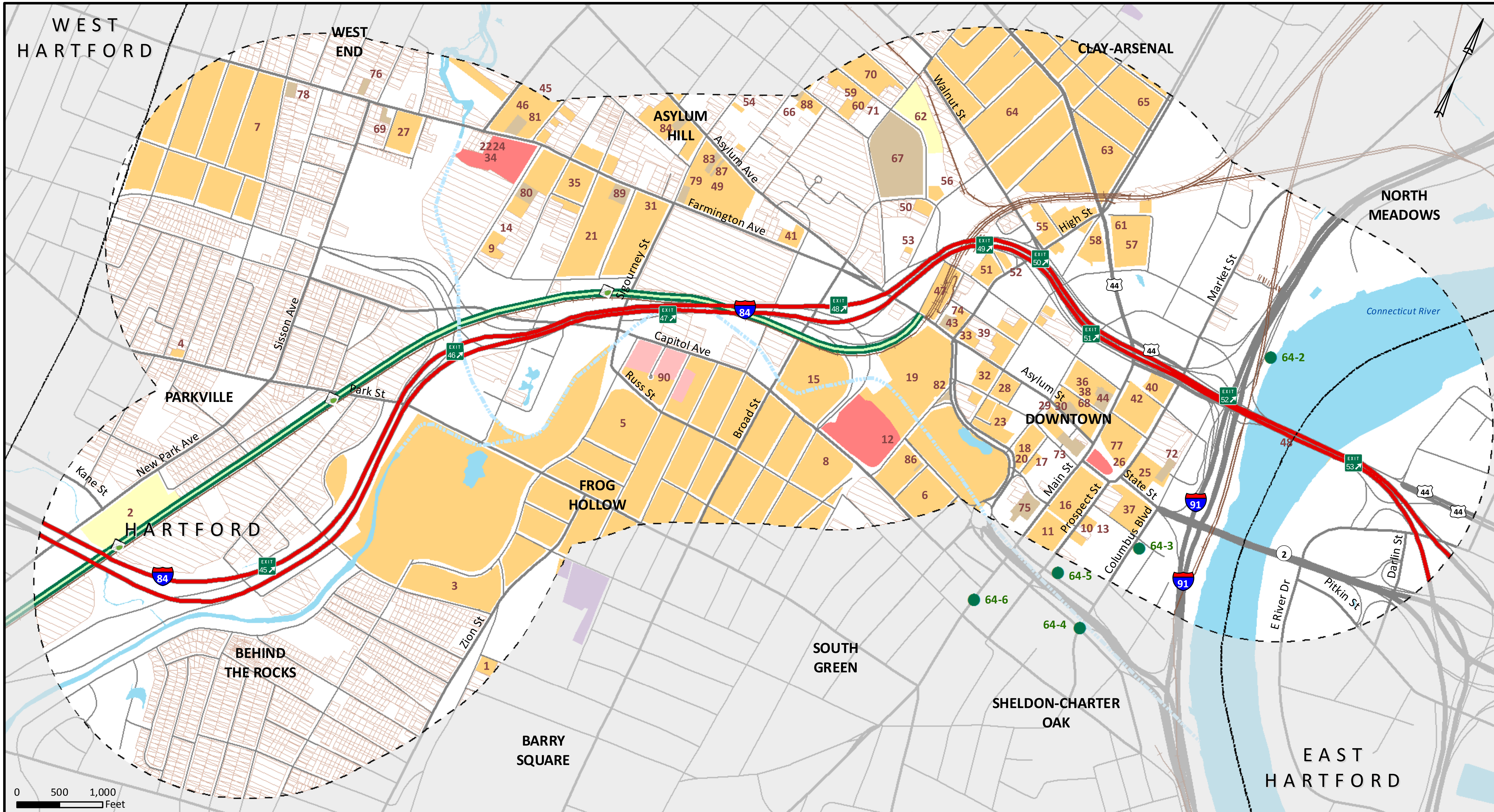
Preliminary identification of archaeological resources within the archaeological search area and historic architectural resources within the Study Area has been completed. Data concerning previously identified archaeological sites registered with the State of Connecticut within the one-mile search area was gathered during a visit to the SHPO office. In addition, the CTDOT GIS data on archaeological site locations based upon the shape files maintained by the Office of the State Archaeologist (OSA) were reviewed for the 2,500-foot cultural resources study area and the one-mile archaeological search radius. Data concerning historic architectural resources was also gathered at that time. Furthermore, information regarding National Register-listed and eligible for listing resources was gathered from the National Park Service (NPS) website. A windshield survey of the 2,500-foot Study Area was also conducted to observe existing conditions.

4.9.1 Archaeological Resources

The archaeological site files at the SHPO were reviewed for Hartford, East Hartford, and West Hartford. Copies of the site forms for previously identified sites that were located within the archaeological search area in Hartford and East Hartford were made for future reference. No previously identified sites were located in West Hartford within the one-mile search radius. In addition to the site files, relevant survey reports at the SHPO were reviewed for information concerning potential archaeological resources within the one-mile search area, and any information concerning the previously identified sites in Hartford and East Hartford.

There are seven previously identified sites located within the archaeological search area; five are located in Hartford, and two are located in East Hartford as depicted in Figure 4-13 and Figure 4-14. Two of the Hartford site locations are located within the 2,500-foot Study Area. Table 4-16, page 4-38, lists the seven archaeological sites, and provides information concerning their temporal and cultural affiliations. It was noted that there have been few archaeological surveys undertaken in the search area during recent years, and these have occurred in the eastern portion of Hartford, primarily along the I-91 corridor.

It should be noted that areas of archaeological potential are likely to exist across the 2,500-foot cultural resources study area. In many instances, the parcels and districts that contain State/National Register-



LEGEND

- I-84 Exit
- CT Fastrak Station
- Study Area
- City Boundary
- I-84
- Interstate Highway
- US Highway
- Major Road
- Local Road
- Railroad
- CT Fastrak
- Park River Conduit
- Water
- Cemetery
- Local Historic District*
- National Historic Landmark, State/National Register-Listed*
- State/National Register-Listed*
- State/National Register-Listed (Demolished)*
- State Register-Listed*
- Potential Historic Resource
- Archaeological Site

*Numbers assigned to historic resources in the map correspond to the numbers in Table 4-14.

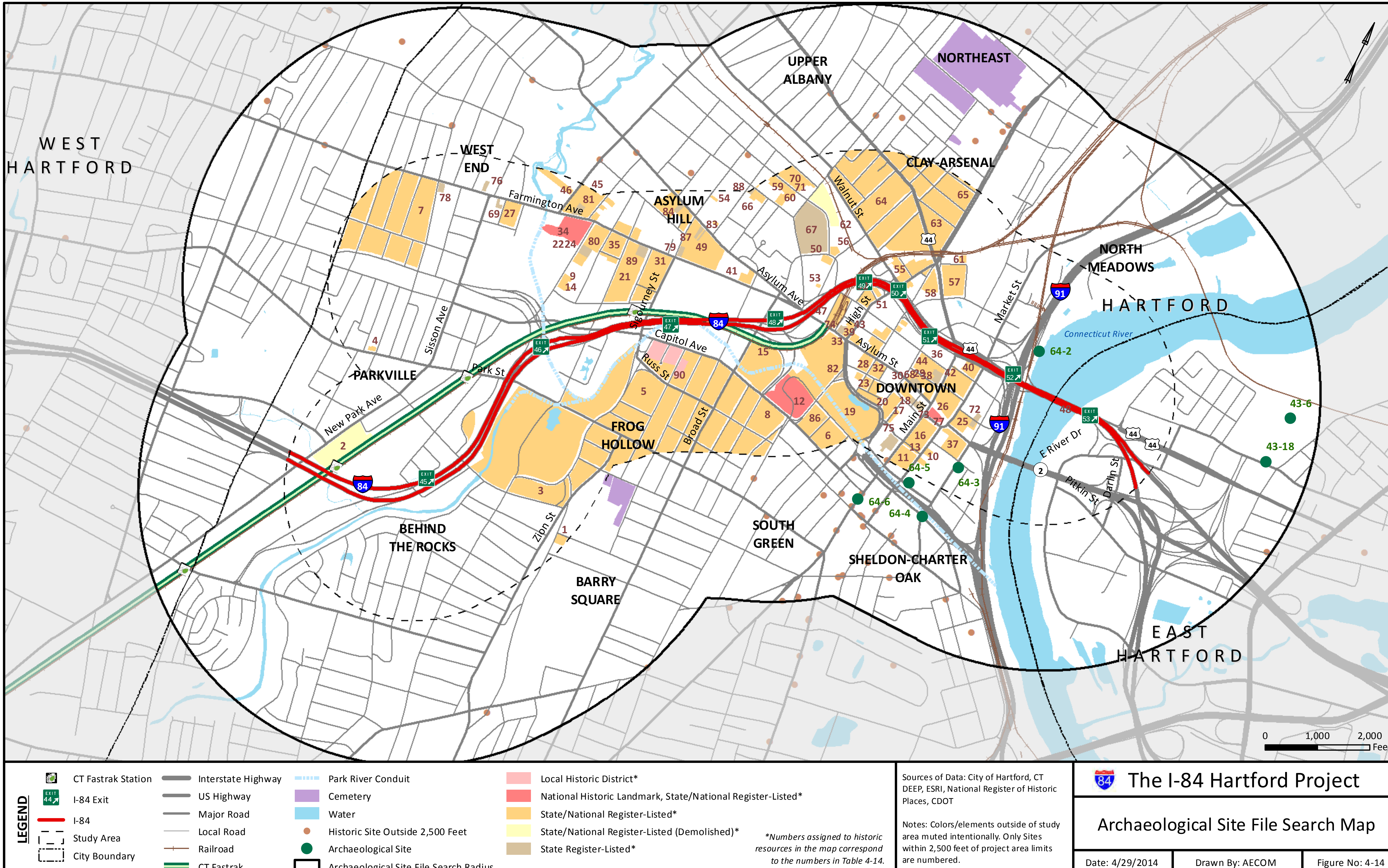
Sources of Data: City of Hartford, CT DEEP, ESRI, National Register of Historic Places, CDOT

Notes: Colors/elements outside of study area muted intentionally. Potential historic resources are structures built more than 50 years ago.

The I-84 Hartford Project

Historic and Archaeological Resources Map

Date: 4/29/2014	Drawn By: AECOM	Figure No: 4-13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Capitol Ave
Sisson Ave
Park St
New Park Ave
Russ St
Broad St
Zion St
High St
Asylum St
Main St
Market St
E River Dr
Pitkin St
Darlin St
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43-18
64-5
64-3
64-6
64-4
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CT Fastrak Station
I-84 Exit
I-84
Study Area
City Boundary
Interstate Highway
US Highway
Major Road
Local Road
Railroad
CT Fastrak
Park River Conduit
Cemetery
Water
Historic Site Outside 2,500 Feet
Archaeological Site
Archaeological Site File Search Radius
Local Historic District*
National Historic Landmark, State/National Register-Listed*
State/National Register-Listed*
State/National Register-Listed (Demolished)*
State Register-Listed*
*Numbers assigned to historic resources in the map correspond to the numbers in Table 4-14.
Sources of Data: City of Hartford, CT DEEP, ESRI, National Register of Historic Places, CDOT
Notes: Colors/elements outside of study area muted intentionally. Only Sites within 2,500 feet of project area limits are numbered.
The I-84 Hartford Project
Archaeological Site File Search Map
Date: 4/29/2014
Drawn By: AECOM
Figure No: 4-14

Table 4-16: Previously Identified Archaeological Sites within the Archaeological Site File Search Area

Site Name	Site #	Time Period	Temporal / Cultural Affiliation	Site Types	Comments	Reference
City of Hartford						
Riverside Dump	64-2	H	19^{th}C	Urban	Excavation at Hartford's first municipal dump identified artifacts in ash matrix; site integrity fair.	CAS 1990
Pottery Site	64-3	H	19^{th} – 20^{th}C	Industrial	Subsurface testing for Adriaen's Landing Project identified remnants of former Stoneware Plant; no further field work recommended.	AHS 2006
Charter Oak Brewery	64-4	H	19^{th} – 20^{th}C	Industrial	Above-ground remains of brewery's foundation walls identified during archaeological survey; site assumed to be destroyed.	PAST 2001
Phoenix Ironworks	64-5	H	19^{th} – 20^{th}C	Industrial	Subsurface testing for Adriaen's Landing Project identified remnants of Phoenix Ironworks Foundry; site noted as destroyed.	AHS 2006
Butler-McCook House	64-6	H	18^{th} – 19^{th}C	Urban	Subsurface testing in association with restoration work identified kitchen midden; site integrity good.	Poirier, Bellantoni and Gradie 1982
Town of East Hartford						
Unnamed site	43-6	P	Woodland	Unknown	Subsurface testing recovered flint flakes from stratified site; site integrity undisturbed.	PAST 1981
Mixmaster I	43-18	P	Late Woodland	Camp	Phase I subsurface testing for Prospect St Bypass recovered chert flakes, FCR, charcoal flecks; site integrity undisturbed.	Koetje 1991

listed and locally designated historic architectural resources may include undisturbed, open land areas that have the potential to contain intact, significant archaeological deposits. Review of the nomination forms for the presently listed and designated historic architectural resources will be a component of the background research that will be conducted for the Phase I archaeological assessment.

As mandated by Section 106 of NHPA, consultation with the SHPO will be initiated for the I-84 Hartford Project. The SHPO has been notified via letter that includes background information and context for the project, information on the status of cultural resources identified to date, and proposed next steps.

As the I-84 Hartford Project progresses and alternatives are developed, the archaeological area of potential effects (APE) will be refined in accordance with Section 106 of NHPA. A Phase I archaeological assessment and reconnaissance survey will be conducted to identify areas of archaeological sensitivity within the archaeological APE. Once these areas are identified, subsurface testing will be conducted as warranted to determine the presence or absence of archaeological resources. If this investigation reveals archaeological resources in the APE, an impacts assessment of the proposed alternatives will be undertaken and included in the NEPA/CEPA document. Consultation with SHPO will continue throughout the process, including development of mitigation measures for adversely affected resources, if necessary.

4.9.2 Historic Architectural Resources

According to NPS guidelines, historic buildings, structures, sites, objects, and districts that are over 50 years old are eligible for listing in the National Register if they possess significance for their association with historic events (Criterion A); lives of persons significant in the past (Criterion B); design and construction (Criterion C); and ability to yield information important in prehistory or history (Criterion D). In addition to significance, such resources must also possess integrity of location, design, setting, materials, workmanship, feeling, and association.

To identify historic architectural resources in the Study Area, State Register files were reviewed at SHPO, and copied for future reference. Relevant survey reports that pertained to Hartford were also reviewed. National Register nomination forms for National Register-listed resources were downloaded from the NPS website. As indicated in Table 4-17, page 4-40, which is keyed to Figure 4-14, research indicates that there are 90 formally designated historic architectural resources in the study area. These include four National Historic Landmarks (NHLs) which are also listed in the State/National Register, 64 State/National Register-listed resources, 21 State Register-listed resources, and 1 locally designated historic district. This historic district is included within the boundary of a larger State/National Register-listed district. In the process of mapping the resources, it was determined that two of the resources were no longer extant, the State/National Register-listed Royal Typewriter Company Building (Resource 2) and the Sigourney Square Historic District (Boundary Increase) (Resource 62). According to Hartford's newspaper *The Courant,* the Royal Typewriter Company Building was partially destroyed in a 1992 fire, subsequently demolished, and replaced by a Stop-and-Shop supermarket (*The Courant,* March 14, 1994). Based on review of aerial mapping, all buildings within the boundary of the Sigourney Square Historic District (Boundary Increase) have been demolished.

As noted on Figure 4-14, page 4-37, one resource is located within the footprint of I-84, the Bulkeley Bridge (Resource 48). In addition, a number of resources are situated adjacent to, or within close proximity to the highway. These include the Frog Hollow Historic District (Resource 5), Hartford Union Station (Resource 47), US Post Office and Federal Building (Resource 51), and Footguard Hall (Resource 52).

In addition to the above-noted resources which have formal designations, Figure 4-14 depicts all previously unevaluated resources in the study area that are over 50 years old, and therefore have the potential to be considered State/National Register-eligible if they meet the requisite criteria. It should also be noted that the main I-84 viaduct structures themselves, constructed in 1965, will be 50 years old in 2015. However, it appears that the viaducts, as part of I-84 would be exempt from Section 106 review under the "Exemption Regarding Historic Preservation Review Process for Effects to the Interstate Highway System" adopted by the Advisory Council on Historic Preservation (ACHP) on March 10, 2005 (*Federal Register*, March 10, 2005). As a result, although the viaducts will be 50 years within a year of publication, they do not need to be evaluated as part of this project.

A windshield survey conducted on August 13, 2013 confirmed the large number of resources over 50 years old in the study area, including many adjacent to, or within close proximity to the highway, as depicted in Figure 4-14. These resources include mid-20th-century and earlier residential, commercial, and industrial buildings, with the highest concentration in the western half of the study area. Relatively few resources in the Study Area appeared to be less than 50 years of age, and these include a recent housing development at the southwest end of the Study Area, and scattered commercial buildings, generally located downtown.

As noted under archaeological resources, consultation with the SHPO has been initiated for the I-84 Hartford Project via letter. Similarly, as the I-84 Hartford Project progresses and alternatives are developed, the historic architectural APE will be delineated, in accordance with Section 106 of NHPA. A survey will be conducted to evaluate resources over 50 years old within the APE that may be considered eligible for listing in the State/National Register. Following identification of historic architectural resources, an impacts assessment of the proposed alternatives will be undertaken in the NEPA/CEPA document. Consultation with SHPO will continue throughout the process, including development of mitigation measures for adversely affected resources, if necessary.

Table 4-17: Architectural Resources within the Study Area

I.D. Number (See Figure 4-13)	Name	Address	Status
1	Saint Anthony Hall	340 Summit Street	State/National Register Listed
2	Royal Typewriter Company Building[1]	150 New Park Avenue	State/National Register Listed
3	Frog Hollow Historic District (Boundary Increase)	Bounded by Park Terrace, Hillside Avenue, Hamilton and Summit streets.	State/National Register Listed

Table 4-17: Architectural Resources within the Study Area

I.D. Number (See Figure 4-13)	Name	Address	Status
4	St. Paul's Methodist Episcopal Church	1886-1906 Park Street	State/National Register Listed
5	Frog Hollow	Roughly bounded by Park River, Capitol Avenue, Oak, Washington, and Madison streets	State/National Register Listed
6	Elm Street Historic District	71-166 Capitol Avenue, 55-97 Elm Street, 20-30 Trinity Street	State/National Register Listed
7	West End South Historic District	Roughly bounded by Farmington Avenue, Whitney and South Whitney streets and, West Boulevard	State/National Register Listed
8	Connecticut State Library and Supreme Court Building	231 Capitol Avenue	State/National Register Listed
9	Hooker, John and Isabella, House	140 Hawthorn Street	State/National Register Listed
10	B.P.O. Elks Lodge	34 Prospect Street	State/National Register Listed
11	Wadsworth Atheneum	25 Atheneum Square	State/National Register Listed
12	Connecticut State Capitol	Capitol Avenue	NHL, State/National Register-listed
13	Hartford Club	46 Prospect Street	State/National Register Listed
14	House at 36 Forest Street	36 Forest Street	State/National Register Listed
15	State Arsenal and Armory	360 Broad Street	State/National Register Listed
16	Main Street Historic District No. 2	West Main, North Central Row, East Prospect streets, and North Atheneum Square	State/National Register Listed
17	First Church of Christ and the Ancient Burying Ground	60 Gold Street	State/National Register Listed
18	Lewis Street Block	1-33, 24-36 Lewis Street, 8-28 Trumbull Street	State/National Register Listed
19	Bushnell Park	Bounded by Elm, Jewell, and Trinity streets	State/National Register Listed
20	Webster Memorial Building	36 Trumbull Street	State/National Register Listed
21	Imlay and Laurel Streets District	Imlay, Laurel and Sigourney streets	State/National Register Listed

Table 4-17: Architectural Resources within the Study Area

I.D. Number (See Figure 4-13)	Name	Address	Status
22	Stowe, Harriet Beecher, House	73 Forest Street	NHL, S/NR-listed
23	Southern New England Telephone Company Building	55 Trumbull Street	State/National Register Listed
24	Day House	77 Forest Street	State/National Register Listed
25	Phoenix Life Insurance Company Building	One American Row	State/National Register Listed
26	Connecticut Statehouse	Main Street at Central Row	NHL, S/NR-listed
27	Little Hollywood Historic District	Farmington Avenue, Owen, Frederick and Denison streets	State/National Register Listed
28	Goodwin Block	219-257 Asylum Street, 5-17 Hayes Street, 210-228 Pearl Street	State/National Register Listed
29	Charter Oak Bank Building	114-124 Asylum Street	State/National Register Listed
30	Stackpole, Moore, and Tryon Building	105-115 Asylum Street	State/National Register Listed
31	Building at 83-85 Sigourney Street	83-85 Sigourney Street	State/National Register Listed
32	Ann Street Historic District	Allyn, Ann, Asylum, Church, Hicks and Pearl streets	State/National Register Listed
33	High Street Historic District	402-418 Asylum Street, 28 High Street, and 175-189 Allyn Street	State/National Register Listed
34	Mark Twain House	351 Farmington Avenue	NHL, S/NR-listed
35	Laurel and Marshall Streets District	Laurel, Marshall, and Case streets, and Farmington Avenue	State/National Register Listed
36	Pratt Street Historic District	31-101 and 32-110 Pratt Street; 196-260 Trumbull Street	State/National Register Listed
37	First National Bank Building	50 State Street	State/National Register Listed
38	Dillon Building	69-71 Pratt Street	State/National Register Listed
39	Batterson Block	26--28 High Street	State/National Register Listed
40	Department Store Historic District	884--956 Main Street and 36 Talcott Street	State/National Register Listed
41	James Pratt Funeral Service	69 Farmington Avenue	State/National Register Listed
42	Cheney Building	942 Main Street	State/National Register Listed

Table 4-17: Architectural Resources within the Study Area

I.D. Number (See Figure 4-13)	Name	Address	Status
43	Judd and Root Building	175--189 Allyn Street and 5--23 High Street	State/National Register Listed
44	Christ Church	955 Main Street	State/National Register Listed
45	Nook Farm and Woodland Street District	Woodland, Gillett, and Forest streets, and Farmington Avenue	State/National Register Listed
46	Lyman House	22 Woodland Street	State/National Register Listed
47	Hartford Union Station	Union Place	State/National Register Listed
48	Bulkeley Bridge	I-84 over the Connecticut River	State/National Register Listed
49	Asylum Avenue District	Asylum and Farmington Aves., and Sigourney Street	State/National Register Listed
50	Apartment at 49-51 Spring Street	49-51 Spring Street	State/National Register Listed
51	U. S. Post Office and Federal Building	135-149 High Street	State/National Register Listed
52	Footguard Hall	Footguard and High Streets	State/National Register Listed
53	Calvin Day House	105 Spring Street	State/National Register Listed
54	Linke, William L., House	174 Sigourney Street	State/National Register Listed
55	Isham-Terry House	211 High Street	State/National Register Listed
56	Myers and Gross Building	2 Fraser Place	State/National Register Listed
57	Downtown North Historic District	Roughly Ann, Atlantic, Ely, High, Main and Pleasant streets	State/National Register Listed
58	Pomeroy, Arthur G., House	490 Ann Street	State/National Register Listed
59	Building at 136-138 Collins Street	136-138 Collins Street	State/National Register Listed
60	Building at 142 Collins Street	142 Collins Street	State/National Register Listed
61	Keney Tower	Main and Ely streets	State/National Register Listed
62	Sigourney Square Historic District (Boundary Increase)	216-232 Garden Street	State/National Register Listed
63	Engine Company 2 Fire Station	1515 Main Street	State/National Register Listed

Table 4-17: Architectural Resources within the Study Area

I.D. Number (See Figure 4-13)	Name	Address	Status
64	Clay Hill Historic District	Roughly bounded by Main, Mather, Garden, and Walnut streets	State/National Register Listed
65	Clay Hill Historic District (Boundary Increase)	8 Florence Street	State/National Register Listed
66	Collins and Townley Historic District	Irregular boundary, along Collins Street to the north between Atwood and Sumner streets, extends south along Atwood and Willard streets to Asylum Street to the south, and halfway down Sigourney Street to the south.	State/National Register Listed
67	Connecticut Mutual Life Insurance Building	140 Garden Street	State Register-listed
68	Asylum-Trumbull-Pearl Streets Historic District	Includes multiple buildings: 76 Asylum Street, 78-82 Asylum Street, 92-110 Asylum Street, 114-124 Asylum Street, 81 Asylum Street , 83 Asylum Street , 105 Asylum Street , 115 Asylum Street , 140 Trumbull Street, 80 Pearl Street, 90 Pearl Street, 100 Pearl Street	State Register-listed
69	Solomon Youngman House	461 Farmington Avenue	State Register-listed
70	Sigourney Square Historic District	Sargent/Ashley/Garden/Sigourney	State/National Register Listed
71	Sigourney Square Boundary Increase #2	21 Ashley Street	State/National Register Listed
72	Hotel America	5 Constitution Plaza	State Register-listed
73	Hartford National Trust and Bank Building	777 Main Street	State Register-listed
74	Capitol Building	410 Asylum Street	State Register-listed
75	Bushnell Tower	1 Gold Street	State Register-listed
76	Colonial Theater	488-492 Farmington Avenue	State Register-listed

Table 4-17: Architectural Resources within the Study Area

I.D. Number (See Figure 4-13)	Name	Address	Status
77	Main Street Historic District No. 1	Roughly the west side of Main Street from Asylum to Pratt streets and east side of Main Street from Kinsely to Talcott streets (includes 11-21 Asylum Street; 18 and 20 Asylum Street; 805-875 Main Street; 852-990 Main Street; 125-185 Market Street; 1-25 Pratt Street.	State Register-listed
78	Rudson-Lake House	551-553 Farmington Avenue	State Register-listed
79	Ahern Funeral Home	180 Farmington Avenue	State Register-listed
80	Hartford Institute of Accounting	66 Forest Street	State Register-listed
81	Immanuel Congregational Church	350-360 Farmington Avenue	State Register-listed
82	Soldiers and Sailors Monument	Trinity Street between Elm and Jewell	State Register-listed
83	Commercial Structure	839 Asylum Avenue	State Register-listed
84	Commercial Structure	903 Asylum Avenue	State Register-listed
85	Commercial Structure	Asylum and Trumbull streets	State Register-listed
86	Commercial Structure	95 Elm Street	State Register-listed
87	Residence	847 Asylum Avenue	State Register-listed
88	Residence	181 Collins Street	State Register-listed
89	Residence	237-239 Farmington Avenue	State Register-listed
90	George Keller Historic District	Capitol Avenue	Local Historic District

[1] No longer extant.

References:

- *Federal Register*. March 10, 2005. “Exemption Regarding Historic Preservation Review Process for Effects to the Interstate Highway System.” Vol.77, No. 46.
- *The Courant.* March 14, 1994. “A Monument to Royal Typewriter Hartford.” Available at: <http://articles.courant.com/1994-03-14/news/9403130076_1_memorial-fund-new-supermarket-shop>. Accessed March 6, 2014

4.10 Visual and Aesthetic Resources

I-84 in the City of Hartford is a significant visual element. The highway is elevated for the majority of the Study Area either via a structural viaduct or an earth embankment, with numerous streets running underneath it: Hamilton Street, Park Street, Capitol Avenue, Laurel Street, Sigourney Street, Flower Street (now closed to traffic), Broad Street, Asylum Avenue, and Church/Myrtle Streets near Union Station and Market Street. Four streets cross over I-84 in downtown Hartford, where the highway is depressed below street level: High Street, Ann Street, Trumbull Street, and Main Street.

In 1970, after the highway was completed, the CTDOT I-84 Environmental and Joint Use Study noted that the highway along with its elevated network is “visually overwhelming.” The study recommended buffering the contrast between the highway and the surrounding downtown area with public-private joint development projects. The visual impact of the highway is particularly prominent in several areas, including Capitol Avenue where the Sisson Avenue ramps tower overhead, Sigourney Street where the highway passes in front of the Aetna Corporate Headquarters (providing the often-used name of the highway as the “Aetna Viaduct”), and between Downtown and Asylum Hill where the highway rises well above the street network and makes a distinctive "S" shape around Union Station.

For the purposes of this analysis, a visual barrier is defined as an object or structure that blocks the human view from one location to another, obstructing sight of other objects, vistas, scenes, or settings. Illustrated on Figure 4-15, page 4-48, five unique viewsheds can be broadly described in terms of I-84's visual and aesthetic resources:

- Flatbush Avenue/New Park Street/Hamilton Street
- Parkville/Frog Hollow
- Capitol Avenue/Sigourney Street/Broad Street
- Asylum Avenue/Union Station
- Downtown

4.10.1 Flatbush Avenue/New Park Street/Hamilton Street

This segment of I-84 runs between light industrial lands to the west and open space (Pope Park) and natural areas to the east. It is characterized as an open, elevated highway with views emerging as one gets closer to the highway underpasses, although it is fairly hidden behind the industrial buildings and areas of invasive vegetation. Some taller buildings within the light industrial area are in close proximity to the highway.

4.10.2 Parkville/Frog Hollow

This segment is an elevated highway with Park Street running underneath. Due to higher grades along Park Street on the west, the highway is mostly hidden from view from this perspective. On the Park Street east side, the highway is much more prominent due to the fact that the Park Street is at a consistently lower elevation. The parking lot of the Park Plaza Shopping Center provides a broad, open expanse from which there is an unimpeded view to the viaduct. Surrounding residential and office towers have full 180 degree views of the highway from the middle and upper floors.

4.10.3 Capitol Avenue/Sigourney Street/Broad Street

The elevated highway is fully exposed between Capitol Avenue and Broad Street as it nears downtown Hartford. Significant visual impact is found at the Capitol Avenue underpass where the Interchange 46 ramps loom several stories above the roadway and can be seen from both west and east. The highway passes in front of the well-known view of the Aetna building at Sigourney Street. Through this segment the highway viaduct is a visual barrier in both directions.

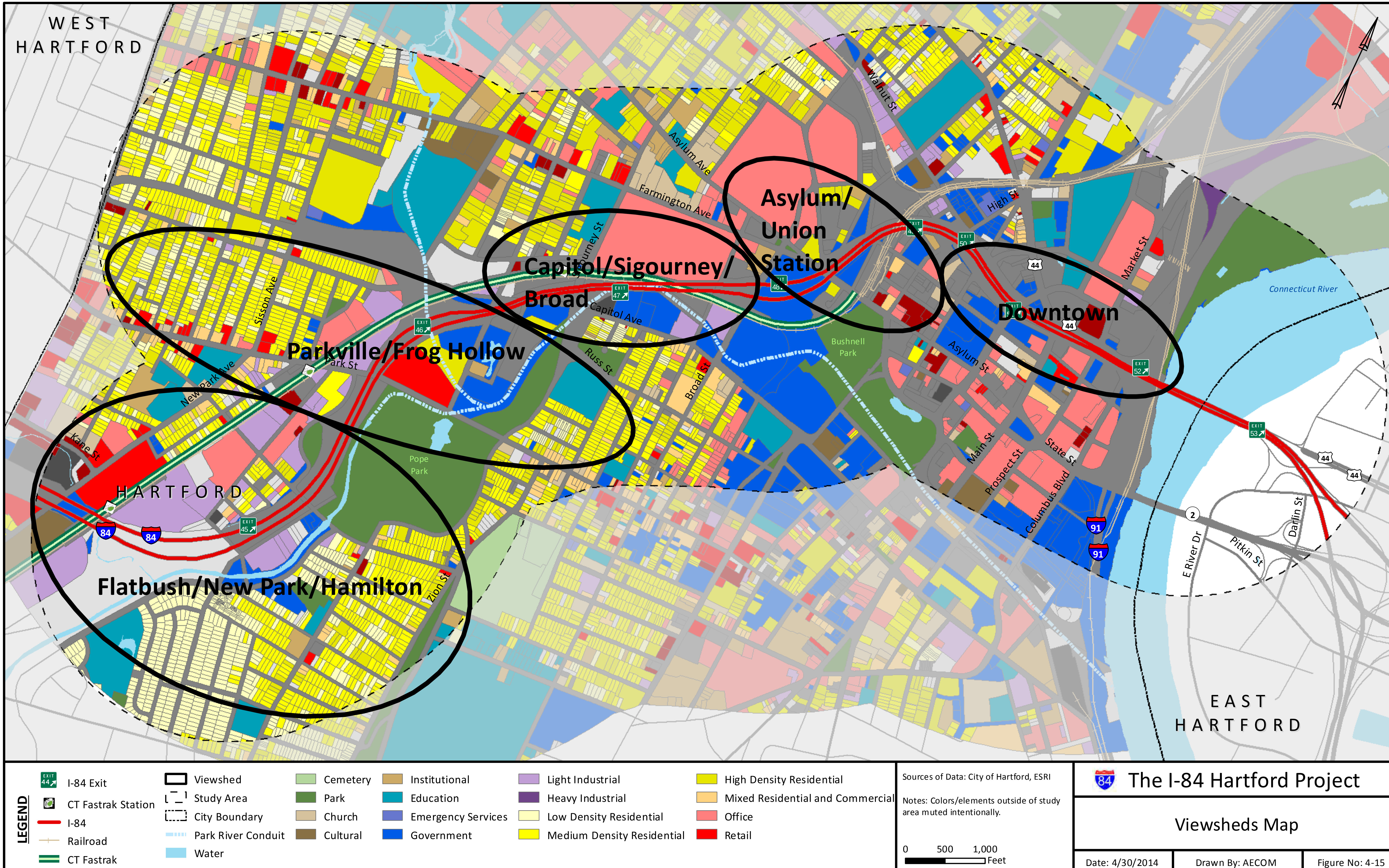
4.10.4 Asylum Avenue/Union Station

I-84 passes over Asylum Avenue and is fully exposed at this "gateway" into downtown Hartford from the west. The highway is mostly hidden behind the Amtrak rail corridor and trees in Bushnell Park from the east. Areas in the Asylum Hill neighborhood are elevated and therefore at eye level or slightly above I-84 in this location, making for a visual barrier when looking to Downtown from these locations.

4.10.5 Downtown

As I-84 crosses into Downtown beyond Union Station, it transitions to become depressed, below the local streets, with several local street overpasses. In this way the highway is less visually intrusive between High Street and Main Street. However, farther to the east, the highway is once again elevated on a viaduct structure and can be seen from both directions where Market Street passes underneath.

Viewer sensitivity and considerations of visual and aesthetic impacts are important in all viewsheds, but especially within the Capitol/Sigourney/Broad and Asylum Avenue/Union Station areas where the I-84 viaduct is particularly exposed due to a lack of vegetation and lack of surrounding built forms that would screen the highway from view.


WEST HARTFORD
HARTFORD
EAST HARTFORD
Asylum/ Union Station
Capitol/Sigourney/ Broad
Parkville/Frog Hollow
Downtown
Flatbush/New Park/Hamilton
Connecticut River
Bushnell Park
Pope Park
Asylum Ave
Farmington Ave
Walnut St
High St
Market St
Sigourney St
Capitol Ave
Sisson Ave
Park St
New Park Ave
Kane St
Russ St
Broad St
Asylum St
Main St
Prospect St
State St
Columbus Blvd
Zion St
E River Dr
Pitkin St
Darlin St
LEGEND
I-84 Exit
CT Fastrak Station
I-84
Railroad
CT Fastrak
Viewshed
Study Area
City Boundary
Park River Conduit
Water
Cemetery
Park
Church
Cultural
Institutional
Education
Emergency Services
Government
Light Industrial
Heavy Industrial
Low Density Residential
Medium Density Residential
High Density Residential
Mixed Residential and Commercial
Office
Retail
Sources of Data: City of Hartford, ESRI
Notes: Colors/elements outside of study area muted intentionally.
0 500 1,000 Feet
The I-84 Hartford Project
Viewsheds Map
Date: 4/30/2014
Drawn By: AECOM
Figure No: 4-15

4.11 Section 4(f) and Section 6(f) Lands

4.11.1 Section 4(f)

The U. S. Department of Transportation Act (DOT Act) Section 4(f) regulations govern the use of lands which are:

- Parks and recreational areas of national, state, or local significance which are both publicly owned and open to the public.
- Publicly owned wildlife and waterfowl refuges of national, state, or local significance which are open to the public to the extent that public access does not interfere with the primary purpose of the refuge.
- Historic sites of national, state, or local significance in public or private ownership regardless of whether they are open to the public.

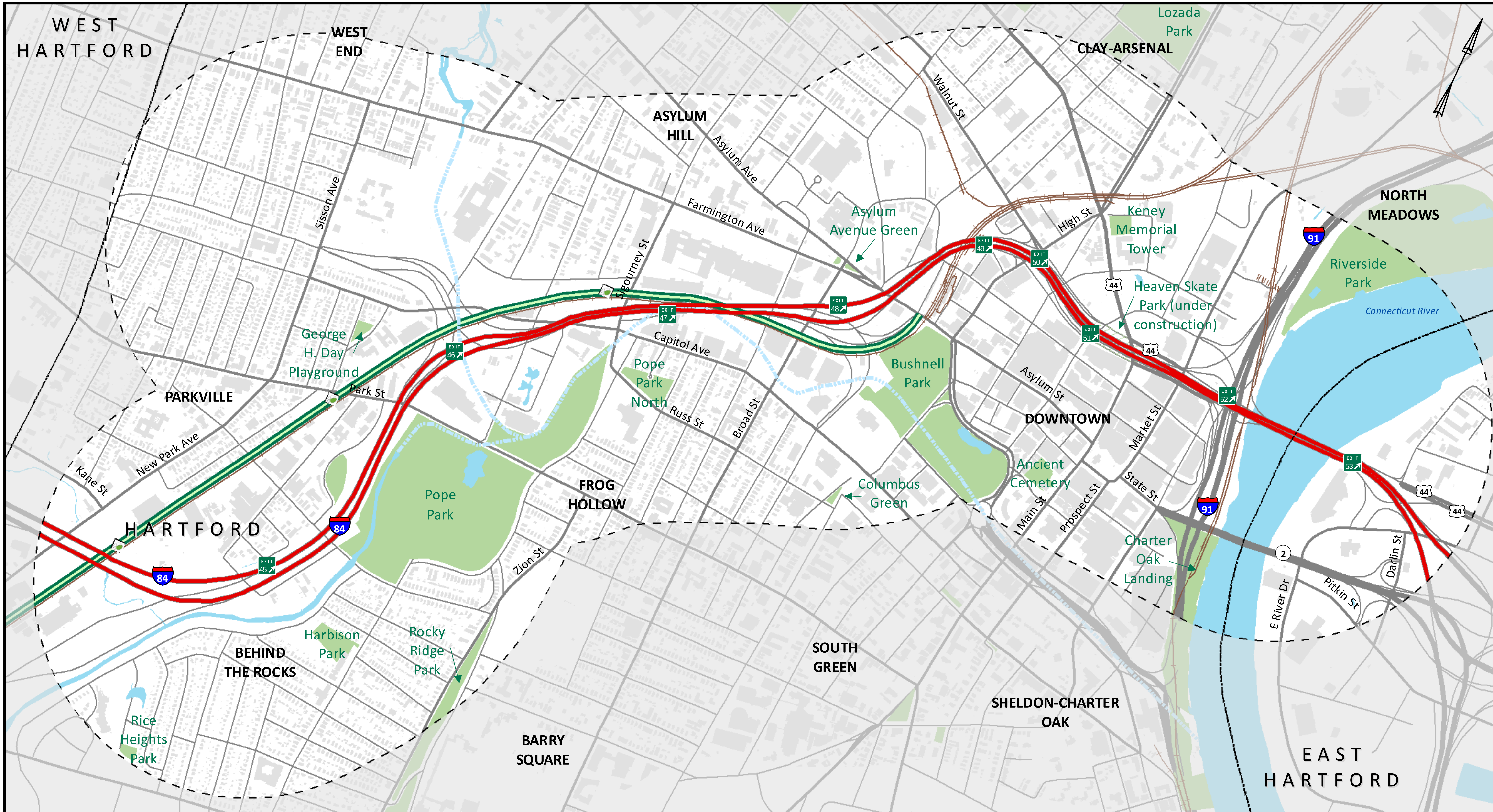
When private institutions, organizations, or individuals own parks, recreational areas or wildlife and waterfowl refuges, Section 4(f) does not apply, even if such areas are open to the public. The City of Hartford Information Services Land Use Data was consulted to develop a list of properties in the Study Area that are protected by Section 4(f). These are illustrated on Figure 4-16, following. Table 4-18, below, lists Section 4(f) resources in the Study Area.

Table 4-18: Section 4(f) Resources within the Study Area

Property Name	Owner	Type of Property
Rice Heights Playground	City of Hartford	Park/Recreation
Pope Park	City of Hartford	Park
George H. Day Playground	City of Hartford	Park/Recreation
Bushnell Park	City of Hartford	Park
Rocky Ridge Park	City of Hartford	Park
Columbus Green	City of Hartford	Park
Asylum Avenue Green	City of Hartford	Park
Keney Memorial Tower	City of Hartford	Park
Ancient Cemetery	City of Hartford	Historic Cemetery
Riverside Park & Charter Oak Landing	City of Hartford	Park/Recreation
Harbison Park	City of Hartford	Park
Heaven Skate Park (currently under construction)	City of Hartford	Recreation

Source: City of Hartford Information Services, 2013.

Use of Section 4(f) property is defined in three ways: (1) Land permanently incorporated into a transportation facility, (2) Land used for temporary occupancy, as required, for project construction-related activities, or (3) Constructive use, which involves no actual physical use of the land and occurs when the proximity impacts of a project result in substantial impairment to the property's activities, features, or attributes.



LEGEND

I-84 Exit	Interstate Highway
CT Fastrak Station	US Highway
I-84	Major Road
Study Area	Local Road
City Boundary	Railroad
	CT Fastrak
Park River Conduit	
Building Footprint	
Water	
Section 4(f) Land	
Recreation Area Under Construction	

Sources of Data: City of Hartford, ESRI

Notes: Colors/elements outside of study area muted intentionally.

0 500 1,000 Feet

The I-84 Hartford Project

Section 4(f) Lands Map

Date: 4/29/2014 | Drawn By: AECOM | Figure No: 4-16

4.11.2 Section 6(f)

The purpose of the Land and Water Conservation Fund Act (LWCFA) (Section 6(f)): 16 U.S.C. 4601-4 to 4601-11 (P.L. 88-578) is to preserve, develop and assure the quality and quantity of outdoor recreation resources and regulate all projects which impact recreational lands purchased or improved with Land and Water conservation funds. The LWCFA provides matching grants to state and local governments provided they be used to acquire and develop public outdoor recreation areas and facilities. The intent in using this approach is to create and maintain high quality recreation areas nationwide. By providing matching funds for this purpose, the federal government is hoping to create the mechanism through which non-federal investments will be devoted to the protection and maintenance of recreational resources throughout the United States.

Section 6(f) states that “no property acquired or developed with assistance under this section shall, without the approval of the Secretary of the Interior, be converted to other than public outdoor recreation uses.” Section 6(f)(3) of the LWCFA contains strong provisions to protect federal investments and the quality of assisted resources. The law is firm but recognizes the likelihood that changes in land use or development may make some assisted areas obsolete over time, particularly in rapidly changing urban areas like Hartford. The law is set up to discourage converting park and recreation facilities to other uses by ensuring that changes or "conversions from recreation use" will bear a cost. The LWCFA contains a clear and common sense provision to protect grant-assisted areas from conversions.

The "anti-conversion" requirement applies to all parks and other sites that have been the subject of Land and Water grants of any type, whether for acquisition of parkland, development, or rehabilitation of facilities. In many cases, even a relatively small LWCFA grant (e.g., for development of a picnic shelter) in a park of hundreds or even thousands of acres provides anti-conversion protection to the entire park site. In the event that Section 6(f) lands are approved through the Department of the Interior to be put to use for another purpose, replacement in kind is typically required.

Funding for the parks and recreational areas within the Study Area are identified in Table 4-19, following. As noted above, properties that have benefited from federal funds are subject to requirements that replacement parklands within a reasonable proximity be provided. For lands acquired through the LWCFA, additional provisions under Title 36, Part 59 § 6(f)(3), known as “conversion protection” requirements, place additional restrictions on the potential conversion of recreation and conservation lands. Similar provisions under Connecticut State Statutes CSS § 7-131i-j, restrict the use of land acquired or developed by a municipality with State funds for anything other than recreation or conservation.

Table 4-19: Funding Sources for Section 4(f) Resources

Property Name	Owner	Type of Property	Funding Sources
Rice Heights Playground	City of Hartford	Park/Recreation	While DEEP has provided funds for playgrounds, no state funding record exists for this site.
Pope Park	City of Hartford	Park	Federal & State
George H. Day Playground	City of Hartford	Park/Recreation	State
Bushnell Park	City of Hartford	Park	State
Rocky Ridge Park	City of Hartford	Park	Federal & State
Columbus Green	City of Hartford	Park	Because of the size and nature, state funding is questionable and no record has been found.
Asylum Avenue Green	City of Hartford	Park	Because of the size and nature, state funding is questionable and no record has been found.
Keney Memorial Tower	City of Hartford	Park	No record of funding for Keney Memorial Tower has been found.
Ancient Cemetery	City of Hartford	Historic Cemetery	Privately funded
Riverside Park & Charter Oak Landing	City of Hartford	Park/Recreation	Federal & State
Harbison Park	City of Hartford	Park	Federal & State
Heaven Skate Park	City of Hartford	Recreation	No state funding record for this site has been found.
Old State House Park	City of Hartford	Park	Federal & State

Sources: City of Hartford Information Services, 2013;
CTDEEP, 2015

4.12 Surface and Groundwater Resources

4.12.1 Surface Water Resources

The Study Area is drained by waterways in the Connecticut River Basin, with water in the local watershed generally flowing southward and eastward towards the Connecticut River. Specifically, the North and South Branches of the Park River converge in the western portion of the Study Area to form the Park River. The Park River itself has a long history that is intimately entwined with the development and history of the City of Hartford. Originally called the Little River in the early 1600s, over time as the river began to be utilized by settlers to power local mill's and as factories were constructed along its banks, the Little River's water quality became impaired and it became known as the Mill River. For a time, due to urban runoff and the fact that pigs were once kept in pastures along the banks of the river, it began to produce horrific odors and was aptly named the Hog River.

In the 1850s, around the time Horace Bushnell was proposing to create Bushnell Park (originally called "City Park"), the river was commonly referred to as the Park River and the name has stuck ever since. The driving force behind the creation of Bushnell Park was to clean up the river and dismantle the existing factories, tanneries and other industrial development that had moved in along the rivers banks and replace them with a scenic place where the citizens of Hartford could come and relax.

Restoration and beautification of the Park River and its immediate surroundings aside, there was another major problem: flooding. The Connecticut River, into which the Park River discharges, drains an enormous area of New England to the north of the confluence of the two rivers. As a result, every year, the Connecticut River's water would rise to flood stage elevations and back up into the Park River's channel, floodplains, and associated low lying areas. Catastrophic flooding in 1936 and 1938 caused hundreds of millions of dollars (in 1930s dollars) in property damage as much of Hartford was underwater. These events in turn triggered the beginning of a process that would occur over the next forty years, the gradual interment of portions of the Park River into an enormous system of underground concrete tunnels, culverts, and associated infrastructure. At the request of officials from the City of Hartford, this process was initiated by the United States Army Corps of Engineers in an attempt to tame the river and eliminate any further flooding episodes. At its completion, the approximately nine miles of underground conduit that presently entomb portions of the river cost over 100 million dollars.

The Connecticut River itself flows southward through the State and ultimately empties into Long Island Sound. The Connecticut River is a fishery for the following species: American eel, common carp, calico bass, largemouth bass, northern pike, small mouth bass, sunfish, walleye, white catfish, white perch, and yellow perch (CT DEEP, 2013 Connecticut Angler's Guide).

The waters of Connecticut (all surface water and groundwater of the State) are assigned a Water Quality Classification by CT DEEP. The Water Quality Classifications are used to relate designated uses and the applicable standards and criteria for each class of surface and ground water resource. Major surface water resources within the study area and their associated water quality classifications are depicted on Figure 4-17, page 4-56, and listed in Table 4-20, following.

Table 4-20: Major Surface Water Resources within the Study Area

Water Body Name	Water Quality Classification
South Branch Park River	B (Recreational use: fish and wildlife habitat; agricultural and industrial supply and other legitimate uses including navigation.)
North Branch Park River	A (Potential drinking water supply; fish and wildlife habitat; recreational use; agricultural and industrial supply and other legitimate uses including navigation.)
Park River	B (Recreational use: fish and wildlife habitat; agricultural and industrial supply and other legitimate uses including navigation.)
Pope Park Pond	A (Potential drinking water supply; fish and wildlife habitat; recreational use; agricultural and industrial supply and other legitimate uses including navigation.)
Lily Pond	A (Potential drinking water supply; fish and wildlife habitat; recreational use; agricultural and industrial supply and other legitimate uses including navigation.)
Connecticut River	SB (Marine fish, shellfish and wildlife habitat, shellfish harvesting for transfer to approved areas for purification prior to human consumption, recreation, industrial and other legitimate uses including navigation.)

Source: CT DEEP. *Water Quality Standards and Classifications Factsheet*. Updated April 29, 2013.

Pursuant to the requirements of Section 305(b) of the Federal Clean Water Act, water bodies that are determined to not be supporting their designated uses in whole or in part are considered impaired, and placed on the Clean Water Act, Section 303(d) List of Impaired Waters, where they are prioritized and scheduled for restoration. The causes of impairment include those pollutants or other stressors that adversely affect the actual chemical, physical, and biological parameters of the water resource. Sources of impairment are not determined until a total maximum daily load (TMDL) assessment is conducted on a water body. Four of the water bodies within the Study Area are listed as impaired in the *2012 State of Connecticut Integrated Water Quality Report*; these are listed in Table 4-21, following.

Table 4-21: Impaired Surface Water Resources within the Study Area

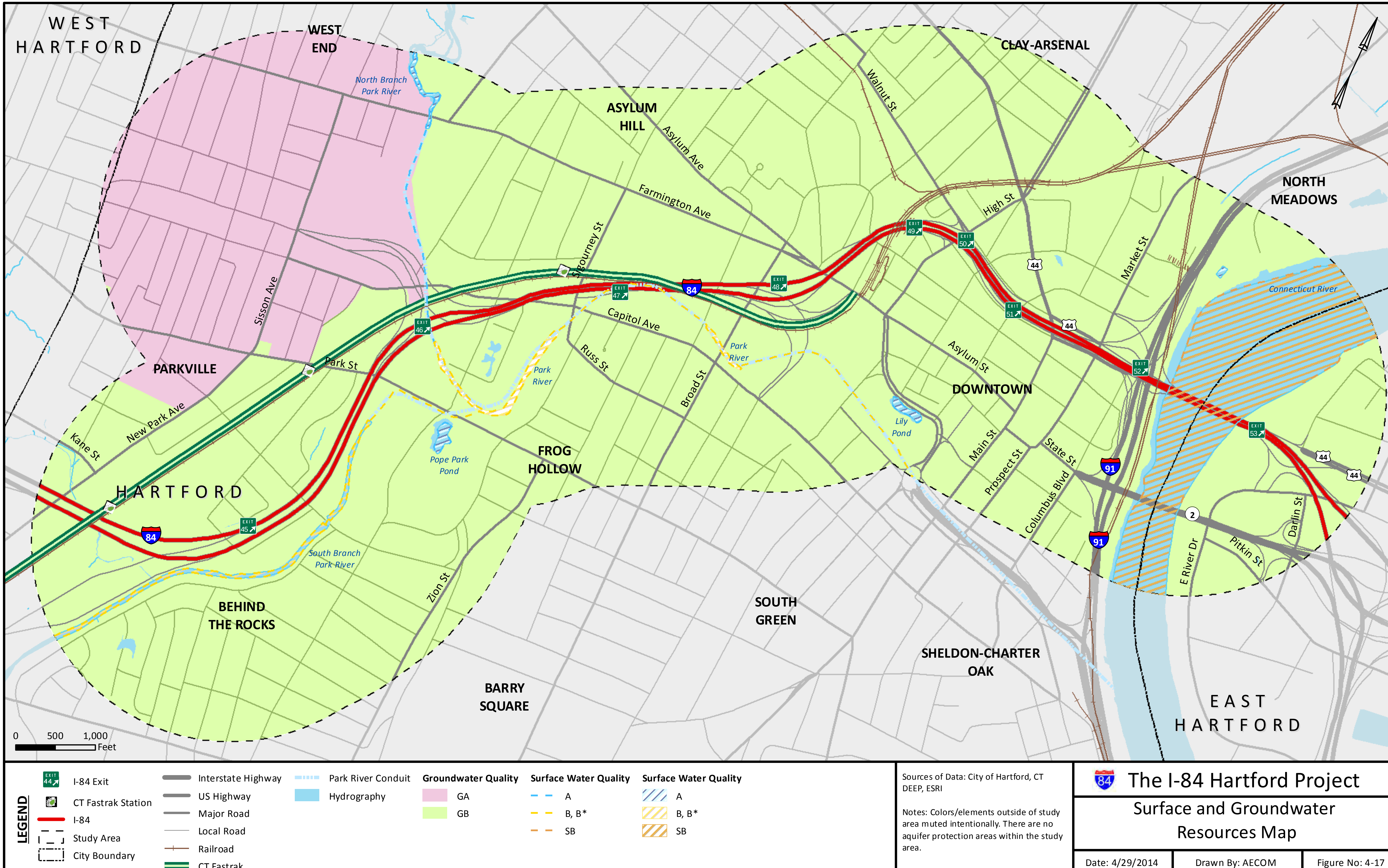
Water Body Name	Impairment
South Branch Park River	Habitat for Fish, Other Aquatic Life and Wildlife: Cause unknown. Potential sources include combined sewer outflows ("CSOs"). Recreation: *Escherichia coli*. Potential sources include non-permitted stormwater, illicit discharges, insufficient septic systems, nuisance wildlife/ pets.
North Branch Park River	Recreation: *Escherichia coli*. Potential sources include permitted and non-permitted stormwater, illicit discharges, CSOs, sanitary sewer overflow ("SSOs"), insufficient septic systems, nuisance wildlife/ pets.
Park River	Recreation: *Escherichia coli*. Potential sources include permitted and non-permitted stormwater, illicit discharges, insufficient septic systems, nuisance wildlife/ pets.
Connecticut River (from Reservoir Brook confluence, Portland, CT, upstream to the MA border)	Fish Consumption: Polychlorinated biphenyls. Recreation: *Enterococcus.* Potential sources include permitted and non-permitted stormwater, illicit discharges, CSOs/SSOs, insufficient septic systems, agricultural activity, nuisance wildlife/ pets. *Escherichia coli.* Potential sources include permitted and non-permitted stormwater, illicit discharges, CSOs/SSOs, insufficient septic systems, agricultural activity, nuisance wildlife/ pets.

Source: CT DEEP. *2012 State of Connecticut Integrated Water Quality Report*. December 17, 2012.

4.12.2 Groundwater

The CT DEEP classifies the state's groundwater resources into four classes and establishes groundwater quality standards and uses for each class and are defined by the CT DEEP as:

- Class GAA: Designated uses are for existing or potential public supply of water suitable for drinking without treatment and baseflow for hydraulically connected surface water bodies. The discharges are limited to: treated domestic sewage, certain agricultural wastes, and certain water treatment wastewaters.
- Class GA: Designated uses are for existing private and potential public or private supplies of water suitable for drinking without treatment and baseflow for hydraulically connected surface water bodies. Discharges are restricted to: the same as for GAA and discharge from sewage treatment facilities subject to stringent treatment and discharge requirements, and other wastes of natural origin that easily biodegrade and present no threat to groundwater.
- Class GB: Designated uses are for industrial process water and cooling waters; baseflow for hydraulically connected surface water bodies and is presumed not suitable for human consumption without treatment. Discharges are restricted to: the same as for GA (Note; same treatment standards apply), and certain other biodegradable wastewaters subject to soil attenuation.



WEST HARTFORD
WEST END
North Branch Park River
ASYLUM HILL
Asylum Ave
Walnut St
CLAY-ARSENAL
NORTH MEADOWS
Farmington Ave
High St
Sigourney St
Sisson Ave
Capitol Ave
Park St
PARKVILLE
New Park Ave
Kane St
Park River
Russ St
Broad St
Asylum St
DOWNTOWN
Market St
Connecticut River
Lily Pond
Main St
Prospect St
State St
Columbus Blvd
Pope Park Pond
FROG HOLLOW
HARTFORD
South Branch Park River
Zion St
BEHIND THE ROCKS
SOUTH GREEN
SHELDON-CHARTER OAK
BARRY SQUARE
E River Dr
Pitkin St
Darlin St
EAST HARTFORD
0 500 1,000 Feet
LEGEND
I-84 Exit
CT Fastrak Station
I-84
Study Area
City Boundary
Interstate Highway
US Highway
Major Road
Local Road
Railroad
CT Fastrak
Park River Conduit
Hydrography
Groundwater Quality
GA
GB
Surface Water Quality
A
B, B*
SB
Surface Water Quality
A
B, B*
SB
Sources of Data: City of Hartford, CT DEEP, ESRI
Notes: Colors/elements outside of study area muted intentionally. There are no aquifer protection areas within the study area.
The I-84 Hartford Project
Surface and Groundwater Resources Map
Date: 4/29/2014
Drawn By: AECOM
Figure No: 4-17

- Class GC: Designated uses are assimilation of discharge authorized by the Commissioner pursuant to Section 22a-430 of the General Statutes. As an example a lined landfill for disposal of ash residue from a resource recovery facility. The GC hydrogeology and hydrologic setting provides the best safeguard to adjacent resources. Discharges are restricted to: potential discharges from certain waste facilities subject to specific permitting requirements.

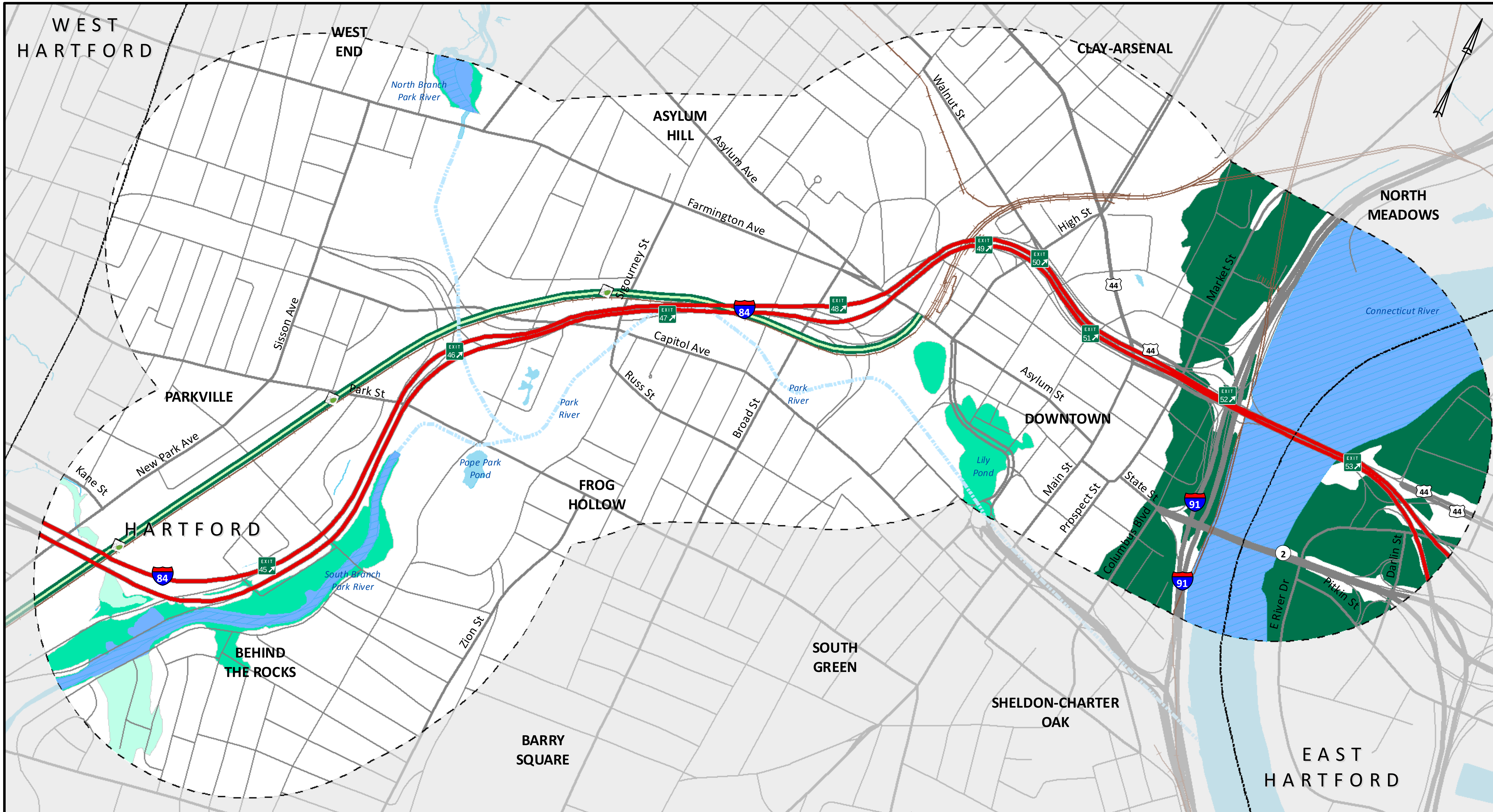
Groundwater resources within the Study Area are depicted on Figure 4-17, previous. A majority (85%) of the groundwater resources in the Study Area are classified as GB. A small area (remaining 15%) located in the northwest corner of the Study Area is classified as GA. The entire Study Area, minus the parks, is in the City sewer service area and there are no aquifer protection areas within the Study Area.

The CT DEEP Connecticut's Aquifer Protection Area Program protects major public water supply wells in sand and gravel aquifers to ensure public drinking water for present and future generations. Currently, the State of Connecticut has 127 active Aquifer Protection Areas in 80 towns that serve more than 1,000 people. CT DEEP Aquifer Protection Area regulations limit development of certain new land use activities that use, store, handle, or dispose of hazardous materials, and require existing regulated land uses to follow best management practices. There are no Aquifer Protection Areas within the Study Area.

4.13 Floodplains

A floodplain is the land area adjacent to a river, stream or other body of flowing water which is, on average, likely to be covered with flood waters resulting from a 100-year frequency storm event as mapped by Federal Emergency Management Agency (FEMA) (refer to Zones A and AE on Figure 4-18, following). Floodplains within the Study Area include lands surrounding the South Branch Park River and tributary, the North Branch Park River, and Lily Pond. A levee protects the Study Area from the Connecticut River flooding events (refer to Zone X Protected by Levee on Figure 4-18, following). All other areas are designated Zone X, and are defined as areas of minimal flood hazard.

A floodway is the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height. These areas within the Study Area include the channels associated with the South Branch Park River, the North Branch Park River, and the Connecticut River (refer to Figure 4-18, following).



LEGEND

I-84 Exit	Interstate Highway	Park River Conduit	**Flood Zone**	X
CT Fastrak Station	US Highway	Floodway		X PROTECTED BY LEVEE
I-84	Major Road	Hydrography	A	0.2 PCT ANNUAL CHANCE FLOOD HAZARD
Study Area	Local Road		AE	
City Boundary	Railroad			
	CT Fastrak			

Sources of Data: City of Hartford, CT DEEP, ESRI

Notes: Colors/elements outside of study area muted intentionally.

0 500 1,000 Feet

The I-84 Hartford Project

Floodplains Map

Date: 4/29/2014 | Drawn By: AECOM | Figure No: 4-18

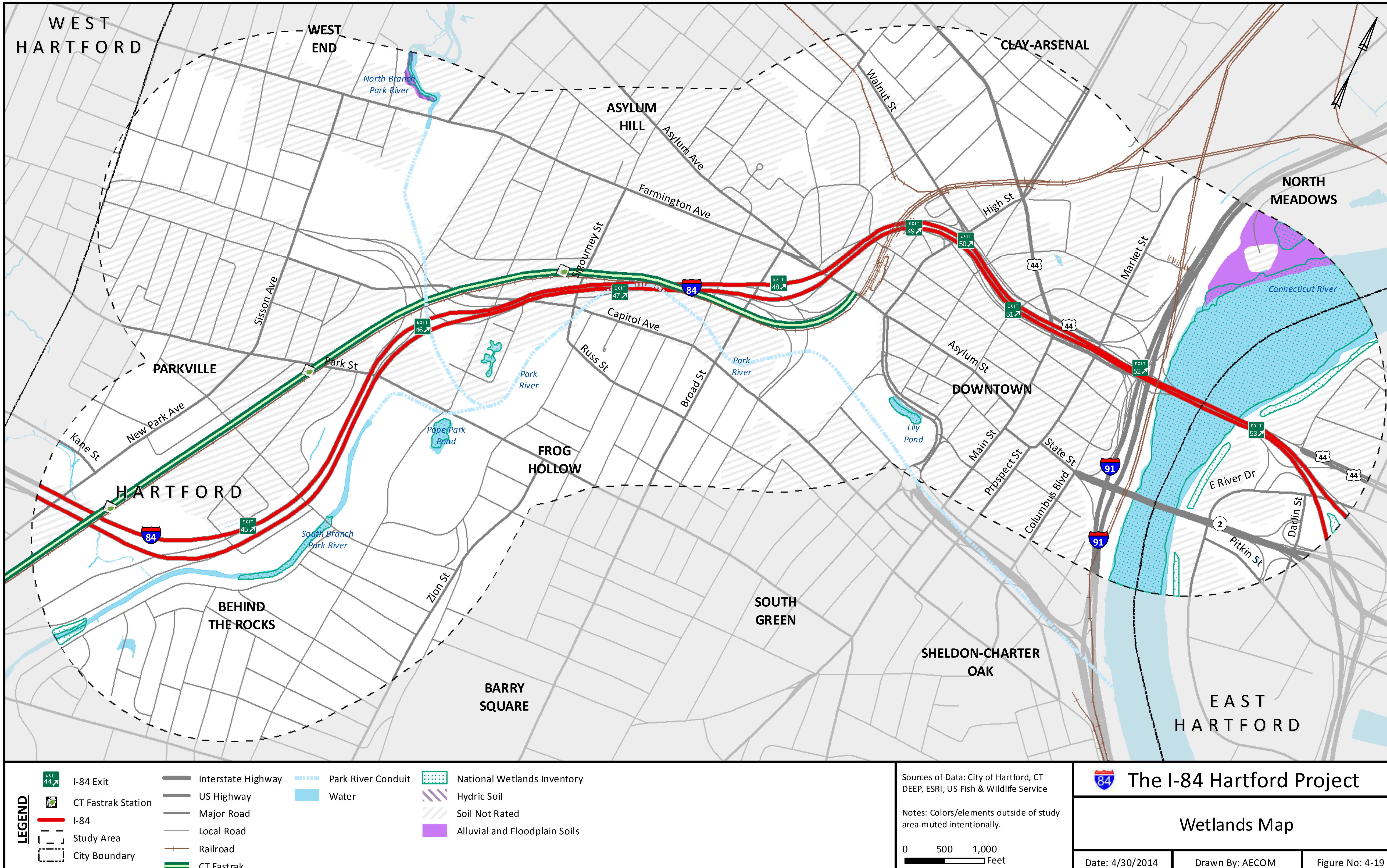
4.14 Wetlands

Pursuant to the Connecticut Inland Wetlands and Watercourses Act, Connecticut General Statues Section 22a-36 through 22a-45, the State of Connecticut defines wetlands as land, including submerged land, consisting of poorly drained, very poorly drained, alluvial, and floodplain soils as defined by the USDA Cooperative Soil Survey. Such areas may include filled, graded, or excavated sites possessing an aquic (saturated) moisture regime as defined by the USDA Cooperative Soil Survey. The Act defines watercourses as rivers, streams, brooks, waterways, lakes, ponds, marshes, swamps, bogs, and also other bodies of water, natural or artificial, public or private, contained within, flow through or border upon the state, or any portion thereof.

In accordance with the United States Army Corps Wetland Delineation Manual (Technical Report Y-78-1, 1987 USACE Manual) and the USACE New England District Wetland Delineation Datasheet and Supplemental Information (CENAE-R-PT Version 9/1/04), areas must exhibit three distinct characteristics to be considered federal jurisdictional wetlands:

1. **Vegetation:** The prevalent vegetation must consist of plants adapted to life in hydric soil conditions. These species, due to morphological, physiological, and/or reproductive adaptations, can and do persist in anaerobic soil conditions.
2. **Hydric Soils:** Soils in wetlands must be classified as hydric or they must possess characteristics associated with reducing soil conditions (typically resulting in redoximorphic features or gleyed soils).
3. **Hydrology:** The soil must be inundated either permanently or periodically at mean water depths less than 6.6 feet (2 meters) or the soil must be saturated at the surface for some time during the growing season of the prevalent vegetation.

Within the Study Area, there are federal and state mapped wetlands associated with the South Branch of the Park River, the North Branch of the Park River, Pope Park Pond, Lily Pond and the Connecticut River. These are illustrated on Figure 4-19, following. The wetland information depicted on Figure 4-19 was obtained using existing data from the National Wetlands Inventory (NWI), and CT DEEP Hydric Soils and Inland Wetland Soils data.


WEST HARTFORD
WEST END
CLAY-ARSENAL
ASYLUM HILL
NORTH MEADOWS
PARKVILLE
DOWNTOWN
FROG HOLLOW
HARTFORD
BEHIND THE ROCKS
SOUTH GREEN
SHELDON-CHARTER OAK
BARRY SQUARE
EAST HARTFORD
North Branch Park River
Park River
South Branch Park River
Pope Park Pond
Lily Pond
Connecticut River
Asylum Ave
Farmington Ave
Walnut St
High St
Sigourney St
Capitol Ave
Russ St
Broad St
Sisson Ave
Park St
New Park Ave
Kane St
Zion St
Asylum St
Main St
Prospect St
Columbus Blvd
State St
Market St
E River Dr
Pitkin St
Darlin St
LEGEND
I-84 Exit
CT Fastrak Station
I-84
Study Area
City Boundary
Interstate Highway
US Highway
Major Road
Local Road
Railroad
CT Fastrak
Park River Conduit
Water
National Wetlands Inventory
Hydric Soil
Soil Not Rated
Alluvial and Floodplain Soils
Sources of Data: City of Hartford, CT DEEP, ESRI, US Fish & Wildlife Service
Notes: Colors/elements outside of study area muted intentionally.
0 500 1,000 Feet
The I-84 Hartford Project
Wetlands Map
Date: 4/30/2014
Drawn By: AECOM
Figure No: 4-19

4.15 Endangered Species

The purpose of the Federal Endangered Species Act, passed in 1973, is to protect and recover imperiled species and the ecosystems upon which they depend. In freshwater and terrestrial ecosystems, the Act is administered by the USFWS. Per consultation with the United States Fish and Wildlife Service (USFWS) website on December 5, 2013, the Study Area does not encompass any known habitat of any federally-listed species under the jurisdiction of the (USFWS, 2013).

The Connecticut Endangered Species Act, passed in 1989, recognizes the importance of the state's plant and animal populations and the need to protect them from threats that could lead to their extinction. The overall goal of the legislation is to conserve, protect, restore and enhance any endangered or threatened species and their essential habitat. Species are listed according to their level of risk, and their status is reviewed every five years. The CT DEEP oversees the implementation of the Connecticut Endangered Species Act.

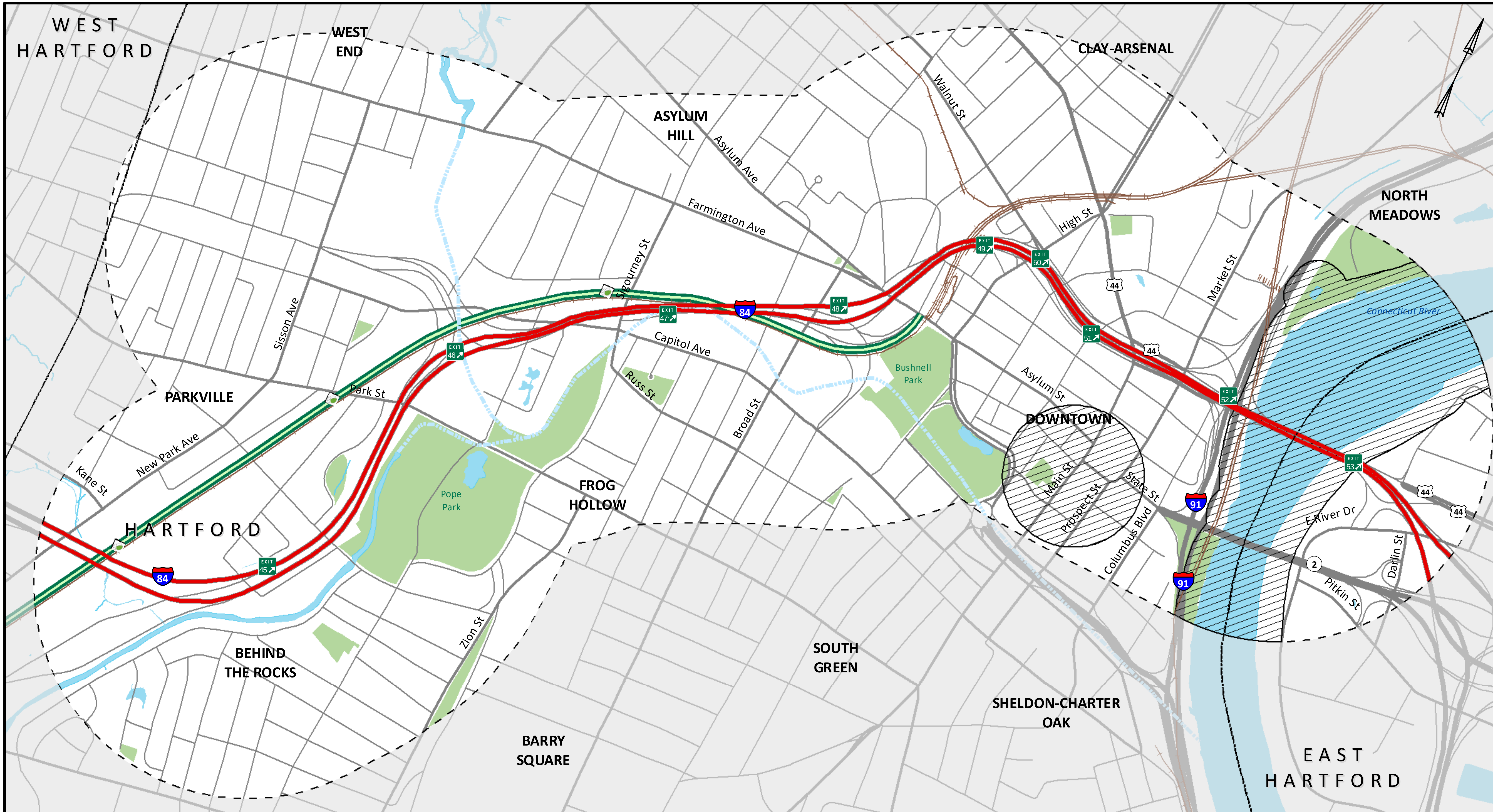
Within the Study Area there are two locations of state-listed threatened, endangered, or special concern species habitat areas. The locations are illustrated on Figure 4-20, following. Further communication/consultation will be undertaken with CT DEEP, as appropriate.

Connecticut Critical Habitats are areas that are classified as rare and specialized wildlife habitats in the state. Within the northeastern corner of the Study Area, there is a small area of critical habitat (forested floodplain). Further communication/consultation will be undertaken with CT DEEP, as appropriate.

4.16 Hazardous Material Risk Sites

The Study Area was reviewed for the potential for encountering hazardous and/or petroleum materials. In order to evaluate this potential risk, historic insurance maps and government databases were reviewed to identify properties which may pose an environmental concern. These documents were obtained from Environmental Data Resources (EDR) located in Milford, Connecticut.

Historic Sanborn Fire Insurance Maps (Sanborn Maps) of the Study Area from 1900, 1922, 1950, and 1979 were reviewed. Sanborn Maps were initially created to estimate fire insurance liabilities in urbanized areas and such contain important information that is typically used when evaluating potential historical environmental impacts. Evaluation of the Sanborn Maps obtained for this hazardous materials risk review indicate that there are numerous properties since 1900 which have the potential to have released petroleum and/or hazardous materials into the surrounding environment.



LEGEND		
I-84 Exit	Interstate Highway	CT Fastrak
CT Fastrak Station	US Highway	Park River Conduit
I-84	Major Road	Water
Study Area	Local Road	Natural Diversity Database State-Listed Species Habitat Polygon
City Boundary	Railroad	

Sources of Data: City of Hartford, CT DEEP, ESRI, USGS

Notes: Colors/elements outside of study area muted intentionally.

0 500 1,000 Feet

The I-84 Hartford Project

Threatened and Endangered Species Map

Date: 4/30/2014 | Drawn By: AECOM | Figure No: 4-20

Many of these properties are operations that associated with auto repair, automotive service stations, and manufacturing. The potential environmental concerns would typically result from poor maintenance and housekeeping practices over long periods of time or from the uncontrolled discharge of materials stored in either aboveground or underground storage tanks. Many of the historic properties identified were found to have once contained one or more gasoline storage tanks, as well as the discovery of numerous automotive service stations (identified on the Sanborn Maps as Filling Stations), many of which haven't been in operation for over 50 years. In addition, many of the historic properties were identified as auto repair shops or machine shops which typically never properly stored and disposed of petroleum and other fluids used in their operations.

Federal, State, and Local environmental databases have been compiled and summarized into a report. Those databases contain information regarding current properties which have been identified by Federal, State and local government agencies as impacting or having the potential to impact the environment. These databases include known hazardous waste sites, sites undergoing investigation and/or remediation under the Connecticut Property Transfer Act, leaking underground storage tanks (UST), regulated underground and above ground storage tanks, and spills.

Our review of the database report has identified several hundred properties within the Study Area which may have or have been identified as having impacted the surrounding environment. Many of these properties have already undergone some type of remediation (such as a removal of a leaking UST) or are currently being investigated for potential environmental impacts. Other properties have been identified as having the potential to impact the environment and as such, a future investigation will be required if the proposed action will need to disturb sites identified as having potential environmental impacts. Other potential impacts to the environment within the corridor include larger spills on I-84 as a result of motor vehicle accidents.

Because of the large number of sites listed on the various databases reviewed, and the knowledge that many of the database listings are associated with minimal discharges, the summary spreadsheet does not include the following sites:

- Facilities currently with USTs that are not identified to have had any releases into the surrounding environment
- Facilities where documentation indicates USTs were removed with no environmental impacts identified
- Sites where petroleum spills and discharges (other than gasoline) are less than 100 gallons
- Sites where gasoline and other hazardous materials are less than 50 gallons
- Sites where sewage has been discharged
- Leaking aboveground storage tanks inside basements or within secondary containment
- Properties listed on the database as Orphan sites; meaning that their specific location cannot be identified

Once further evaluation has been conducted to narrow the Study Area, the review of locations of potential environmental impacts based upon the summary spreadsheets developed for both the Sanborn Fire Insurance Maps and the EDR Database Report.

4.17 Prime Farmland Soils

Prime farmland, as defined by the United States Department of Agriculture (USDA), is the land that is best suited to producing food, feed, forage, fiber, and oilseed crops. It has the soil quality, growing season, and moisture supply needed to economically produce a sustained high yield of crops when it is treated and managed using acceptable farming methods. The Study Area contains five prime farmland soil units and three statewide farmland soil units as illustrated on Figure 4-21, following, and listed in Table 4-22, below.

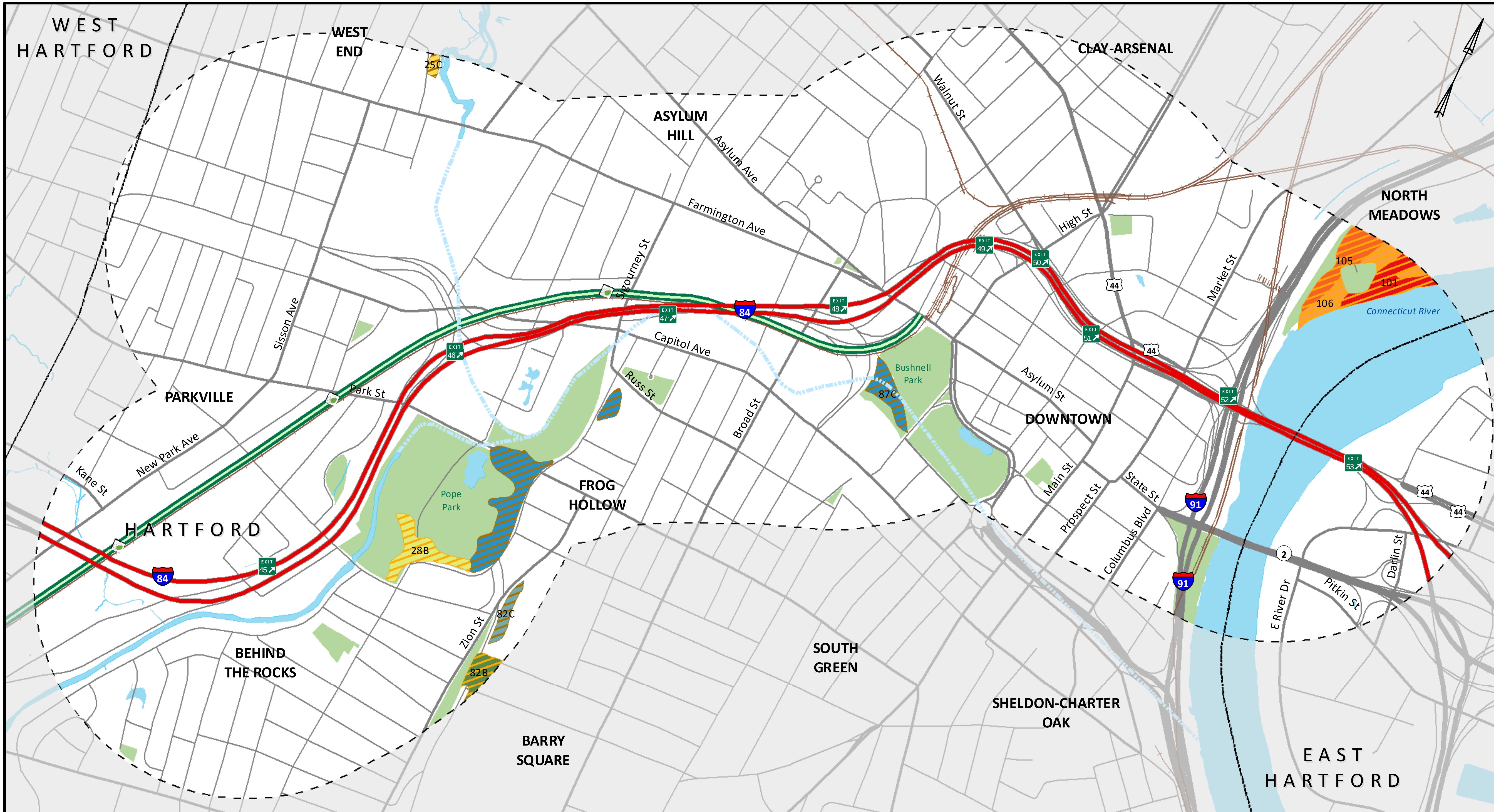
Table 4-22: USDA Prime Farmland Soils within the Study Area

Soil Map Unit Symbol	Name	Percent Slope	Prime or Statewide Importance
28B	Elmridge fine sandy loam	3-8	Prime
82B	Broadbrook silt loam	3-8	Prime
101	Occum fine sandy loam	Nearly level	Prime
105	Hadley silt loam	Nearly level	Prime
106	Winooski silt loam	Nearly level	Prime
25C	Brancroft silt loam	8-15	Statewide
82C	Broadbrook silt loam	8-15	Statewide
87C	Wethersfield loam	8-15	Statewide

Source: United States Department of Agriculture, *Natural Resources Conservation Service Soil Survey of the State of Connecticut*, 2003.

Prime farmland soils could be used as cropland, pastureland, rangeland, forestland, or other land. Urbanized land and water are exempt from consideration as prime farmland. Within the Study Area, prime farmland soils exist on land occupied by open space areas such as parks and playgrounds, and along the alluvial and floodplain areas associated with the Connecticut River, see Figure 4-21, following.

Farmland of statewide importance is land that is designated by the CT DEEP as areas with soils that fail to meet one or more of the requirements of prime farmland, but are important for the production of food, feed, fiber, or forage crops. They include those soils that are nearly prime farmland and that economically produce high yields of crops when treated and managed according to acceptable farming methods. While the Study Area contains soil types suitable for farming, the areas identified on the map are not actively farmed and are not protected farmland soils since they have been converted to urban uses.



LEGEND

- I-84 Exit
- CT Fastrak Station
- I-84
- Study Area
- City Boundary
- Interstate Highway
- US Highway
- Major Road
- Local Road
- Railroad
- CT Fastrak
- Park River Conduit
- Park
- Water
- Prime Farmland Soil
- Farmland Soil of Statewide Importance
- Occum fine sandy loam
- Hadley silt loam
- Winooski silt loam
- Brancroft silt loam, 8-15% slopes
- Elmridge fine sandy loam, 3-8% slopes
- Broadbrook silt loam, 3-8% slopes
- Broadbrook silt loam, 8-15% slopes
- Wethersfield loam, 8-15% slopes

Sources of Data: City of Hartford, CT DEEP, ESRI

Notes: Colors/elements outside of study area muted intentionally.

0 500 1,000 Feet

The I-84 Hartford Project

Farmland Soil Map

Date: 4/30/2014	Drawn By: AECOM	Figure No: 4-21

4.18 Noise

A noise assessment is proposed to document the potential impacts associated with the I-84 Hartford Project. The traffic noise assessment would be conducted in accordance with the CTDOT's *Highway Traffic Noise Abatement Policy for Projects Funded by the Federal Highway Administration* (dated July 2011). Future noise levels from the proposed I-84 Hartford Project alternatives would be evaluated at noise-sensitive receptors identified within the Study Area. Based on an initial review and screening of the Study Area, several noise-sensitive receptors were identified including residences, parks (Bushnell Park), churches, libraries, hotels, and office buildings. Using traffic data developed for each of the project alternatives, future noise levels would be predicted at discrete sites selected to be representative of the noise-sensitive receptors identified as part of this initial screening assessment.

To document traffic noise impacts and in accordance with the CTDOT noise policy, baseline noise levels will be measured at select locations to document existing traffic noise exposure. A prediction model will also be developed using the Federal Highway Administration's (FHWA) *Traffic Noise Model* (currently TNM 2.5) to validate the measured noise levels. Using this validated approach, the prediction model will be updated to reflect each of the proposed project alternatives. The future traffic noise levels at the representative modeling sites would be predicted using traffic data that reflects the highest volumes typically with Level of Service (LOS) "C" or better. The traffic prediction model would reflect the proposed terrain and roadway edge conditions to accurately reflect any structural shielding and attenuation. If the future traffic noise levels are predicted to exceed the FHWA and CTDOT noise abatement criteria (NAC), candidate mitigation measures would be identified and evaluated using the "feasibility and reasonableness" criteria included in CTDOT's noise policy.

To assess the noise impacts due to temporary construction activities, FHWA Roadway Construction Noise Model (RCNM) will be used to determine the areas of potential adverse effects and the types of control measures that may be required to mitigate these impacts.

In the event the railroad line is relocated as part of the preferred alternative for the I-84 Hartford Project, a noise assessment would be completed in accordance with FRA's Noise and Vibration Assessment Methodology. The FRA uses the Federal Transit Administration (FTA) Noise and Vibration Impact Assessment procedures outlined in "Transit Noise and Vibration Impact Assessment," May 2006. FRA's Railroad Noise Emission Compliance Regulation (49 CFR Part 210) prescribes compliance requirements for enforcing railroad noise emission standards adopted by the EPA (40 CFR Part 201). While not a rule or standard, the guidance is intended to satisfy NEPA documentation and assist project sponsors in addressing predicted construction and operation noise and vibration during the design process. Construction noise would also be evaluated using FRA and FTA guidelines should the railroad track be relocated as part of the Preferred Alternative for this project.

4.19 Air Quality

An air quality assessment is proposed to document the potential impacts associated with the I-84 Hartford Project. This detailed assessment would be prepared to demonstrate that the proposed project alternatives comply with the most current National Ambient Air Quality Standards (NAAQS) established by the US Environmental Protection Agency (EPA). Additionally, this detailed analysis is intended to demonstrate that the project complies with the 1990 Clean Air Act Amendments (CAAA) particularly the transportation conformity rule (TCR), which includes compliance with the provisions of the Connecticut State Implementation Plan (SIP).

The Project is located in Hartford County, which is currently designated by the US Environmental Protection Agency (EPA) as marginal nonattainment for ozone (O_3) and a maintenance area for carbon monoxide (CO) due to violations before 1996. Therefore, the project must demonstrate transportation conformity on a project level that future regional emissions for six criteria pollutants (including CO, ozone, particulate matter (PM), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and lead (Pb)) under the proposed Build Alternatives do not increase over future No Build or No Action Conditions. Similarly, the project must also demonstrate that concentrations at localized hot spots or congested intersections do not exceed the NAAQS for carbon monoxide for which the region is currently a maintenance area.

The air quality effects expected during temporary construction activities would also be described qualitatively with a focus on mitigation measures. Typical air quality mitigation measures may include good housekeeping such as dust suppression and control methods to minimize fugitive dust on dry and windy days.

The air quality assessment proposed for the Project will demonstrate that this project does not interfere with the attainment or maintenance of the NAAQS and that it does conform to the provisions of the Connecticut SIP.

4.20 Consistency with State Plan

The Conservation & Development Policies: The Plan for Connecticut for 2013-2018 (State C&D Plan) and the *Locational Guide Map* (LGM) were consulted to determine whether the Project is consistent with the State C&D Plan. The State C&D Plan was prepared by the Office of Policy and Management in accordance with Connecticut General Statutes Section 16a-29 and provides relevant policy statements for state agencies to assess the consistency of their proposed plans and actions with the State C&D Plan.

The State C&D Plan LGM classifies parcels as one of the following: Priority Funding Areas, Balanced Priority Funding Area, Village Priority Funding Area, Conservation Area, Protected Lands, Undesignated Lands, Local Historic District, Water, or Regional Center. Within the Study Area, parcel classifications include Priority Funding Areas, Balanced Priority Funding Areas, Conservation Areas, Local Historic District, and Protected Lands. These classifications are illustrated on Figure 4-22, following. These State C&D Plan LGM classifications are defined below:

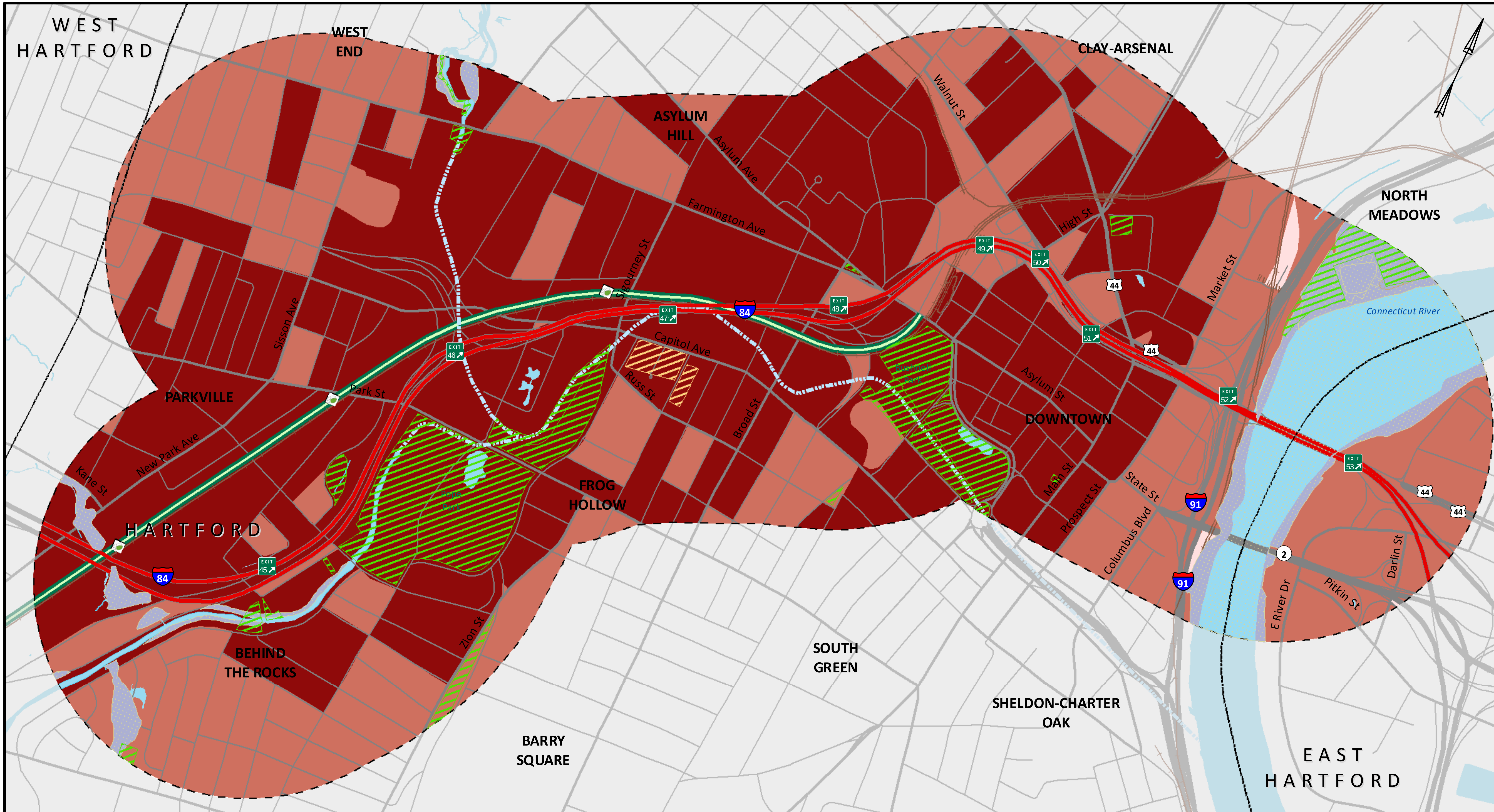
Priority Funding Areas are classified by Census Blocks that include:

- Designation as an Urban Area or Urban Cluster in the 2010 Census
- Boundaries that intersect a ½ mile buffer surrounding existing or planned mass-transit stations
- Existing or planned sewer service from an adopted Wastewater Facility Plan
- Existing or planned water service from an adopted Public Drinking Water Supply Plan
- Local bus service provided 7 days a week

Balanced Priority Funding Areas are classified as areas that meet the criteria of both Priority Funding Areas and Conservation Areas (Conservation Areas are defined below).

Conservation Areas are delineated based on the presence of factors that reflect environmental or natural resource values, and includes any one or more of the following factors:

- Core Forest Areas Greater than 250 acres based on the 2006 Land Cover Dataset
- Existing or potential drinking water supply watersheds
- Aquifer Protection Areas
- Wetland Soils greater than 25 acres
- Undeveloped Prime, Statewide Important and locally important agricultural soils greater than 25 acres
- Category 1,2 or 3 Hurricane Inundation Zones
- 100 year Flood Zones
- Critical Habitats; and
- Locally Important Conservation Areas



LEGEND

- I-84 Exit
- CT Fastrak Station
- I-84
- Study Area
- City Boundary
- Interstate Highway
- US Highway
- Major Road
- Local Road
- Railroad
- CT Fastrak
- Park River Conduit
- Water

Priority Funding Area

- 1 - 2 Criteria
- 3 - 4 Criteria
- 5 Criteria
- Balanced Priority Funding Area

Conservation Areas

- 1 - 3 Factors
- 4 - 5 Factors
- Protected Land
- Local Historic District

Sources of Data: City of Hartford, CT DEEP, ESRI, CT OPM

Notes: Colors/elements outside of study area muted intentionally.

0 500 1,000 Feet

The I-84 Hartford Project

State Plan of Conservation and Development Map

Date: 4/30/2014 | Drawn By: AECOM | Figure No: 4-22

Local Historic Districts are established by the community to help ensure that the distinctive and significant characteristics of each district are protected, by having local preservation commissions review architectural changes for compatibility.

Protected Lands are lands that have some form of restriction on development, such as permanently protected open space or property in which the development rights have been acquired.

The purpose of the Project is to address structural deficiencies, improve traffic operations and safety, and reduce congestion on the I-84 mainline and interchanges in Hartford on I-84 between the Flatbush Avenue and the I-91 Interchanges. Addressing these deficiencies would allow I-84 to continue to serve as a vital link in the interstate highway system in the Northeast and provide needed access to Hartford business districts and the State Capitol. These improvements would also enhance access, safety and mobility for vehicular traffic, bicycles, and pedestrians within the Study Area. At the same time, the Project would strive to reduce the highway's footprint on the city, create linkages to existing and proposed future modes of transportation, and support the City of Hartford's economic development goals.

Therefore, the scope, purpose and proposed outcome of the I-84 Hartford Project are all consistent with the State C&D Plan's six growth management principles (GMPs), which are detailed below.

Growth Management Principle #1 (GMP 1): Redevelop and revitalize regional centers and areas with existing or currently planned physical infrastructure.

The Project would entail improvements and improve safety of an existing physical infrastructure. Improved traffic flow through the City of Hartford would help to revitalize the downtown of the State's capital and fourth largest city as well as the surrounding capital region.

Growth Management Principle #2 (GMP 2): Expand housing opportunities and design choices to accommodate a variety of household types and needs.

Because the Project would address access, safety, and mobility for vehicular traffic, bicycles, and pedestrians in the area, the Project would ultimately improve people's access to affordable and mixed use neighborhoods and connectivity to the downtown Hartford area.

Growth Management Principle #3 (GMP 3): Concentrate development around transportation nodes along major transportation corridors to support the viability of transportation options.

I-84 is an existing major transportation corridor that bisects the city of Hartford and serves as a critical east-west transportation link between New York and Massachusetts. It provides connectivity to and from Interstate 91 in Hartford and Route 2 in East Hartford. Within the Project area are the Hartford Line, formerly the New Haven-Hartford-Springfield (NHHS), high-speed rail corridor and the CT*fastrak* bus rapid transit system. While improving access between New York and Massachusetts is key, it is also essential that the points in between, including Hartford, are included into the economic web of the region and market. The planning, design, construction, and operation of the I-84 Hartford Project would accommodate municipal and state plans and the needs of all users to the extent possible.

Growth Management Principle #4 (GMP 4): Conserve and restore the natural environment, cultural and historical resources, and traditional rural lands.

The Project would not result in significant impacts to natural resources, cultural and historic resources, or traditional rural lands.

Growth Management Principle #5 (GMP 5): Protect and ensure the integrity of environmental assets critical to public health and safety.

The Project would not impact public drinking water supplies and existing groundwater resources, or have any effect on surface water resources or floodplains. By improving traffic flow and reducing congestion, the Project would reduce carbon dioxide emissions and be consistent with the recommendations of the Connecticut Climate Change Preparedness Plan.

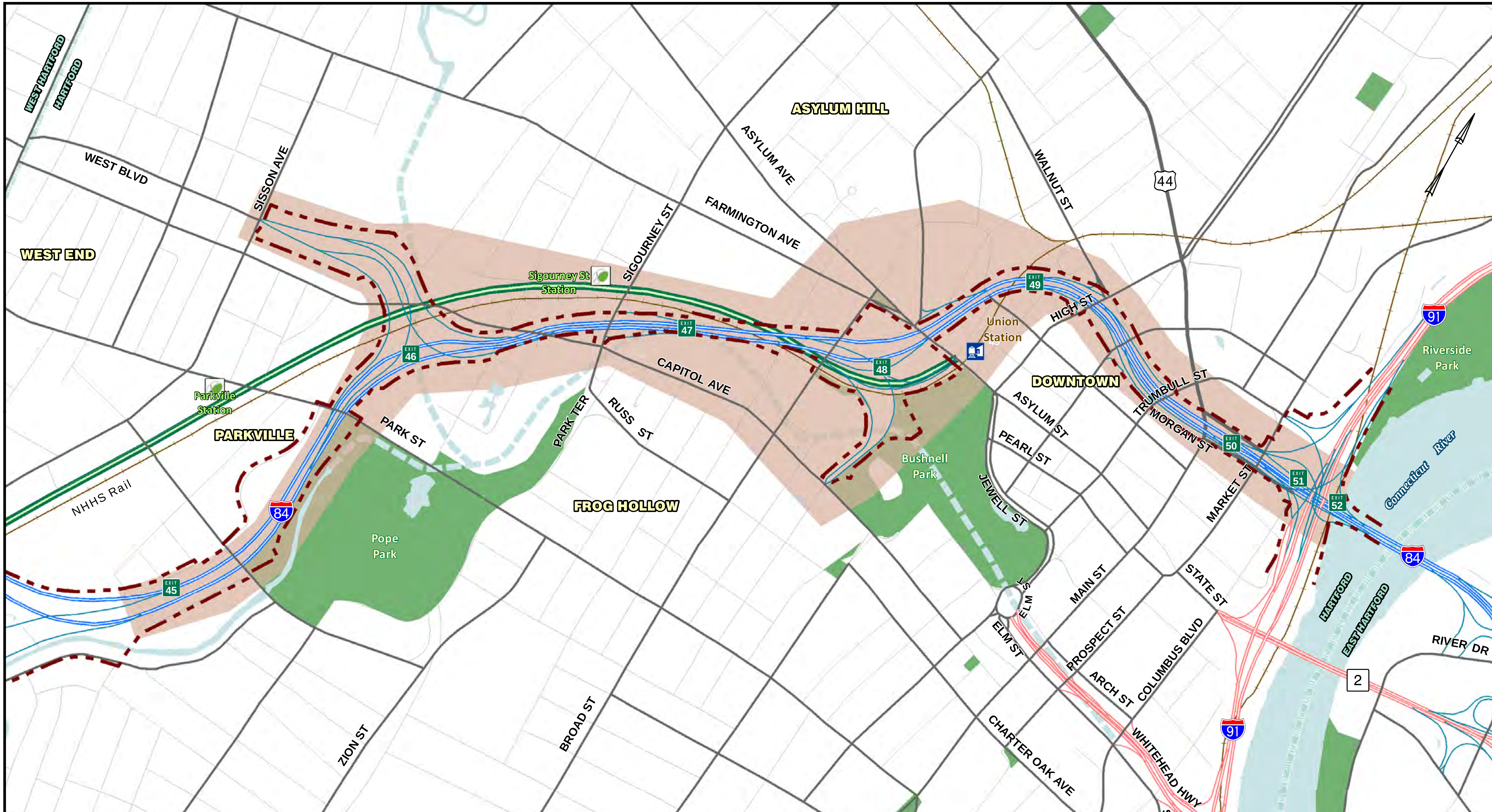
Growth Management Principle #6 (GMP 6): Promote integrated planning across all levels of government to address issues on a statewide, regional, and local basis.

The Project would comply with the goals and objectives of the local, regional, and statewide government planning organizations. The Project Team has established a Public Advisory Committee comprised of members of the civic and governmental agencies and/or organizations with responsibilities and interests in the project Study Area. The Project Team has also developed a (draft) Agency Coordination Plan to provide a framework for communicating and coordinating with the federal and state agencies that have been identified as participating and/or coordinating agencies for the environmental review of this project.

4.21 Right-of-Way and Property Impacts

The existing right-of-way (ROW) for I-84 and its ramps has been evaluated and illustrated in Figure 4-23, following. The source for the ROW mapping is the City of Hartford GIS database. As the Project advances, detailed aerial survey will provide more accurate property and ROW lines. With a few exceptions, the existing ROW line for I-84 is located within 50 feet of the edge of pavement, creating a constrained corridor. Off-line realignment (for permanent or temporary conditions) or widening of the highway to add standard-width shoulders is likely to have ROW and property impacts. These impacts will be documented further through the Alternatives Analysis phase.

Notable areas include the area south of Park Street, where CTDOT acquired ROW for a set of interchange ramps which were not constructed. The Interchange 46 (Sisson Avenue) ramps occupy a large area which could be consolidated by redesign of the interchange. The large green space at the southwest quadrant of the Farmington Avenue/Broad Street intersection is within the I-84 ROW, as the original design of the highway included a pair of on- ramps in this location. This land is now vacant. Further development of alternatives will indicate potential areas of ROW and property impacts.



LEGEND

- Rights of Way
- Project Corridor
- Town/City Limit
- I-84
- I-84 Ramp
- Other Freeway
- U.S. Highway/State Road
- Major Road
- Park River Conduit
- I-84 Exit #
- Union Station
- Park
- Water
- CTfastrak
- CTfastrak Station

0 500 1,000 Feet

Sources of Data: City of Hartford, CT Transit, City of Hartford

The I-84 Hartford Project

Rights of Way Map

Date: 1/12/2015	Drawn By: TranSystems	Figure No: 4-23

4.22 Summary of Socioeconomic and Environmental Constraints

This chapter has identified the various community, cultural, and environmental resources that exist within the Study Area surrounding the Project Corridor in Hartford. Key resources and constraints are illustrated in Figure 4-24, following. While not prohibitive to development and construction, certain steps must be taken to avoid, minimize, or mitigate impacts to the community, environmental, and historic resources. Within the Study Area, there are historic and cultural resources, environmental justice communities, parks, potential contamination sites, and water resources. Each of these resources is described above and will be representative of the key issues that will need to be evaluated as the project progresses and various alternatives are developed.

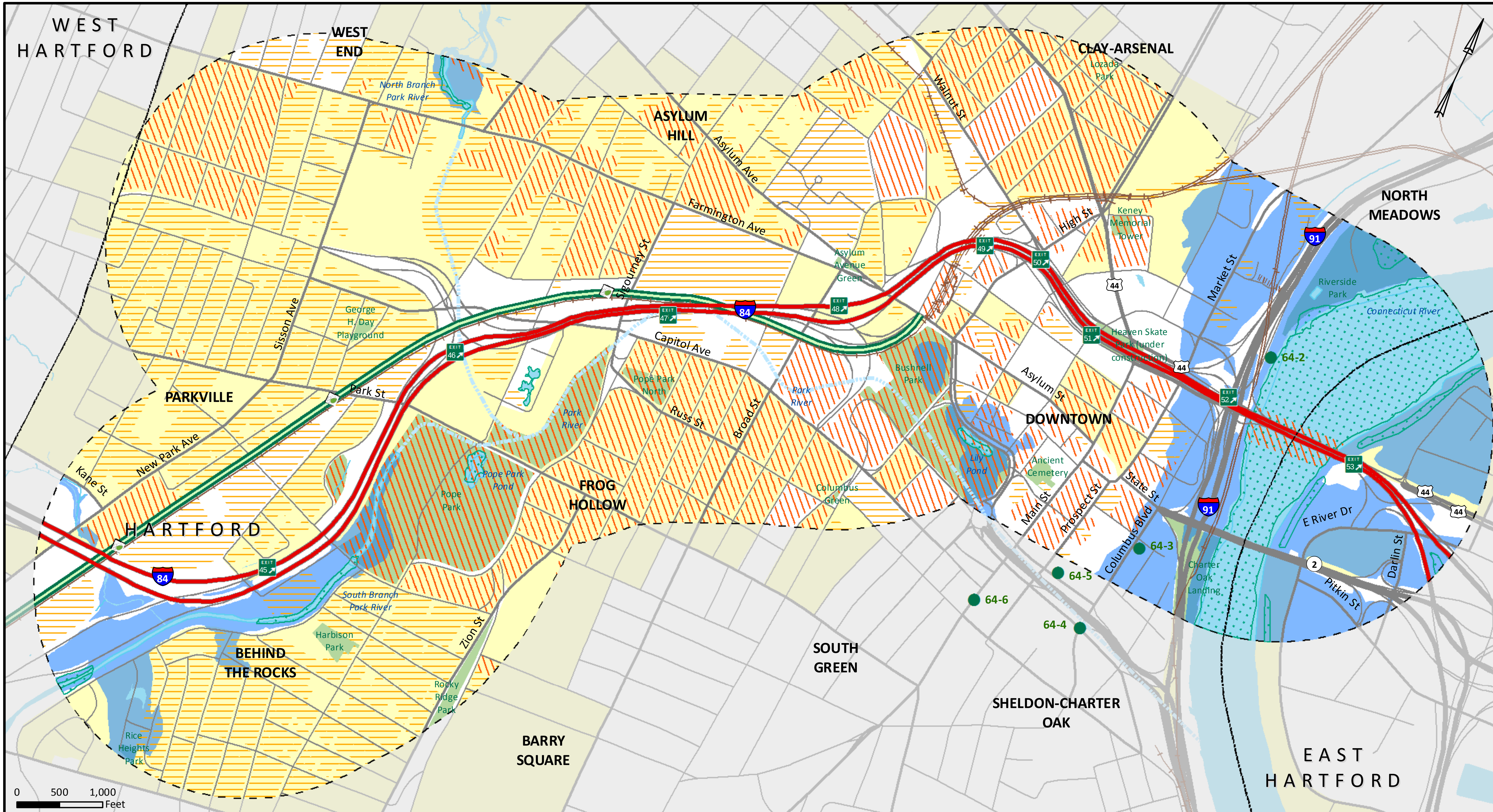
Hartford is a historic city. More than two thirds of the structures within the Study Area have been standing for more than 50 years. Some historic resources are located immediately adjacent to the I-84 right-of-way, such as Union Station, US Post Office and Federal Building, Footguard Hall, and the Bulkeley Bridge, as well as the Ann Street and Downtown North Historic Districts. Other buildings, which may potentially be listed on the historic register within the next few years, are located within close proximity to the I-84 corridor.

Within the Study Area exists potential environmental justice communities that must be addressed in the I-84 Hartford Project. These communities are numerous and varied and are defined based on low-income, minority status, limited English proficiency, and the availability of personal vehicles for transportation. Potential environmental justice communities, regardless of their definition, abut the I-84 corridor in the Behind the Rocks, Frog Hollow, Downtown, and Asylum Hill neighborhoods. Impact assessment and public outreach to these communities will play a significant role as the project progresses and applicable regulatory guidelines are followed.

The Study Area boasts several parks and recreation areas. Pope Park is located on both sides of the I-84 corridor in the Frog Hollow neighborhood. Heaven Skate Park in Downtown opened in July 2014. Also in Downtown is the State/National Register-listed Bushnell Park.

The eastern and western edges of the Study Area are filled with water resources, including the Connecticut River to the east and the Park River to the west. The flood zones for these water features extend into the I-84 corridor. The Park River Conduit crosses under I-84 near Interchange 46 and runs parallel to the corridor between Sigourney and Flower Streets.

As stated, while these potential constraints do not prohibit development in the study corridor, it is important to note that resources exist within or in close proximity to the study corridor and as the NEPA/CEPA process progresses, they will be fully evaluated. As alternatives are developed, impacts to these resources will be quantified and, in accordance with regulatory requirements, avoidance, minimization, and mitigation of these impacts will be a primary focus.



LEGEND

- I-84 Exit
- CT Fastrak Station
- I-84
- Park
- Interstate Highway
- US Highway
- Major Road
- Local Road
- Railroad
- CT Fastrak
- Study Area
- City Boundary
- Park River Conduit
- Wetlands
- Floodway/Flood Zone
- Surface Waters
- EJ Population
- Listed Historic Resource
- Potential Historic Resource
- Archaeological Site

Sources of Data: City of Hartford, ESRI, CT DEEP, National Register of Historic Places, CDOT, US Census Bureau 2010

Notes: Colors/elements outside of study area muted intentionally.

The I-84 Hartford Project

Study Area Constraints Map

Date: 4/30/2014	Drawn By: AECOM	Figure No: 4-24