Transportation Planning Study
I-293 Exits 6 and 7
(Manchester #16099)

Prepared for
New Hampshire
Department of Transportation

In partnership with
City of Manchester
Town of Goffstown
Town of Hooksett

Prepared by
Vanasse Hangen Brustlin, Inc.
Bedford, New Hampshire

In association with
Southern New Hampshire Planning Commission
RKG Associates

December 2013

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December 2013 (Final Report)

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Executive Summary

A. Introduction/Background

The New Hampshire Department of Transportation (NHDOT) has retained a Study Team lead by Vanasse Hangen Brustlin, Inc. (VHB) to conduct a Transportation Planning Study aimed at addressing capacity and safety related deficiencies along I-293/F.E. Everett Turnpike at the Exit 6 and Exit 7 interchanges in Manchester, New Hampshire. The study also considers relocating or reconfiguring Exit 7 into a full directional interchange.

The purpose of the study is to evaluate potential broad transportation system changes and establish a range of practicable alternatives. Further development of alternatives and more detailed evaluation will be required under the National Environmental Policy Act (NEPA) phase of the project.

B. Study Area

The study corridor begins just north of Exit 5 (Granite Street) near the West Bridge Street overpass, winding between the Merrimack River to the east and the Amoskeag Millyard Historic District to the west. I-293 continues northerly through Exit 6 (Amoskeag Street) and Exit 7 (Front Street). The study corridor extends for approximately another mile where alternatives for a new fully directional interchange replacing the existing Exit 7 are being examined.

C. Public Outreach

The study includes an open and consensus-driven public participation process. A Technical Advisory Committee comprised of public officials, business leaders, and community representatives met regularly (9 meetings). Five public informational meetings, one of which was an informal workshop, were held in an effort to share information and solicit public input. A study website allowed the public to review study documents, follow the progress of the study, and submit questions, comments, or ideas to the Study Team. Other forms of communication include distribution of a newsletter describing the alternatives being evaluated and frequent e-mail communication with stakeholders and members of the public.

D. Problem Areas

Based on the results of an existing conditions analysis, field observations, and public input, a list of problem areas were identified. The following is a list of some of the issues that were identified.

Exit 6

- Substandard I-293 mainline segment between Exits 5 and 6 (curve radius and super-elevation)
- I-293 "Red List" bridges crossing Black Brook
- Vehicle queuing back onto I-293, particularly at the Exit 6 northbound off-ramp
- High speed weaving
- Short on-ramps with limited acceleration length
- High frequency of vehicular crashes
- Confusing maneuvers and vehicular congestion at the Exit 6 Amoskeag Circle
- Impact of highway noise on nearby residential communities

Exit 7

- Restricted truck access between Goffstown and I-293
- Congestion and safety concerns at the Manchester Community College driveway on Front Street (NH 3A)
- Absence of ramps to/from the north at Exit 7
- Proximity of Exit 6 and 7 interchanges causing operational challenges

E. Alternatives

Having identified the existing and potential future capacity and safety deficiencies and having solicited input from the public and the Technical Advisory Committee on defining the study area problems, issues, constraints, and potential solutions, a practicable range of alternatives were developed. In addition to a No Build, Transportation Demand Management (TDM), and Transportation System Management (TSM) alternatives, a range of long-term mainline and interchange Build alternatives were developed and evaluated.

The No Build alternative will not meet the study purpose. Capacity analyses performed for the existing I-293 freeway segments and ramps under the 2035 No Build alternative show substantial degradation in traffic operations. Many of the freeway segments and ramp junctions are expected to degrade to LOS E or F. All but two of the nine signalized intersections are expected to operate at a LOS D or worse.

Transportation Demand Management (TDM), encompassing a wide range of strategies designed to change personal travel behavior, can result is a reduction in demand for automobile use and in the need to construct additional roadway capacity. TDM actions alone will not meet the study purpose. However, TDM actions need not be an either/or alternative

but could be implemented in conjunction with a Build alternative. There is a wide-range of TDM strategies and actions that have the potential to reduce vehicular travel demand. These actions will be further developed and evaluated in more detail under Part B of the study (Environmental Documentation).

Transportation System Management (TSM) strategies are generally low cost, easy to implement actions aimed at optimizing the performance of the existing transportation system. Some examples of TSM actions include traffic signal coordination, access management, and incident management. Based on feedback from the public NHDOT forces cut back growth along the east side of I-293, south of the Exit 6 northbound off-ramp. This low cost and easy to implement action had an immediate effect of improving driver sight lines as motorists approach the interchange. In addition, the NHDOT is evaluating opportunities to install dynamic message boards along I-293 aimed at alerting southbound motorists of peak period congestion at the Exit 6 ramps. Other actions being considered include increasing the storage capacity of the Exit 6 northbound off-ramp by widening the ramp to provide two-lanes, with possible traffic signal enhancements at Amoskeag Street. These actions will be further developed under Part B.

Three mainline alternatives were considered. One alternative maintained the existing two travel lanes per direction while upgrading only the interchanges. The other two alternatives involve expanding the mainline section to three lanes each direction along with upgrading the interchanges. The difference between the two three-lane alternatives is that in the southern segment of the corridor one alternative widens to the east towards the Merrimack River while the other alternative widens to the west towards the Amoskeag Millyard Historic District.

Five alternatives were considered at Exit 6 including a Single Point Urban Interchange (SPUI), a standard Diamond Interchange, an Off-set Diamond Interchange, a Diverging Diamond Interchange (DDI), and a Diamond Interchange with Roundabouts.

Five alternatives were considered at Exit 7. One of those alternatives involves reconstructing the existing Exit 7 partial interchange to a fully directional interchange at its existing Front Street location. The other four alternatives involve relocating the existing interchange to a new fully directional interchange to the north. The four relocated alternatives have the same interchange configuration. The alternatives differ in that two of the options consider different locations intersecting Front Street to the east. Two options are considered for providing connection to the west, with one extending to Dunbarton Road. The other alternative extends westerly across Black Brook to Goffstown Road.

F. Key Findings

I-293 Mainline

Meeting the study purpose will likely necessitate the widening and reconstructing of the I-293 mainline from its current four-lane divided highway configuration to a modern six-lane divided highway for most of the study corridor. However, the projected travel demand for the segment through and north of Exit 7 would suggest that an upgraded four-lane divided highway section could be retained through this area. Regardless of the number of lanes that would be initially constructed, consideration should be given to constructing the Exit 7 interchange to accommodate a full six-lane divided highway.

Potential Impacts to the Merrimack River

The Merrimack River, which flows along the easterly edge of the study area directly adjacent to I-293 and a portion of Front Street, is the most prominent environmental resource occurring within the study area and is regionally an important water resource. Additionally, two perennial tributaries, Black Brook and Milestone Brook, drain from the west with their watersheds primarily located in communities of Manchester, Dunbarton and Goffstown. However, the Merrimack River is known to have water quality impairments and its existing water quality is not sufficient to fully support all designated uses.

A primary factor influencing water quality is the amount of impervious surface in a watershed. Larger percentages of impervious surfaces are associated with decreased water quality. Increased runoff, if not properly managed, may have a variety of impacts to the Merrimack River. These potential impacts include increased pollutant loading, increased flooding, erosion of stream banks and drainage ways, warming of stream waters, and decreased groundwater base flow due to less infiltration. Thus, because all of the study alternatives that propose to expand the pavement surface will result in increased imperviousness, careful study and management of the potential impact to the Merrimack River and its tributaries will be a critical issue during subsequent project phases.

Balancing Impacts to Merrimack River and Historic Millyard

The 0.8-mile mainline segment, which begins just north of Exit 5, is constrained with the Amoskeag Millyard Historic District on the west and the Merrimack River on the east. Developing a workable alternative in this section will involve a tradeoff between impacts to the Merrimack River and the Millyard. Minimizing impacts to one resource may involve increased impacts to the other. Widening the highway to the east may result in impacts to the river, whereas widening to the west may impact the Millyard. Balancing these impacts and choosing a preferred alternative will be a key issue during the NEPA phase. Substantial regulatory protection is in place for both floodplain and riverbank impacts (e.g., NH RSA 482-A relative to dredge and fill in wetlands, the Clean Water Act Section 404 and Executive Order 10988), as well as impacts to historic resources (e.g., Section 106 of the National

Historic Preservation Act and Section 4(f) of the USDOT Act, which requires demonstration that no prudent or feasible alternative exists to the "use" of historic property).

Exit 6

Of the five alternative configurations evaluated at Exit 6, the Single Point Urban Interchange (SPUI) will meet the study purpose, provide acceptable operating conditions, and will distribute traffic flow well. The Front Street/Eddy Road connection to Amoskeag Street will be provided by a bridge separated from the ramp movements that will be accommodated at the SPUI. Each of the diamond interchange configurations, with the exception of the Diamond Interchange with Roundabouts, will also meet the study purpose and provide acceptable operating conditions. However, these configurations may not distribute traffic flow as well as the SPUI.

The proximity of the traffic signal controlled northbound ramps and the traffic signal controlled Amoskeag Street intersection show potential queuing problems under the Standard Diamond Interchange Alternative and the Diverging Diamond Interchange Alternative. The Diamond Interchange with Roundabouts Alternative does not operate well (Level of Service F) and will not meet the study purpose and should be eliminated from further consideration.

Exit 7

Reconfiguring Exit 7 to provide full directional connectivity to I-293 at its current Front Street location will moderately meet the capacity and safety study purpose. However, the spacing between the existing location and Exit 6 will necessitate an additional weaving lane in each direction on I-293 between the interchanges. Additionally, reconstructing the interchange at its existing location will fail to meet the City of Manchester's desire to support connectivity to the Hackett Hill area and the Town of Goffstown's desire to support connectivity between I-293 and the town's industrial zoned land.

Each of the alternatives that involve relocating the Exit 7 interchange to the north will operate well and meet the capacity and safety study purposes. The relocated interchange alternatives that provide a westerly connection to Dunbarton Road will meet the City of Manchester's desire to support connectivity to the Hackett Hill area. However, only the alternatives that extend westerly to Goffstown Road, crossing Black Brook, will meet the Town of Goffstown's desire to support connectivity between I-293 and the town's industrial zoned land.

Crossing of Black Brook

During the course of the study, members of the public and Town of Goffstown officials expressed a strong desire to create a direct connection between I-293 and Goffstown. In response to the public comments, Alternatives 10A and 10B were developed. Both alternatives will construct a (0.7-mile) Goffstown Connector Road. This extension will require construction of a new bridge over Black Brook. The creation of a new crossing of this perennial tributary to the Merrimack River stands out as a potential impact that will need further study during the next project phase.

Benefits of Enhanced Regional Highway Access

In addition to the immediate and direct benefits associated with highway improvements (safety, increased capacity, improved level of service), there is the potential for indirect and induced economic benefits within a broader regional context.

Regardless of the selected alternative, improvements to Exit 6 will allow for improved connectivity between downtown Manchester to points north and south. Downtown Manchester serves as a regional employment and financial services hub within the State of New Hampshire. Due to the availability of existing office and light industrial/research & development (R&D) space, it has the capacity to increase the workforce. Easier access to and from the downtown area may accelerate existing economic development trends, leading to higher employment within the region.

Similarly, the relocation of Exit 7 will enhance accessibility to existing and potential job generation areas. For example, the Hackett Hill Master Plan calls for a total build-out of over a million square feet of office and R&D space. The various Exit 7 alternatives may accelerate the development of new facilities and create jobs. In addition, Alternatives 10A and 10B include improved access to Goffstown Road linking undeveloped industrial zoned land in the Town of Goffstown with I-293. This improved access may accelerate development of this property and increase the tax base for both communities.

G. Next Steps

The evaluation presented in this planning study phase identifies key issues on a conceptual basis, and should not be interpreted as a conclusive study of impacts. More formal analysis of impacts will need to occur during the next preliminary design and environmental analysis phase with the more detailed evaluation of the alternatives under the National Environmental Policy Act (NEPA). NEPA is a comprehensive federal law that applies to all projects that may receive federal funds for any portion of the financing or licensing for the project. The main provision of NEPA requires an Environmental Impact Statement (EIS) be written for all "major federal actions" which may have a "significant impact" on the environment. However, NEPA permits an Environmental Assessment (EA) to be prepared for an action where the significance of the social, economic, and environmental impacts are not clearly established. The NEPA study under an EA will examine the project alternatives and impacts in greater detail with additional in-depth public involvement.

In addition to the federal requirements under NEPA, the NHDOT will need to prepare and submit an Interchange Modification Report (IMR) to the Federal Highway Administration (FHWA) under the next phase of the project study. The IMR is required because the project considers the reconfiguration and potential relocation of interstate system interchanges along the interstate system. This action serves as a formal request through FHWA to modify Exit 6

and Exit 7, regardless of the funding source of project. At a minimum, the interchange modification request will evaluate and document eight FHWA policy requirements. The IMR for the improvements along I-293 with Exit 6 and 7 must demonstrate that:

- *The existing system cannot accommodate the design-year traffic demands.*
- *All reasonable alternatives have been considered.*
- *The proposed change does not have a significant adverse impact on the safety and operation of the Interstate facility or on the local street network based on both the current and the planned future traffic projections.*
- *The proposed access connects to a public road only and will provide for all traffic movements.*
- *The proposal is consistent with local and regional land use and transportation plans.*
- *The proposal is consistent with any long-range system or network plan.*
- *When a new or revised access point is due to a new, expanded, or substantial change in current or planned future development or land use, requests must demonstrate appropriate coordination has occurred between the development and any proposed transportation system improvements.*
- *The proposal will be included as an alternative in the required environmental evaluation, review and processing.*

The FHWA approval of the interchange modifications and/or relocation constitutes a federal action, and as such, requires the NEPA process be followed. For this project, the preparation of the IMR and the NEPA documentation can be conducted concurrently through the next project development phase.

During the next project phase a review of funding sources will be necessary. Funding through FHWA, New Hampshire Turnpike Capital Program and local funds are potential sources to finance this project. I-293 is eligible for FHWA funding given that it is a "free section of the Turnpike" where motorists can access/egress the highway without paying a toll. Federal funds, if available, may also be used to support the infrastructure improvements along the access roads to the interchanges. Funding for right-of-way and/or construction within the Turnpike Capital Program would require specific legislative authority to the NHDOT and would likely be contingent on review of toll revenues to pay the expanded bonding authority. Other funding sources through local municipal contributions and/or public/private partnerships may be necessary for any desired system upgrades to the local roadway system.

1 Introduction

1.1 Study Purpose

The New Hampshire Department of Transportation (NHDOT) has retained a Study Team lead by Vanasse Hangen Brustlin, Inc. (VHB) to conduct a Transportation Planning Study aimed at addressing capacity and safety related deficiencies along I-293/F.E. Everett Turnpike at the Exit 6 and 7 interchanges in Manchester, New Hampshire. The study also considers relocating Exit 7 into a full directional interchange. The study (Part A) is the first part of a three part process. The study will be followed by Preliminary Engineering and Environmental Documentation (Part B) and Final Design Plans (Part C), and ultimate construction.

The purpose of the study is to evaluate and establish a range of practicable alternatives for further development, and more detailed evaluation under Part B. The study includes an assessment of existing and anticipated future deficiencies as well as the development and evaluation of a range of alternatives aimed at addressing the defined deficiencies.

1.2 Study Area

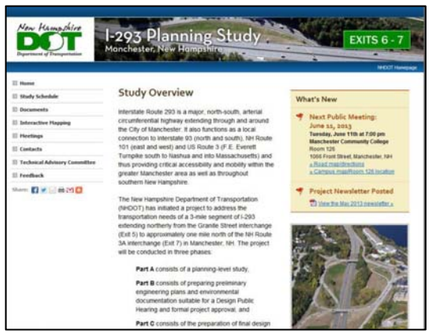
The I-293 study corridor begins just north of Exit 5 (Granite Street) near the West Bridge Street overpass, winding between the Merrimack River to the east and the Amoskeag Millyard Historic District to the west. I-293 continues northerly through Exit 6 (Amoskeag Street) and Exit 7 (Front Street). The study corridor extends for approximately another mile where alternatives for a new full directional interchange replacing the existing Exit 7 are being examined. The study area is shown in **Figure 1.2-1**.

Exit 6 provides connection to the east, and Downtown Manchester, by way of the Amoskeag Bridge, and to the west and, the Town of Goffstown, by way of Goffstown Road. The Manchester Landfill and Dunbarton Road are located on the west side of I-293 just north of Exit 7. To the east of I-293 and just north of Exit 7 is the Manchester Community College campus.

1.3 Public Participation Process

An open and consensus-driven public participation process that engages all stakeholders is an important element in the development and refinement of thoughtful transportation solutions. Good planning practice involves a mutual learning process among practitioners, elected officials, residents, business groups, citizen groups, and other affected parties. The thoughts, concerns, and ideas generated by the general public on study area transportation needs, problems, and solutions are critical to crafting and refining solutions that are practical, permittable, affordable, and context-sensitive.

The public participation process includes holding a series of public informational meetings and the establishment of a Technical Advisory Committee, comprised of public officials, business leaders, and community representatives. A study website (www.293planningstudy.com) provides the public with an opportunity to review study documents, presentation material, and meeting notes. The website also provides video of a number of the public presentations. Most importantly, the website provides a feedback page where individuals can submit questions, comments, or ideas, and correspond thru e-mail with the Study Team. A newsletter describing the conceptual alternatives was also distributed in advance of the June 2013 public meeting, in an effort to disseminate information about the study to the widest possible audience.



1.3.1 Technical Advisory Committee

A Technical Advisory Committee composed of public officials, business leaders, and community representatives met on a regular basis to review study progress. The Committee provided invaluable insight to the needs and desires of the communities, also serving as a "sounding board" in the development of transportation solutions. The Technical Advisory Committee members are as follows:

- Chris Wellington – City of Manchester
- David Beauchesne – City of Manchester
- Bruce Thomas – City of Manchester
- Mark Lemay – Town of Goffstown
- Carl Quiram – Town of Goffstown
- Tony Marts – Goffstown Citizen Rep
- Jo Ann Duffy – Town of Hooksett
- Leo Lessard – Town of Hooksett
- Will Stewart - Manchester Chamber of Commerce
- Barbara Cocci – Hooksett Chamber of Commerce
- Susan Huard – Manchester Community College
- Jeff Nyhan – Manchester Community College
- Tim White – Southern New Hampshire Planning Commission
- David Boutin – State Senator, District 16

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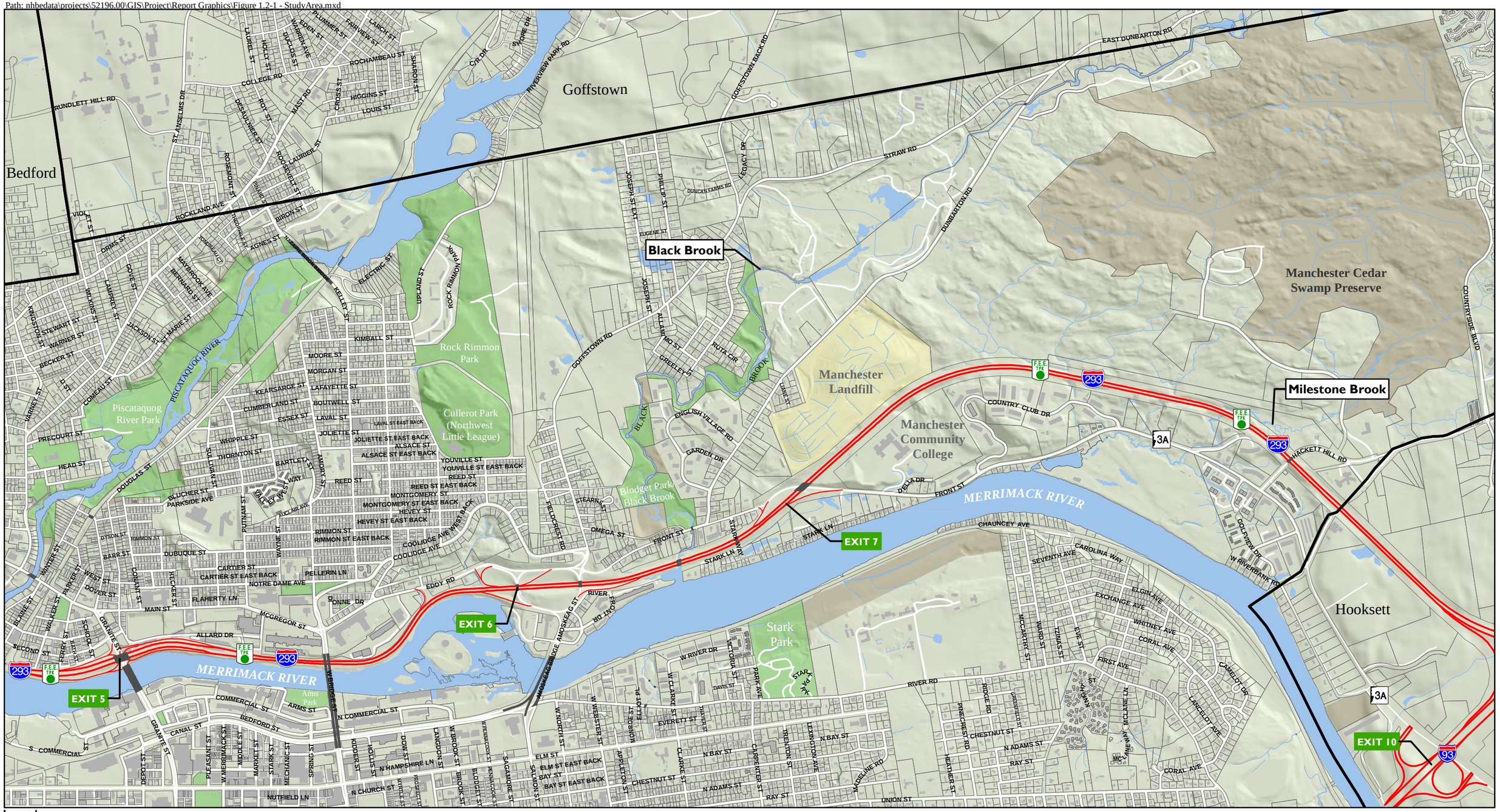

Legend

- Assessor's Tax Parcels
- Building
- Surface Water
- Stream
- City Park Land
- Conservation/Public Land
- Bridge
- Town/City Boundary

0 1,500 3,000 Feet

Vanasse Hangen Brustlin, Inc.

Manchester 16099
FEET/I-293, Exit 6-7 Planning Study

Figure 1.2-1
Study Area

Manchester, NH

New Hampshire DOT Department of Transportation

In addition to the community members, the Committee included representatives from the NHDOT and the Federal Highway Administration (FHWA). Nine Advisory Committee meetings were held, as summarized in Table 1.3-1.

Table 1.3-1 Technical Advisory Committee Meetings

Meeting	Date	Topics
1	June 27, 2012	Study area and study purpose, study schedule, and study process.
2	August 13, 2012	Committee feedback on July 18th public meeting; review comments/ideas submitted through website; future year traffic projections; discussion on September workshop
3	September 26, 2012	Review input from September 18th public workshop; discuss preliminary interchange configuration ideas
4	December 4, 2012	Discussion on and advanced look at material that will be presented at December 12th public meeting
5	January 31, 2012	Review feedback from December public meeting; recap of potential alternatives; discussion on traffic volume demand and diversion; discussion on conceptual design issues; video presentation on Diverging Diamond Interchanges (DDI)
6	February 28, 2013	Overview of decision making process; evaluation criteria, traffic volume projections for each alternative; update on the status of conceptual designs
7	April 10, 2013	Review of conceptual alternatives, preview of traffic simulations, discussion on the results of the evaluation matrix
8	June 20, 2013	Review feedback from June 11th public meeting, results of mini-O/D survey conducted at Exit 6, discuss steps to complete study
9	November 14, 2013	Review and discuss summary report

1.3.2 Public Informational Meetings

Five public informational meetings were held for the purpose of sharing information with, and soliciting input from, the public. Four meetings were held within the study area at Manchester Community College located on Front Street. The final meeting was held at the Manchester City Hall. Each meeting included a formal presentation followed by time for the public to share their thoughts and ask questions. The second public meeting (September 18, 2012) used a informal workshop-type format where attendees had an opportunity to interact one-on-one with the Study Team. While visiting various stations that were set up in the meeting room, attendees were asked to help define the study area problems, issues and constraints, and potential solutions.

The dates and topics for each of the public meetings are summarized in Table 1.3-2.

Table 1.3-2. Public Informational Meetings

Meeting	Date	Topics
1	July 18, 2012	Review of the study area, study purpose, and study schedule; results of the existing data collection; and public involvement plan
2	September 18, 2012	Workshop format where attendees provide input on problems, issues and constraints, and potential solutions
3	December 12, 2012	Results of the existing and future deficiency analyses and a presentation on the initial alternatives
4	June 11, 2013	Presentation and discussion on the results of the alternatives evaluation
5	December 11, 2013	Study findings and next steps

1.3.3 Project Website and Other Media

Website

A study website (www.293planningstudy.com) was created to ensure the public access to study related material. The website provided an overview of the study process, the study schedule and numerous documents such as traffic flow networks and resource maps. Interactive mapping allows visitors to view the various conceptual alternatives on aerial maps, overlaid with selected resource data. The site also provides a record of all meeting notes, as well as video of three public meetings. Most importantly, the website provides a feedback page where individuals can submit questions, comments, or ideas, and correspond thru e-mail with the Study Team.

Email Updates

The Study Team maintains an e-mail distribution list, which includes the e-mail addresses of members of the public who voluntarily submitted their e-mail addresses through the website or at public meetings. Throughout the study notices and reminders of upcoming meetings and other material, such as project newsletters, were e-mailed to those on the distribution list. Additionally, some members of the public corresponded directly with the Study Team sharing their questions, comments, and ideas.

Newsletter

In advance of the June 2013 Public Informational meeting, a four-page study newsletter was published and distributed in May. The newsletter describes and illustrates mainline and interchange alternatives that were to be presented and discussed at the public meeting. Copies of the newsletter were made available at the Manchester City Hall, the Goffstown Town Hall, the Hooksett Town Hall, the Southern New Hampshire Planning Commission, the Greater Manchester Chamber of Commerce, the Hooksett Chamber of Commerce, and

the NHDOT. The newsletter was also posted on the study website and distributed electronically to those on the e-mail distribution list.

2 Existing Conditions

2.1 Introduction

This chapter describes the existing, or baseline conditions, within the study area. Existing transportation infrastructure, traffic flow characteristics and traffic-operating conditions, as well as environmental and socioeconomic resources, are described. Information on the natural and cultural resources was obtained from file reviews, agency consultations, geographic information system (GIS) database retrieval, and a windshield-level field-reconnaissance effort. It is this affected environment that the impacts of the various study alternatives are evaluated against in Chapter 5.

2.2 Existing Facilities

This section describes the study area's transportation system including the roadway network, public transportation system, and available bicycle facilities. **Table 2.2-1** summarizes the existing geometric roadway features in the study area including travel way and shoulder width, posted speed, minimum curve radius, maximum grade and the merge and diverge taper rate for vehicles entering and exiting I-293.

2.2.1 Roadways

I-293 Mainline

The project study area consists of a 3.5-mile section of I-293 beginning north of Exit 5 (Granite Street) and ending approximately 1.5-miles north of Exit 7 (Front Street). This section of I-293 consists of an urban, four-lane, median divided limited access highway. Beginning at the newly reconstructed Exit 5 interchange, the corridor winds between the Merrimack River on the east and the historic Millyard on the west, before intersecting with Exits 6 and 7, which were constructed in the late 1950s. The posted speed is 50 miles per hour thru Exit 7, and 65 mph north of Exit 7.

For the purpose of this description, the I-293 corridor was divided into three separate roadway segments that include a Mainline Segment, an Exit 6 Segment and an Exit 7 Segment. The Mainline segment includes the southerly 0.8-mile section of the I-293 study area. The Exit 6 Segment includes the Exit 6 interchange and a 0.8-mile section of I-293. The Exit 7 Segment includes the Exit 7 interchange and a 1.9-mile section of I-293 north of the Exit 6 Segment.

The 0.8-mile Mainline Segment begins just north of Exit 5 and follows the existing I-293 corridor between the Millyard buildings on the west and the Merrimack River on the east, passing under the West Bridge Street Bridge before ending just south of Exit 6. The existing reverse curves in this section (minimum radius for the 55 mph design) in combination with traffic entering and exiting just north at Exit 6 create congestion and unsafe vehicle operations. Poor sight lines further complicate traffic operations in this area. The sight line for motorists traveling in the northbound passing lane who may need to slow or stop to avoid a rear-end crash, for example, is obscured in some instances by a vehicle in the southbound passing lane. In addition, the sight line for northbound traffic decelerating and exiting at Exit 6 is poor due to the highway's curvature and vegetation on the riverbank, especially during the weekday evening peak hours when traffic from the off-ramp queues back onto the I-293 mainline.

Table 2.2-1 Existing Geometric Roadway Features

Roadway	Travel Way Width (Feet)	Min Shoulder Width (Outside/Inside) (Feet)	Posted Speed (MPH)	Min Curve Radius (Feet)	Max. Vertical Grade (Percent)	Merge Diverge Taper Rate	Comments
Mainline							
South of Exit 6	12/2 lanes	8/2	50	950	2.7%		
Exit 6 to Exit 7	12/2 lanes	10/2	55	2,875	2.8%		
North of Exit 7	12/2 lanes	8/12	65	2,875	1.9%		
Exit 6 Ramps							
NB Off	16/1 lane	2/2	30	954	6.0%	12:1 Decel	
NB On	16/1 lane	2/2	not posted	225	3.5%	15:1 Accel	260 ft merge taper
SB Off	16/1 lane	2/2	not posted	150	4.9%	Parallel Decel Lane	300' +/- weave
SB On	16/1 lane	2/2	not posted	418	7.3%	Parallel Accel Lane	area between On and Off ramps
SB On - Slip	16/1 lane	2/2	not posted	150	1.0%	17:1 Accel	475 ft merge taper
Exit 7 Ramps							
NB On	16/1 lane	2/2	30	1,432	3.6%	12:1 Decel	
SB On	16-20/1 lane	2/2	not posted	636	0.8%	27:1 Accel	
Front St	12/2 lanes	2/2	30	250	5.7%		
Eddy Rd	12/2 lanes	2/2		350	6.7%		
Amoskeag St	12/2-3 lanes	2/2	30	250	3.7%		
Goffstown Rd	12/2 lanes	2/2	30	325	6.0%		
Dunbarton Rd	12/2 lanes	2/2	30	330	7.2%		

Information compiled from existing as-built plans and GIS data

Exit 6 Segment

Exit 6 serves as a major connection to Downtown Manchester across the Amoskeag Bridge on the east, as well as a primary link to the residential areas of Goffstown and Dunbarton to the west. The layout of the interchange ramps is substandard and does not meet today's design criteria.

The existing northbound on-ramp taper (260-feet) for merging traffic is substandard. Northbound ramp traffic entering must rapidly accelerate to mainline speed often using the shoulder to merge with through traffic. This merge is further exacerbated by the heavy volume of traffic using the outer lane to exit at the Exit 7 northbound off-ramp. Occasionally the on-ramp vehicles come to a complete stop before merging while looking for a safe gap within the through traffic stream.

The Amoskeag Circle flows in a counter-clockwise direction connecting the local roadway network with I-293. The merge configuration where the northbound off-ramp traffic yields to the northbound Eddy Road traffic, in the vicinity of the LaQuinta Inn and Suites, often slows the northbound off-ramp traffic creating a stopped queue along the northbound mainline shoulder (noted earlier in the Mainline Segment discussion). The northbound weaving section created between the Eddy Road/northbound off-ramp intersection and the Amoskeag Street traffic signals further compromises safe and efficient traffic operations.

Currently, the southbound on-ramp and off-ramp are configured such that traffic must weave when entering or exiting the highway. The existing weaving geometry is substandard by today's design criteria, which hinders traffic operations and safety. Exiting southbound traffic often decelerates in the through traffic lane to exit onto the 25 mph ramp. The southbound off-ramp is short, resulting in the exiting traffic often queuing back into the weaving section with the southbound on-ramp traffic. The southbound on-ramp is steep and traffic often stops while looking for a gap to safely merge into the mainline through traffic. The congestion within this weave section of I-293, especially in the morning peak hour, often affects the safe operations of through traffic. To avoid this conflict, the mainline through traffic often shifts to the median lane.

To the south, the short southbound on-ramp from Eddy Road is operationally similar to the northbound on-ramp. The ramp acceleration area for traffic merging into the southbound mainline is substandard. The on-ramp traffic must accelerate rapidly often using the shoulder to merge with through traffic. The southbound on-ramp merges with I-293 on the outside of a sharp curve creating additional conflict between the through traffic and the entering ramp traffic.

Exit 7 Segment

Approximately 0.4-miles north of Exit 6, the Exit 7 partial interchange supports connectivity for motorists traveling to and from the south on I-293 with a southbound on-ramp and northbound off-ramp only. I-293 northbound speed limit changes from 50 mph to 65 mph north of the northbound off-ramp near Manchester Community College. The I-293 southbound speed limit changes from 65 mph to 50 mph near the merge area for the southbound on-ramp.

The northbound off-ramp is substandard by today's standards including the deceleration area for exiting traffic and the intersection layout with Front Street. Left-turning traffic from the northbound off-ramp onto Front Street often creates queues backing onto I-293 during peak hour conditions resulting in a potentially unsafe operating condition. To avoid the left-turn backup, many motorists who are destined toward Dunbarton Road will instead turn right onto Front Street and right onto Stark Lane to access Front Street where the left-turn is less congested. In addition to the northbound off-ramp congestion during peak periods, traffic turning left into Manchester Community College queues on Front Street, slowing and stopping northbound through traffic on Front Street.

The intersection of Front Street and the southbound on-ramp is confusing and unexpected where the southbound motorist on Front Street does not fully realize that they have the right-of-way when entering onto I-293. Northbound traffic on Front Street has a combination slip-lane onto the southbound on-ramp and a through lane stop condition. The merge area with I-293 for the southbound on-ramp is also substandard, occasionally forcing motorists to stop and look for a gap in traffic before merging onto the highway.

2.2.2 Public Transportation

The Manchester Transit Authority (MTA) (http://www.mtabus.org) provides public transportation within the study area. MTA provides 13 regular bus routes through the city, including a free downtown circulator, known as the Green DASH (Downtown Area Shuttle). In general, service is hourly, with more frequent service along corridors served by multiple routes. The Green DASH runs every 10 minutes during peak periods and every 20 minutes the rest of the day. The study area's existing transit routes are shown in **Figure 2.2-1**.

The MTA system converges downtown at Veterans Park with one line departing from the nearby Manchester Transportation Center on Canal Street. Service is generally limited to the City of Manchester, with a few lines extending into the neighboring towns of Bedford, Goffstown, Hooksett and Londonderry. Two express lines run to Concord and Nashua. Bedford contributed funding to the MTA until 2010, and service coverage was significantly

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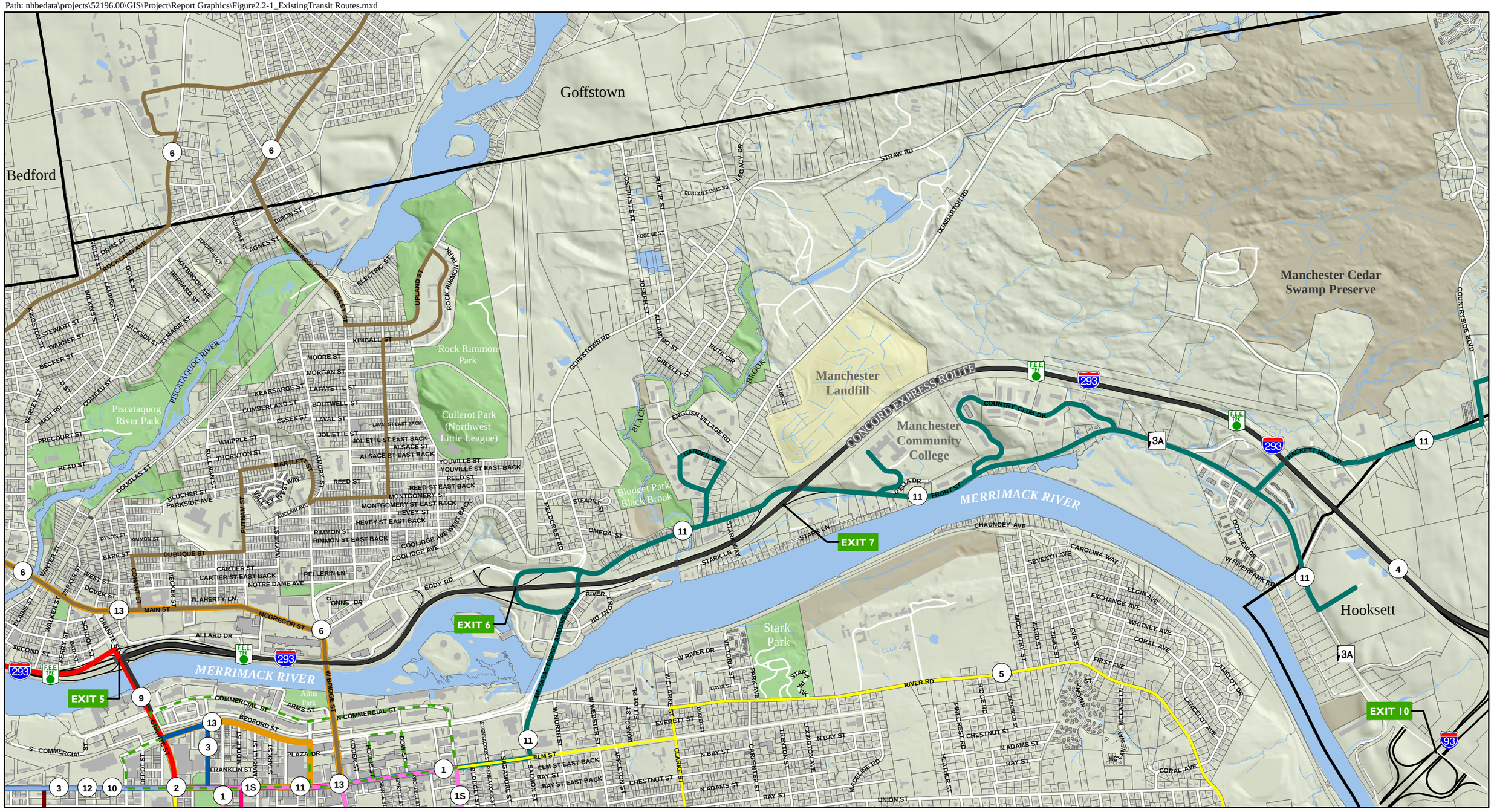

Legend

- Assessor's Tax Parcels
- Building
- Surface Water
- Stream
- City Park Land
- Conservation/Public Land
- Bridge
- Town/City Boundary

Manchester Transit Authority Routes

- Route 1 - Healthcare Shuttle/East Side Plaza
- Route 2 - Hanover St/East Side Plaza
- Route 3 - Brown Ave/Airport Industrial Area*
- Route 4 - Concord Express*
- Route 5 - River Road/SNHU
- Route 6 - Bremer St/Mast Road
- Route 9 - Nashua Express
- Route 10 - Valley St/Weston Rd/Mall of NH
- Route 11 - Front Street/Hackett Hill Road
- Route 12 - South Beech St/Mall of NH
- Route 13 - Bedford Grove Plaza/Second St
- GREEN DASH - Downtown Area Shuttle*

Note: * Weekday service only.
All other routes include Saturday service.

0 1,500 3,000 Feet

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Figure 2.2-1
Existing Transit Routes

Manchester, NH

New Hampshire DOT Department of Transportation

reduced within the town the following year. As of 2009, 97 percent of Manchester residents lived within 0.25-mile of an MTA bus line.

In addition to the 13 public transit routes, the MTA operates:

- "StepSaver" a program that provides assistance to individuals with disabilities who are unable to use the regular fixed route bus service.
- "Shopper Shuttle" a program that operates three days a week to three local grocery stores.
- School buses for the Manchester School District.

The Manchester Transportation Center is owned by the City of Manchester and operated by Boston Express. The terminal is located at 119 Canal Street off I-293 Exit 5. Scheduled service at this terminal is provided by Boston Express, Concord Coach Lines, Greyhound Bus Lines and Peter Pan Bus Lines.

- Boston Express provides service between Concord to the north and Londonderry, Salem, Nashua, and Tyngsborough (MA) to the south with continuing service to Logan Airport and Boston South Station.
- Concord Coach Lines provides service to the south at Londonderry, Salem, Logan Airport, and Boston South Station. Concord Coach Lines provides service as far north as Littleton and Gorham.
- Greyhound Bus Lines provides two daily round trips between Boston and Montreal stopping in Manchester.
- Peter Pan Bus Lines provides one daily round trip between Concord and Foxwoods (CT) stopping in Manchester.

2.2.3 Bicycle Facilities

The NHDOT has designated bicycle routes throughout the state as shown on seven Regional Bicycle maps available online at: http://www.nh.gov/dot/programs/bikeped/index.htm. The study area falls within the Merrimack Valley Region that generally offers rolling terrain with heavy traffic within urban areas. Within the study area, the following have been designated as bicycle routes:

- Dunbarton Road east of Straw Road in Goffstown continuing onto Front Street to Goffstown Road, just west of the Amoskeag Traffic Circle.
- Straw Road from Dunbarton Road continuing onto Goffstown Road to Coolidge Avenue, just west of the Amoskeag Traffic Circle.
- Coolidge Avenue between Goffstown Road and West Bridge Street.
- Kelly Street between Goffstown and Coolidge Avenue.
- Bridge Street from Coolidge Avenue through Downtown Manchester to I-93;
- Elm Street from Bridge Street to Queen City Avenue.
- Canal Street from Bridge Street continuing along River Road, West Clark Street, and Union Street beyond I-93 in Hooksett.

2.3 Traffic Flow

This section presents the existing traffic volume demands and other traffic flow characteristics on I-293 such as travel speeds, vehicle crash data, and operational levels of service (LOS). Also presented is a brief description of the regional travel demand model that was used to assist with traffic forecasting and the evaluation of study alternatives.

2.3.1 Traffic Volumes

To determine the existing traffic volume demands and flow patterns in the study area, a traffic volume count program was conducted in April 2012. The 2012 counts were supplemented with other count data available from the NHDOT. Weekday morning and weekday evening peak period manual turning movement counts were conducted at Exit 6, Exit 7, and other major intersections surrounding the I-293 study area. Multi-day automatic traffic recorder counts were also conducted along key local roadways that provide access to and from Exits 6 and 7.

Review of the hourly traffic volumes for a typical weekday (June 2012) on I-293 northbound and southbound, as depicted in **Exhibits 2.3-1 and 2.3-2** respectively, reveals typical commuter route characteristics. The graphs show distinct weekday morning and evening commuter activity. The highest recorded northbound traffic volume occurs during the weekday morning peak hours, while the highest recorded southbound volume occurs during the weekday evening peak hours.

Exhibit 2.3-1 – Hourly Volumes
I-293 Northbound between Exits 5 and 6

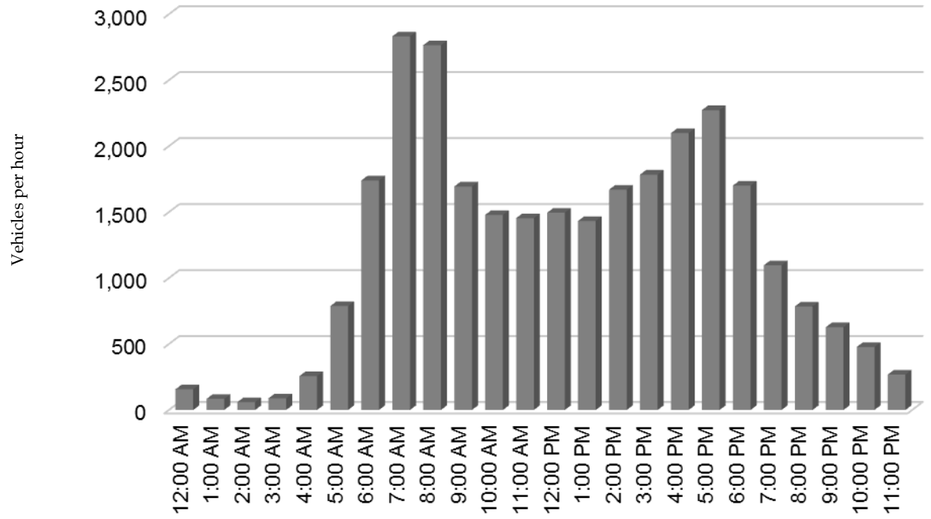
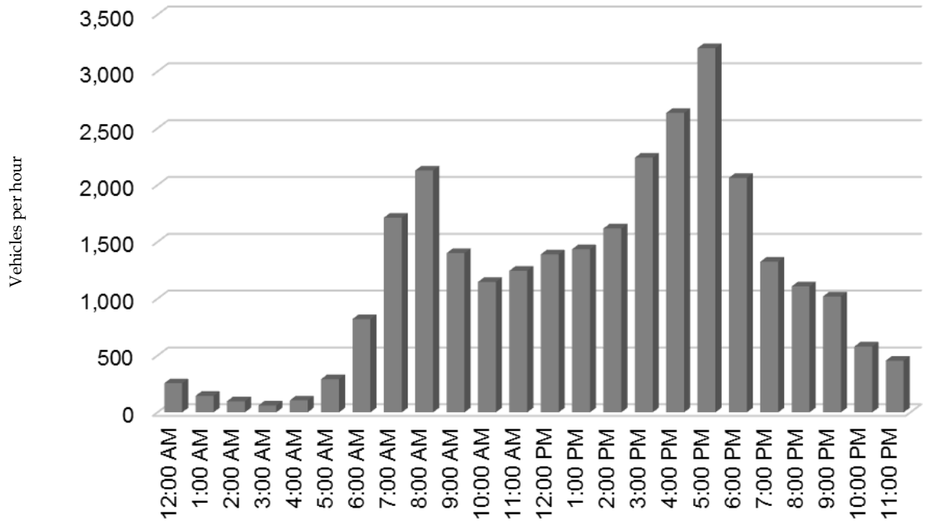
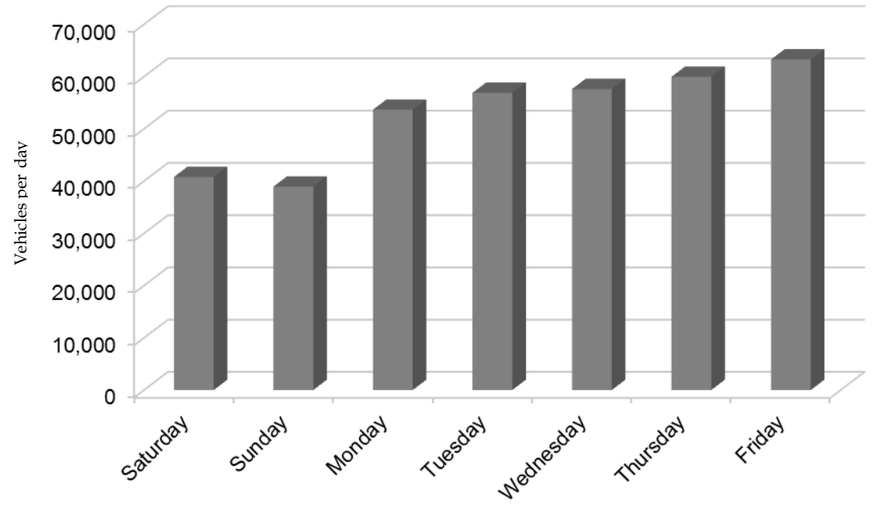


Exhibit 2.3-2 – Hourly Volumes
I-293 Southbound between Exits 5 and 6



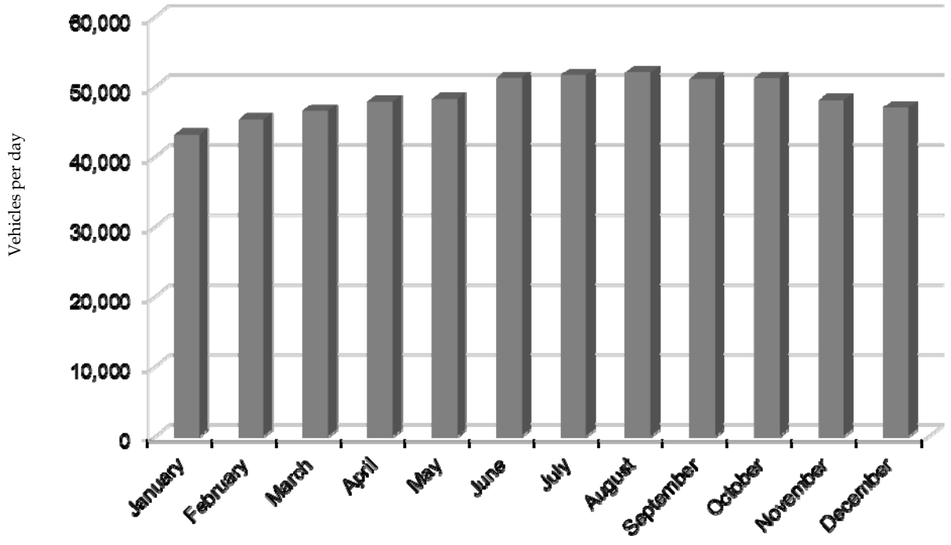
Examination of the daily traffic volumes (**Exhibit 2.3-3**) during June 2012 revealed only moderate variation during the weekdays with the highest daily volume occurring on Friday. The weekday volumes range from approximately 53,700 vehicles per day (vpd) to 63,300 vpd. The weekend daily volumes are lower with the Saturday and Sunday daily volumes recorded at approximately 40,800 vpd and 38,900 vpd, respectively.

Exhibit 2.3-3 – Daily Volumes
I-293 Both Directions between Exits 5 and 6



In addition to the hourly and daily traffic volume trends, a review of monthly traffic volumes (**Exhibit 2.3-4**) show that the highest volume months occur from early summer (June) through mid-fall (October).

Exhibit 2.3-4 – Seasonal Volumes
I-293 Both Directions between Exit 5 and 6



Design Hour Volume (DHV)

The unit of measure used to evaluate and design roadway facilities is an hourly traffic volume measured in vehicles per hour (vph). However, because hourly traffic volumes can vary during the course of a day, and throughout the year, it is necessary to select an appropriate design hour volume (DHV) condition. The hourly traffic volume used for the purpose of design should not be exceeded very often or by very much. However, it should not be so high that the traffic volume would rarely be high enough to make full use of the facility. It is wasteful to design a facility based on the maximum peak hour traffic of the design year, yet the use of the average hourly traffic may result in an inadequate design. Therefore, the procedure typically used to evaluate traffic volume demands on a roadway system, as described in *A Policy on Geometric Design of Highways and Streets,*[1] is to establish a 30th-highest hour volume, or DHV, as the future design condition. Given the economic considerations involved in the planning and design of roadway facilities, the DHV design criterion is selected because the 30th-highest hour volume generally reflects a "point of diminishing return" in that a substantial increase in capacity would only accommodate few periods of higher traffic volumes.

[1]American Association of State Highway and Transportation Officials, *A Policy on Geometric Design of Highways and Streets*, Sixth Edition, Washington, DC, 2011.

A review of historical count data at the NHDOT count station on I-293 between Exits 5 and 6 (Station #02285002) revealed that increasing the June peak hour traffic counts on I-293 by four percent best approximates the DHV condition. Specifically, the K-Factor (12.41 percent), which is the percent of traffic of the Average Annual Daily Traffic (AADT) that occurs during the 30th highest hour at this location, was applied to the estimated 2012 AADT (26,675) to establish the DHV (3,310) on I-293 northbound during the weekday evening peak hour. A four percent adjustment was also applied to the slightly lower weekday morning peak period on I-293. **Figures 2.3-1 and 2.3-2** show the 2012 DHV on I-293.

Seasonal Adjustment

The manual turning movement counts collected in April 2012 were seasonally adjusted to represent a peak month condition. Historical count data at numerous nearby NHDOT permanent count stations (I-293 in Manchester between Exits 5 and 6, F.E. Everett Turnpike at the Bedford Tolls, I-93 at the Hooksett Tolls, I-93 in Manchester between Exits 9 and 10, and NH Route 3A in Bow south of Robinson Road) revealed that peak month conditions are approximately five percent higher than the April conditions. Therefore, a five percent increase was applied to the April 2012 intersection counts to represent a peak month condition. **Figures 2.3-1** and **2.3-2** show the seasonally adjusted 2012 weekday morning and weekday evening peak hour volumes.

Limited Origin-Destination License Plate Survey

An origin-destination study was conducted on May 7, 2013 approaching the Exit 6 interchange to identify the destination of vehicles traveling eastbound on Goffstown Road and southbound on Front Street. Partial license plate numbers were recorded between 7:30 AM and 8:30 AM to identify the weekday morning peak hour distributions. The destinations for these vehicles were identified as I-293 southbound, Eddy Road (traveling southbound), I-293 northbound, and Amoskeag Street. Over 1,300 vehicles were recorded originating on Goffstown Road and Front Street with 89% (1,232 vehicles) of the vehicle destinations captured during the weekday morning peak hour. The results of the observations are summarized in **Table 2.3-1.**

Table 2.3-1 Origin-Destination Survey Summary

Approach to Exit 6	I-293 North	I-293 South	Amoskeag St East	Eddy Rd South
Goffstown Rd Eastbound	19 %	21%	26%	14%
Front St Southbound	11%	12%	29%	27%

2.3.2 Regional Travel Demand Model

Southern New Hampshire Planning Commission (SNHPC) maintains a regional transportation daily model which utilizes the TP+/Viper travel demand modeling software package and 2010 Census data. The model is used to help understand traffic demand in the future based on land use growth and planned roadway projects. The base model contains

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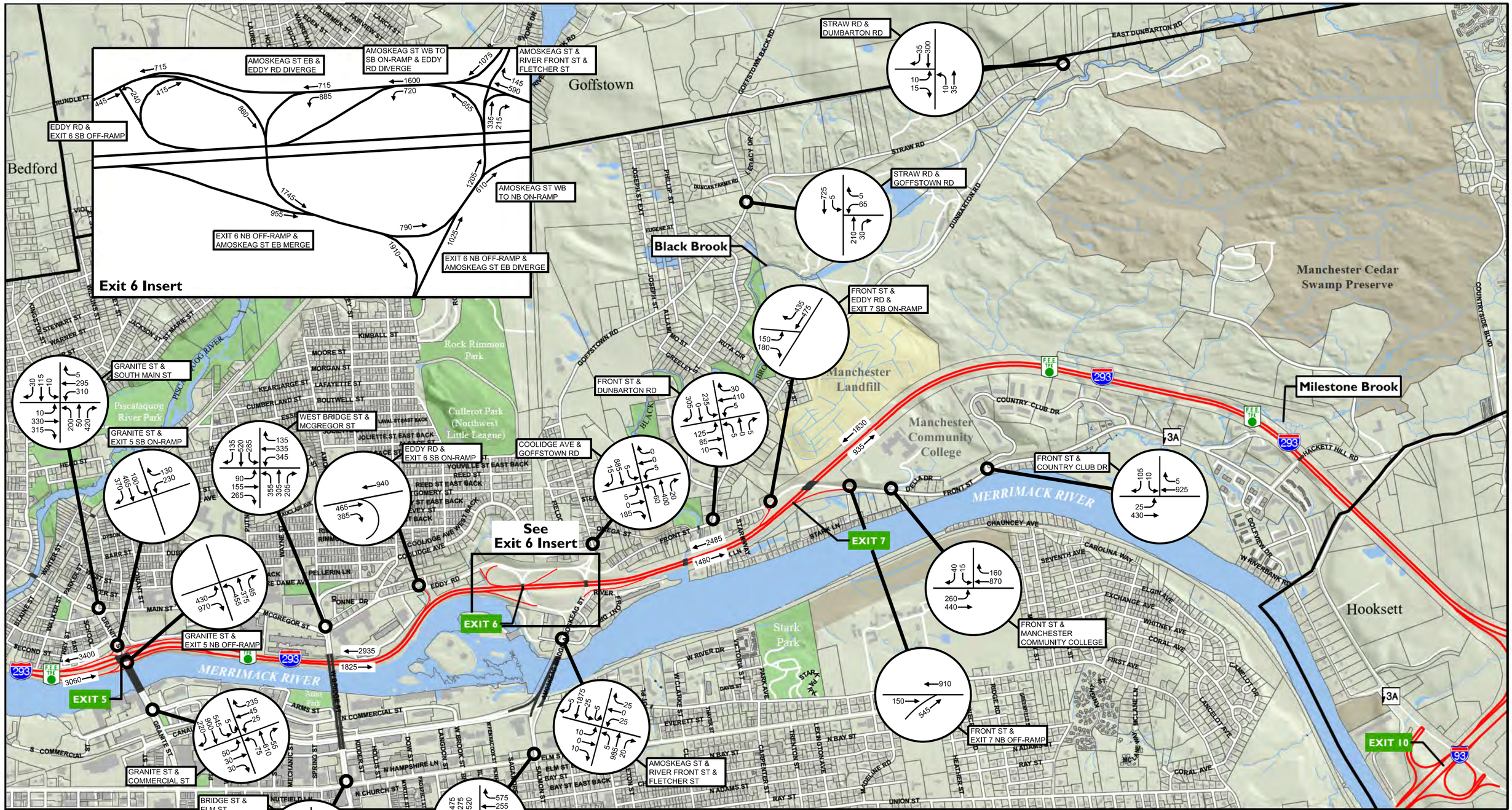

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Figure 2.3-1
2012 Existing Weekday Morning Peak Hour Traffic Volumes

Manchester, NH

New Hampshire DOT Department of Transportation

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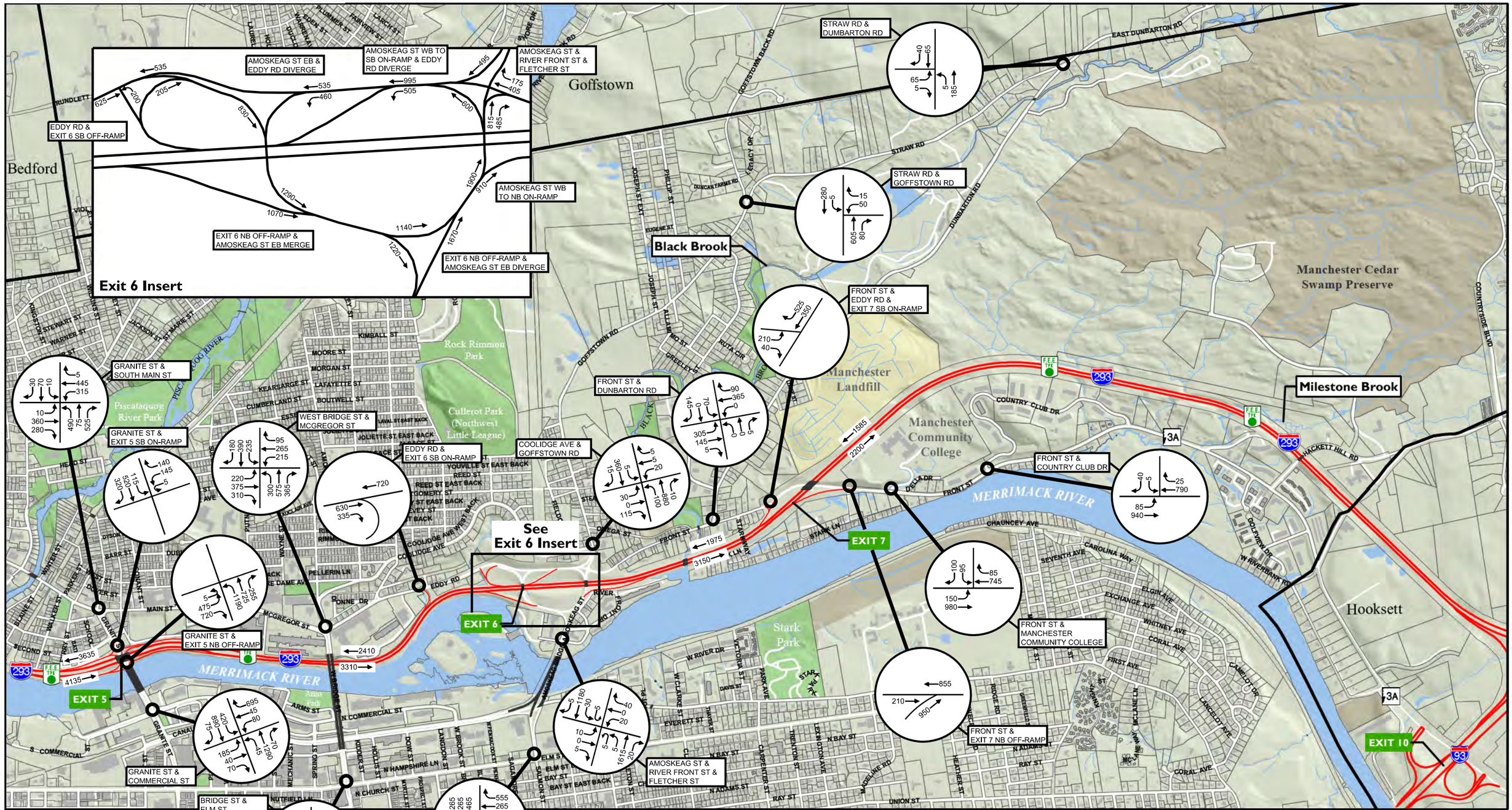

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Figure 2.3-2
2012 Existing Weekday Evening Peak Hour Traffic Volumes

Manchester, NH

New Hampshire DOT Department of Transportation

290 internal traffic analysis zones (TAZs) and 67 external stations. Internal TAZs are geographic units that contain land use information (population, households, and employment) while external TAZs represent vehicle traffic that enters and exits the model area from outside the region. The traffic forecasting procedure generally follows the standard four-step process described below:

- Trip Generation: Determines the quantity of trips generated by each TAZ based on the land use contained in it.
- Trip Distribution: Determines the origin and destination patterns of trips generated at each TAZ.
- Modal Split: Determines what modes the trips are going to use to travel to their destinations.
- Traffic Assignment: Determines which routes the trips are going to take to their destination.

The roadway network assumed in the regional model includes the principal roadway street system as defined by NHDOT. It is not necessary to include all the local streets in the region. Within the model, a road segment is called a "link" and the intersection of two or more streets is called a "node". Each link is defined by characteristics such as length, average free flow speed, number of lanes, capacity, and one-way or two-way traffic flow.

Before the model can be used to forecast traffic for a horizon year, it must first be able to reasonably represent base year travel activity in the region. This involves modifying the model parameters until actual base year traffic is replicated.

For the purpose of this study, and to better understand the traffic patterns and flows in the study area, a number of TAZs were further broken down or detailed. Four TAZs in the study area were broken down into a total of 15 TAZs. The land use associated with each TAZ was assigned to these new TAZs based on 2010 Census data, as well as the SNHPC's employment database.

To check the model's calibration along I-293, and surrounding roadway network, the traffic model output was compared to actual daily traffic volume counts at 51 locations. These locations included all of the links on I-293 in the study area, ramp volumes at Exits 4 through 7, and roadways on either side of I-293. Once the model was calibrated, it was run using 2035 land use and roadway assumptions. The annual daily growth rate was then calculated for each of the 51 calibration check points. This annual growth rate provides the basis for forecasting future year 2035 traffic volumes for this study. It is important to note that the regional model is a daily model and was not directly used to establish future year peak hour volumes used for analysis purposes. In addition to establishing the growth rate for future traffic volumes, the regional model was instrumental in understanding the potential traffic volume "shifts" (diversions) that may occur under the various alternatives considered in the study.

2.3.3 Travel Speeds

The NHDOT conducted an automatic traffic recorder (ATR) count along I-293 between Exit 5 and Exit 6 north of the West Bridge Street Overpass to record volume and speed along the highway from June 2, 2012 through June 8, 2012. The data was recorded separately for each travel lane. For the purpose of presenting this information, the traditionally slower right-hand travel lane is referred to as the travel lane and the traditionally faster left-hand travel lane, is referred to as the passing lane. The count data revealed that the average hourly speed along I-293 (between Exits 5 and 6) during a typical weekday was 63 mph for the southbound travel lane and 60 mph for the northbound travel lane. The average hourly speed in the southbound and northbound passing lanes was recorded to be slightly higher at 66 mph. The average hourly speeds on I-293 fluctuate over the course of a typical weekday between 57 and 66 mph in the travel lanes and between 60 and 70 mph in the passing lanes. The highest hourly average speeds were recorded during the day at 6:00 AM (just prior to the weekday morning peak hour) and at 6:00 PM (just after the weekday evening peak hour). The lowest hourly average speeds were recorded during the overnight hours (8:00 PM through 3:00 AM). The travel speeds are summarized in **Table 2.3-2**.

Table 2.3-2 Travel Speed Summary

	I-293 (Exit 5-6) Weekday Travel Speeds			
	Southbound		Northbound	
Condition	Travel Lane	Passing Lane	Travel Lane	Passing Lane
Average Hourly Speed (mph)	63	66	60	66
Minimum Hourly Speed (mph)	58	59	57	60
Maximum Hourly Speed (mph)	66	70	63	69

2.3.4 Vehicle Crash Evaluation

NHDOT vehicle crash data was compiled for I-293 within the study area and the surrounding roadway network for the most recent three-year period available (2009 – 2011). As shown in **Figure 2.3-3**, a total of 246 crashes were reported within the study area during this three-year period. Of the total 246 crashes, 73 (30 percent) occurred on I-293, 67 (27 percent) occurred on the Exit 6 and 7 ramps, and the remaining 106 occurred along the adjacent study area roadways.

Ramp junctions and major intersections are generally the highest crash locations. Specifically, the Exit 6 ramps along the Amoskeag Traffic Circle experience the highest number of crashes, and the highest crash rates, within the study area. The crash data for Exit 6 indicates that the physical deficiencies described in Section 2.2.1 appear to be contributing toward the frequency of occurrences in this area. High numbers of crashes were also reported along Amoskeag Street between the Merrimack River and Front Street, along Eddy Road at the Exit 6 southbound on and off-ramps, on I-293 at Exit 7, and between Exits 5 and 6 along the "S-Curve". **Table 2.3-3** summarizes the number of crashes and crash rates along I-293 and the Exit 6 and 7 ramps within the study area.

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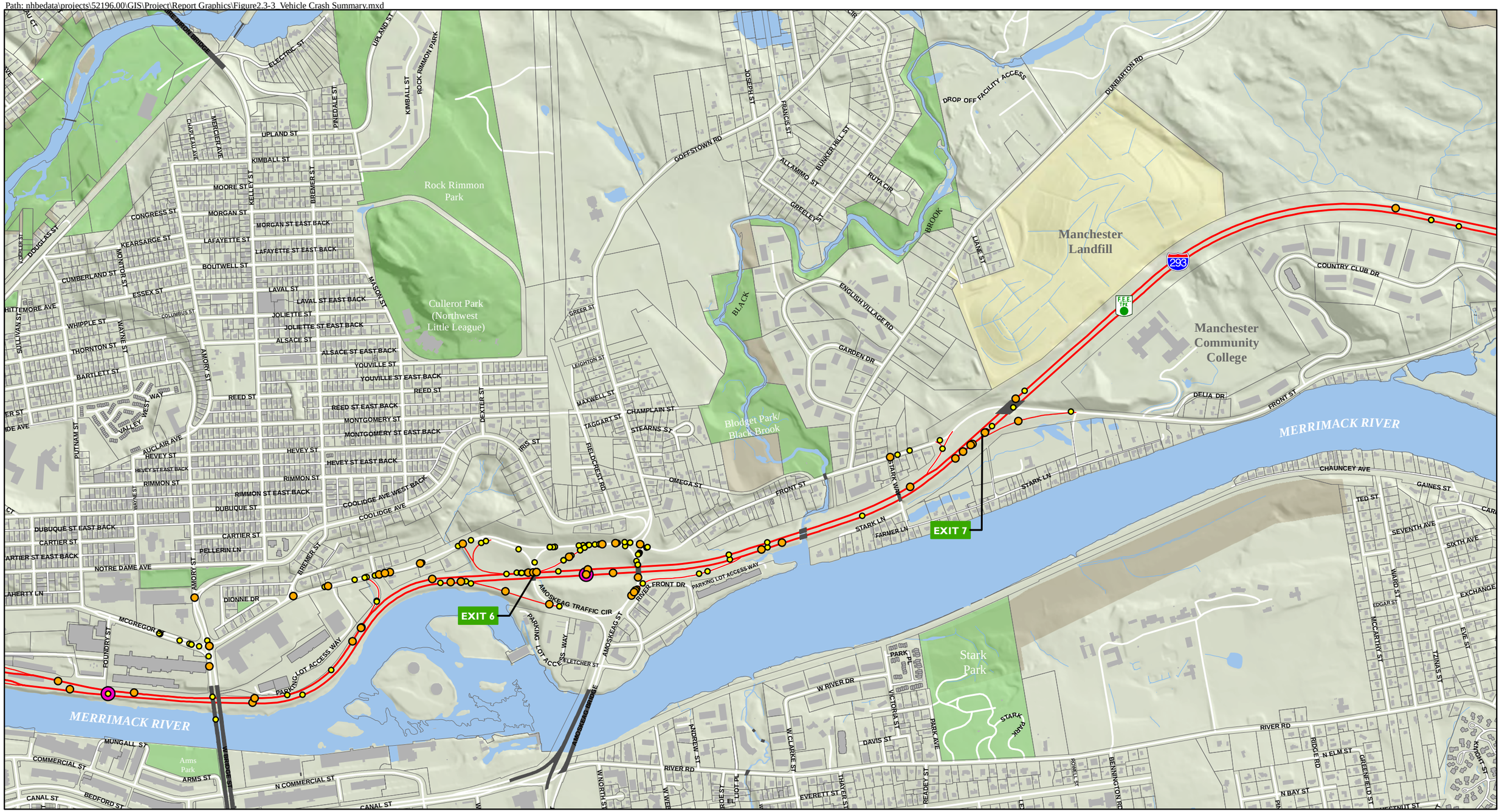

Legend

- Assessor's Tax Parcels
- Building
- Surface Water
- Stream
- City Park Land
- Conservation/Public Land
- Bridge
- Town/City Boundary
- Crash Location - No Injuries Reported (179 Crashes)
- Crash Location - Injuries Reported (65 Crashes)
- Crash Location - Fatality Reported (2 Crashes)

0 900 1,800 Feet

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Figure 2.3-3
I-293 Crash Summary (2009-2011)

Manchester, NH

New Hampshire DOT Department of Transportation

In 2009 two fatal crashes were reported within the study area on I-293 northbound; one crash just north of the Exit 5 on-ramp merge and the other between the Exit 6 off and on-ramps. Of the 246 reported crashes 65 (26 percent) resulted in personal injuries while the remaining 179 crashes (73 percent) reported no injuries (property damage only).

Table 2.3-3 I-293 Crash Summary (2009 - 2011)

	Crashes (2009 - 2011)		2012 Traffic Volume		Length	Crash Rate
	Total	Average	Peak Hour	Daily	(miles)	(MVMT)
FEET (I293) Northbound Freeway Segments						
Exit 5 On Ramp - Exit 6 Off Ramp	6	2.0	3,310	26,672	0.89	0.23
Exit 6 Off Ramp - Exit 6 On Ramp	11	3.7	2,240	18,050	0.52	1.07
Exit 6 On Ramp - Exit 7 Off Ramp	9	3.0	3,150	25,383	0.48	0.67
North of Exit 7 Off Ramp	8	2.7	2,200	17,728	1.00	0.41
Total Segment	34	11.3	2,707	21,812	2.89	0.49
FEET (I293) Northbound Ramp Segments						
Exit 6 Off Ramp	7	2.3	1,070	8,622	0.17	4.36
Exit 6 On Ramp	8	2.7	910	7,333	0.21	4.74
Exit 7 Off Ramp	6	2.0	950	7,655	0.18	3.98
Total Segment	21	7.0	971	7,828	0.56	4.38
FEET (I293) Southbound Freeway Segments						
North of Exit 7 On Ramp	3	1.0	1,830	14,939	1.00	0.18
Exit 7 On Ramp - Exit 6 On Ramp	14	4.7	2,485	20,286	0.71	0.89
Exit 6 On Ramp - Exit 6 Off Ramp (weave)	5	1.7	3,205	26,163	0.08	2.18
Exit 6 Off Ramp - Exit 6 On Ramp	3	1.0	2,550	20,816	0.25	0.53
Exit 6 On Ramp - Exit 5 Off Ramp	14	4.7	2,935	23,959	0.68	0.78
Total Segment	39	13.0	2,384	19,460	2.72	0.67
FEET (I293) Southbound Ramp Segments						
Exit 7 On Ramp	2	0.7	655	5,347	0.12	2.85
Exit 6 On Ramp (north)	29	9.7	720	5,878	0.10	45.06
Exit 6 Off Ramp	11	3.7	655	5,347	0.14	13.42
Exit 6 On Ramp (south)	4	1.3	385	3,143	0.07	16.60
Total Segment	46	15.3	626	5,112	0.43	19.11
Total Freeway	73	24.3	5,091	41,272	5.61	0.29
Total Ramps	67	22.3	1,598	12,939	0.99	4.78
Total Freeway & Ramps	140	46.7	6,688	54,211	6.60	0.36

Crash Rates are expressed in crashes per million vehicle miles traveled (MVMT).

Daily volume is estimated based on a K-Factor from the NHDOT count station on FEET (I-293) between Exit 5-6:

- NB K-Factor (PM Peak Hour) = 12.41%
- SB K-Factor (AM Peak Hour) = 12.25%

2.3.5 Field Observations

In addition to conducting traffic volume counts, measuring travel speeds, researching vehicle crash data, and conducting operational analyses, general field observations were made. These field observations consisted of driving and walking the study area in an effort to gain a better understanding of how the I-293 mainline, entrance and exit ramps, and side streets function and what deficiencies currently exist. The following are some of the observations that were noted.

- Reverse curves along I-293 mainline, south of Exit 6, combined with proximity of interchange ramps, and high travel speeds creates conflicts, congestion, and safety issues.
- Vehicles queue back onto the I-293 mainline from the Exit 6 northbound off-ramp. Mainline curvature combined with vegetation and snow banks restrict sight lines creating potentially hazardous conditions.
- The short acceleration lane at the Exit 6 auxiliary southbound on-ramp from Eddy Road in conjunction with a mainline reverse curve compromises safety at this merge condition, especially during peak hours when there are few gaps in the mainline flow to accept ramp traffic.
- Substandard horizontal and vertical geometry at the Exit 6 southbound on and off-ramp weave section forces peak hour on-ramp motorists to stop at ramp nose and wait for gaps in the mainline traffic stream. This condition causes mainline motorists to slow to avoid conflicts. On-ramp traffic attempts to accelerate from a stop condition.
- Motorists aggressively change lanes along the mainline to avoid delays and slowdowns caused by motorists entering and exiting the highway.
- The short acceleration lane at the Exit 6 northbound on-ramp forces motorists to merge with mainline traffic prematurely. During high volume periods, motorists entering the highway are often forced to stop to wait for a gap in the mainline flow.
- At-grade braided ramps at the Amoskeag Traffic Circle cannot adequately accommodate high volume weaving movements, resulting in congestion and delay.
- Motorists exit from the Exit 7 northbound off-ramp onto Front Street at high speeds through a short merge area with limited sight lines. Motorists destined to the west use Stark Lane as a turnaround to reverse direction. Traffic operations are further complicated by queuing on Front Street associated with Stark Lane and the driveway to Manchester Community College.
- Motorists approaching the Exit 7 southbound on-ramp from Front Street northbound must stop to determine if southbound Front Street traffic is continuing on Front Street or traveling through the intersection to the on-ramp. Once on the on-ramp, motorists are frequently forced to enter the highway from a stop condition. The short acceleration length is further complicated by the high volume of trucks entering the highway from Front Street southbound.

2.3.6 Traffic Operations

Measuring the volume of traffic in the study area indicates the importance of I-293 to the regional transportation system but does not necessarily indicate the quality of traffic flow. To assess the quality of traffic flow along the corridor, capacity analyses were conducted to determine how well the roadway facilities serve the traffic demands placed on them. The traffic performance measures and the evaluation criteria used in the operational analyses are based on the methodology presented in the *2000 Highway Capacity Manual*.[2]

A primary result of capacity analysis is the assignment of level of service (LOS), which is a qualitative measure describing operational conditions. LOS generally describes these conditions in terms of such factors as speed and travel time, density or freedom to maneuver, traffic interruptions, comfort, and convenience, thereby providing an index to quality of traffic flow. Six levels of service are defined that range in letter designation from LOS A to LOS F, with LOS A representing the best operating condition and LOS F representing the worst. LOS C describes a stable flow condition and is considered desirable for design hour traffic flow. LOS D is generally considered acceptable, particularly when the cost and impacts of making the additional improvements needed to achieve LOS C are deemed unjustifiable. LOS E reflects a capacity condition, but under certain circumstances may be considered acceptable, such as in urban areas or where there's a desire to encourage multi-modal use and discourage single-occupant vehicles.

Results of the 2012 existing conditions operational analyses, which were conducted for the key freeway, ramp merge, ramp diverge, and ramp weave segments throughout the study area, as well as signalized and unsignalized intersections that control traffic operations at nearby major intersections are summarized in **Tables 2.3-4** (freeway and ramps), **2.3-5** (signalized), and **2.3-6** (unsignalized).

Mainline (Freeway and Ramps)

As shown in **Table 2.3-4**, the results of the 2012 existing conditions analysis at the freeway and ramp junctions indicate that several freeway segments and ramp junctions are currently operating at LOS D. This occurs during the peak periods along I-293 southbound during the weekday morning and northbound during the weekday evening. The only facility shown to operate at LOS E is the Exit 6 southbound on and off-ramps weave during the weekday morning peak hour. However, it is important to note that the software used to evaluate the freeway segments and ramps does not have the ability to incorporate the effects associated with the overall roadway network, such as when the ramp intersections back-up onto I-293. Therefore, some of the reported levels of service are likely better than experienced in the field.

[2] *2000 Highway Capacity Manual, Special Report 209*, Transportation Research Board, Washington, DC.

Table 2.3-4. 2012 Existing Freeway and Ramp Analysis

Location	Facility	Peak Period	2012 LOS
I-293 Northbound Exit 5 to Exit 6	Freeway	AM	B
		PM	D
I-293 Northbound Exit 6	Off Ramp (diverge)	AM	B
		PM	D
I-293 Northbound Exit 6	On Ramp (merge)	AM	B
		PM	D
I-293 Northbound Exit 6 to Exit 7	Freeway	AM	B
		PM	D
I-293 Northbound Exit 7	Off Ramp (diverge)	AM	B
		PM	D
I-293 Northbound Exit 7 to I-93	Freeway	AM	A
		PM	C
I-293 Southbound I-93 to Exit 7	Freeway	AM	B
		PM	B
I-293 Southbound Exit 7	On Ramp (merge)	AM	C
		PM	B
I-293 Southbound Exit 7 to Exit 6	Freeway	AM	C
		PM	C
I-293 Southbound Exit 6	Weave	AM	E
		PM	C
I-293 Southbound Exit 6 at Eddy Rd	On Ramp (merge)	AM	D
		PM	C
I-293 Southbound Exit 6 to Exit 5	Freeway	AM	D
		PM	C

Signalized Intersections

As shown in **Table 2.3-5**, the results of the 2012 existing conditions operational analyses indicate that four of the nine signalized intersections examined in the study are operating at LOS D or E. Specifically, the intersection of Granite Street at Main Street is shown to operate at LOS D during both the weekday morning and evening peak hours. The intersection of Granite Street at Commercial Street is shown to operate at LOS D during the weekday morning and LOS E during the weekday evening with a volume-to-capacity ratio (v/c) of 0.94 (94 percent of capacity). The intersection of McGregor Street and Bridge Street is shown to operate at LOS E during the weekday morning with a v/c of 0.90 and LOS D during the weekday evening. The intersection of Salmon Street at Elm Street is shown to operate at LOS C during the weekday morning and LOS D during the weekday evening with a v/c of 0.89. All other signalized intersections are shown to operate at a LOS C or better.

Table 2.3-5 2012 Existing Signalized Intersection Analysis

Location	Peak Period	2012 Existing v/c*	2012 Existing Delay**	2012 Existing LOS***
Granite Street at	AM	0.78	35	D
Main Street	PM	0.84	40	D
Granite Street at	AM	0.80	26	C
I-293 Exit 5	PM	0.87	31	C
Granite Street at	AM	0.73	39	D
Commercial Street	PM	0.94	73	E
McGregor Street at	AM	0.90	60	E
Bridge Street/Amory St	PM	0.75	41	D
Bridge Street at	AM	0.53	29	C
Elm Street	PM	0.64	32	C
Amoskeag Street at	AM	0.65	6	A
Goffstown Rd/Front St	PM	0.74	10	B
Amoskeag Street Traffic Circle	AM	0.66	14	B
(I-293 Northbound Approach)	PM	0.94	33	C
Amoskeag Street at	AM	0.74	10	A
River Front Dr/Fletcher St	PM	0.68	9	A
Salmon Street at	AM	0.81	29	C
Elm Street	PM	0.89	41	D

* Volume to capacity ratio.

** Delay in seconds per vehicle.

*** Level of service.

Unsignalized Intersections

Results of the 2012 existing conditions analyses for the unsignalized intersections (**Table 2.3-6**) reveal that the majority of side-street movements along the primary local roadways operate at poor levels of service (i.e., LOS E and F). Most notably, vehicles exiting from side streets onto Eddy Road, Goffstown Road, and Front Street experience long delays during peak-hour conditions. It is important to note that LOS E and F results for vehicles exiting from a side street do not necessarily mean that traffic operations are unacceptable or that improvements should be required at a particular location. Longer delays during peak hour conditions are common for minor streets and driveways intersecting major roadways. In situations where the existing lane geometry and traffic control devices at an intersection are optimal, and the intersection volume demands or crash rates do not meet the warrant criteria for the installation of a traffic signal, then LOS E or F can be considered acceptable.

Table 2.3-6. 2012 Existing Unsignalized Intersection Analysis

Location / Movement	AM Peak Hour Demand*	AM Peak Hour Delay**	AM Peak Hour LOS***	PM Peak Hour Demand	PM Peak Hour Delay	PM Peak Hour LOS
Exit 6 Southbound Off-Ramp at Eddy Road						
Exit 6 Southbound Off-Left	240	#	F	200	#	F
Exit 6 Southbound Off-Right	415	47	E	205	20	C
Exit 6 Northbound Off-Ramp at Amoskeag						
Exit 6 Northbound Off Ramp	955	#	F	1070	#	F
Amoskeag Westbound Slip Lane at Eddy Road						
Amoskeag Westbound Slip Lane	655	#	F	600	#	F
Goffstown Road at Coolidge Ave						
Goffstown Road Eastbound	905	0	A	380	0	A
Goffstown Road Westbound	480	2	A	990	3	A
Coolidge Ave Northbound	190	110	F	145	#	F
Business Drive Southbound	5	#	F	30	#	F
Front Street at Dunbarton Rd						
Dunbarton Road Eastbound	540	#	F	215	#	F
Retail Drive Westbound	10	79	F	5	9	A
Front Street Northbound	220	6	A	455	9	A
Front Street at Exit 7 SB On-Ramp						
Front Street Northbound	330	103	F	250	32	D
Front Street at Exit 7 NB Off-Ramp						
I-293 Exit 7 NB Off-Ramp Approach	545	40	E	950	#	F
Front Street at Manchester Community College						
Community College Exit	55	#	F	195	#	F
Front Street at Country Club Drive						
Country Club Dr Exit	115	32	D	45	29	D
Front Street Northbound	455	1	A	1025	4	A
Goffstown Road at Straw Road						
Straw Road Southbound	70	25	D	65	32	D
Dunbarton Road at Straw Road						
Straw Road Northbound	25	11	B	70	11	B

* Demand in vehicles per hour.

** Delay in seconds per vehicle. # Delay greater than 3 minutes.

*** Level of service.

2.4 Environmental Resources

This section describes the environmental resources in the study area. The existing-conditions inventory was compiled using various sources, as discussed herein. Environmental resources inventoried include wetlands; surface water; groundwater; floodplains; farmlands; rare, threatened, or endangered species; wildlife habitat; and potential soil and groundwater contaminated sites.

2.4.1 Wetlands

The US Fish & Wildlife Service (USFWS) National Wetlands Inventory (NWI) mapping, National Resources Conservation Service (NRCS) hydric-soils mapping, and 2010 aerial-photography-interpreted wetlands provided by the City of Manchester were reviewed to determine the potential location of wetlands within the study area. Environmental scientists verified potential wetlands by completing a windshield-level field-reconnaissance effort in October 2012. If the field-reconnaissance confirmed the presence of a wetland, wetland identification codes were assigned, wetland classification codes were assigned, brief notes regarding each wetland were recorded, and representative photos were taken. Wetlands were classified using the USFWS Methodology, "*Classification of Wetlands and Deepwater Habitats*, Cowardin et al, 1979".

Forty-three wetland/stream resources were observed in the study area. The field-reconnaissance effort does not constitute a wetland boundary determination. Field delineation of wetland boundaries during the NEPA/design phase may result in a greater number of wetlands as well as modifications to the size and shape of the wetland areas. Wetlands associated with Black Brook and those in the floodplain of the Merrimack River have the potential for greater overall functional values than many of the more disturbed wetlands in the study area. Many of the wetlands in the forested area to the north of the Manchester Landfill are potential vernal pools. **Figure 2.4-1** graphically displays the wetland resources.

I-293 Mainline (South of Exit 6)

Together, the photo-interpreted wetlands data provided by the City of Manchester and NWI mapping indicated two palustrine wetlands located in the study area. The windshield survey identified one additional wetland and refined the boundary of an additional wetland. The east side of the study area is bordered by the Merrimack River. Top-of-bank mapping for the Merrimack River was not delineated for this phase of the study, but was estimated based on aerial photography.

Two small wetlands are located on the west side of I-293, in the vicinity of the Eddy Road southbound on-ramp. The first wetland (Wetland 1) is located north of the former Coca-Cola bottling facility, adjacent to a parking lot. Wetland 1 is an isolated scrub-shrub wetland surrounded by invasive species. Silky dogwood and sensitive fern were observed as well as scattered litter throughout the wetland. The second wetland (Wetland 2) is an intermittent stream system with a submerged headwall at the inlet near Eddy Road. The stream outlets under I-293 and discharges to the Merrimack River. The two wetlands do not appear to be hydrologically connected.

The third wetland (Wetland 3) is forested wetland located immediately west of Eddy Road across from a commercial landscaping business. There was no visible surface outlet to Wetland 4 (located approximately 50 feet to the north) at the time of the field-reconnaissance, but the two wetlands are likely connected via a groundwater seep or high water connection.

Exit 6

Eight wetlands are located within the Exit 6 study area. Four of the eight wetlands were previously identified in the City of Manchester's aerial mapping. These wetlands consist of emergent, forested, scrub/shrub, and open-water habitat. Given the proximity of these wetlands to the existing I-293 and the surrounding developed area, many of these wetlands have been disturbed and are surrounded by invasive species such as Phragmites, Japanese knotweed, bittersweet, and others.

Wetlands 4 and 5 are located on the southern end of the Exit 6 study area in vicinity of the Exit 6 southbound off ramp. Wetland 4 is located on the west side of Eddy Road across from an existing gas station. A two to three foot wide sinuous intermittent stream channel flows through the wetland that outlets under Eddy Road to Wetland 5. The upland edge closest to Eddy Road is dominated by invasives such as bittersweet, Japanese knotweed, and burning bush. Wetland 4 is likely connected to Wetland 3 (located upslope of Wetland 4 and discussed in the previous section.)

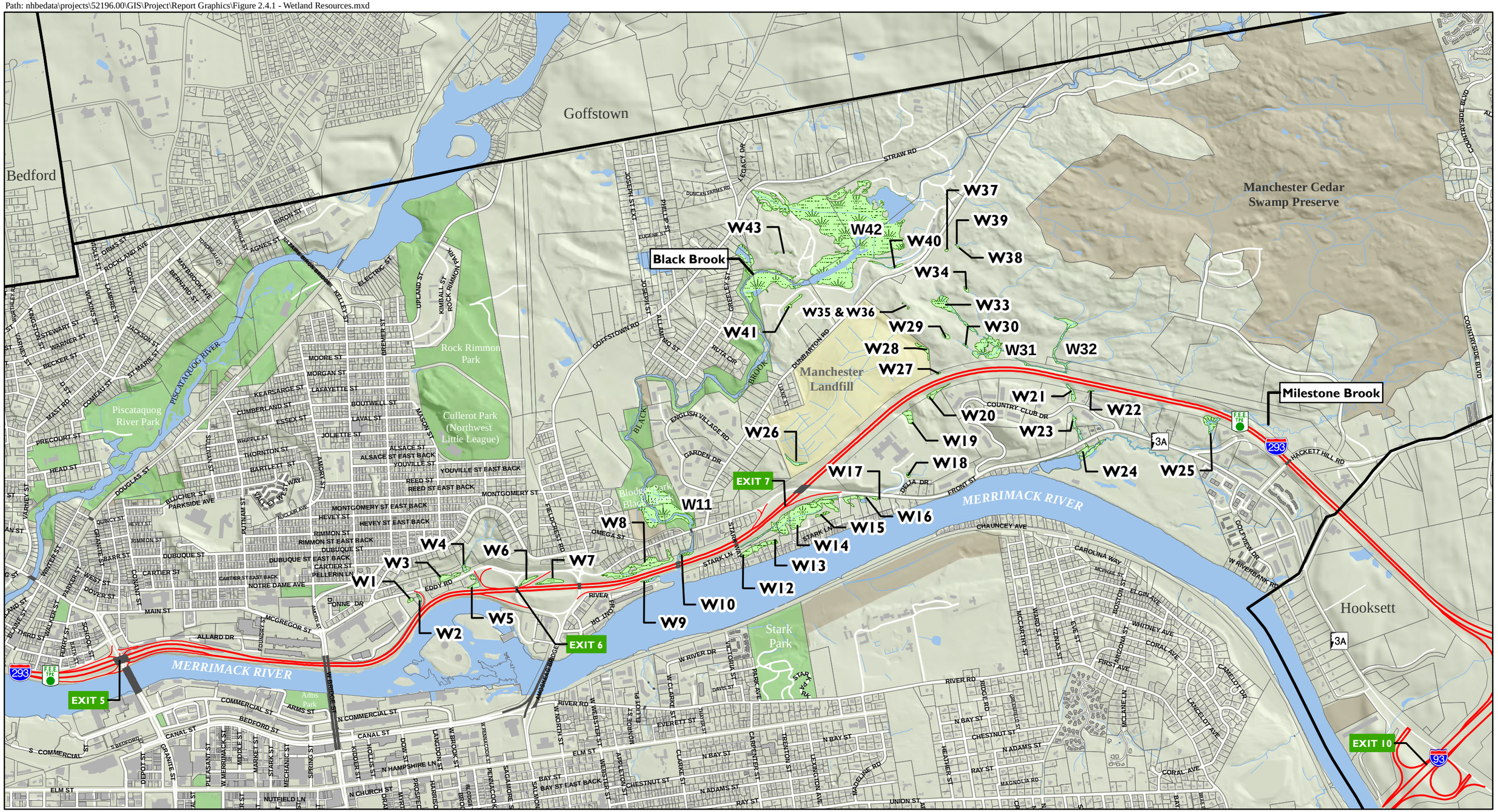
Wetland 5 is a scrub/shrub wetland with an intermittent stream channel flowing through it. The wetland system receives flow from three catch basins associated with the southbound off-ramp. A narrow stand of red maple saplings and equisetum are located adjacent to the intermittent stream channel. The shrub portion of the wetland is surrounded by a dense stand of knotweed, with trash and other debris scattered about the wetland.

Wetlands 6 and 7, which are both emergent systems, are located north and south of the Exit 6 southbound on-ramp. These wetlands are likely to be determined non-jurisdictional drainage areas associated with the construction of I-293. Wetland 6 is a cattail wetland, while Wetland 7 is dominated by Phragmites. Wetland 7 is located on the slope south of the Exit 6 southbound on-ramp. Both wetlands are connected to a series of catch basins and drainage pipes that connect to a larger drainage network which outlets to the Merrimack River in the vicinity of the Exit 6 northbound off-ramp.

The northern boundary of the Exit 6 study area extends approximately 400 feet north of Black Brook. In addition to Black Brook and the Merrimack River, four palustrine wetlands were identified (Wetlands 8-11) in this area. Wetland 11, with its scrub-shrub habitat, is one of the larger wetlands in the study area, and is located along Black Brook in Blodget Park (located off of Front Street). Much of Wetland 11 is located in the former impoundment on Black Brook that was removed several years ago. Wetland 10 is a small forested wetland located on the north side of the bank, just west of the I-293/Black Brook crossing.

Wetland 8 is located south of the Black Brook crossing and Front Street. Wetland 8 is classified as forested/emergent wetland primarily dominated by red maple. The southern end of the wetland is dominated by a solid stand of Phragmites. The western edge of the wetland is bordered by residential development along Front Street and is surrounded by Japanese knotweed. There was no obvious outlet observed in the field, but there is likely a culvert outlet under I-293.

Path: nhbedata\projects\52196.00\GIS\Project\Report Graphics\Figure 2.4.1 - Wetland Resources.mxd



Legend

- Assessor's Tax Parcels
- Building
- Surface Water
- Stream
- City Park Land
- Conservation/Public Land
- Bridge
- VHB Verified Wetland

0 1,500 3,000 Feet

Vanasse Hangen Brustlin, Inc.

Manchester 16099
FEET/I-293, Exits 6-7 Planning Study

Figure 2.4-1
Wetland & Surface Water Resources

Manchester, NH

New Hampshire DOT Department of Transportation

Wetland 9 is a small forested wetland along the cul-de-sac at the end of Riverfront Drive and includes many invasive species such as knotweed, bittersweet and others. Standing dead trees in the wetland were observed during the field visit.

Exit 7

Overall, thirty-two wetlands were identified in the Exit 7 study area. NRCS identified two types of hydric soils in this area: Chatfield-Hollis-Rock outcrop complex and Greenwood mucky peat. Many (n=13) of these wetlands (Wetlands 27-39) are located north of Manchester Landfill in undeveloped land associated with the western edge of Hackett Hill. A utility right-of-way traverses this area as well, where one of the larger wetlands (Wetland 33) is located. Wetlands 30 thru 34 are connected by a series of intermittent streams flowing northeasterly to a culvert at Wetland 32, which drains under I-293. Wetland 31 is another large and diverse wetland with potential vernal pool indicators in some pockets of standing water. The other wetlands in this area consist mostly of small isolated forested wetlands and intermittent stream channels.

The field-reconnaissance also confirmed fourteen wetlands (Wetlands 12-25) east of I-293, between the highway and the Merrimack River. Six (6) of these wetlands (Wetlands 12-17) are located in the vicinity of the existing Exit 7 northbound off-ramp and along Front Street. Wetland 14 is the largest wetland in this area and is primarily an emergent wetland system. The radio towers and fences associated with the WGIR radio station are in this wetland. Many invasive species are growing around Wetland 14 along Stark Lake, but mainly purple loosestrife was noted within the wetland itself. Other wetlands in this area consist of smaller emergent cattail and open wetlands, but have been altered by construction activities along Stark Lane and Front Street.

Wetlands 18 thru 25 are located north of the Manchester Community college driveway and south of Milestone Brook. Many of these wetlands consist of forested habitat with intermittent and perennial streams flowing through them. Several of these wetlands are connected to each other (Wetlands 21-25), but are also connected by culverts to upstream wetlands (Wetlands 31-33) on the west side of I-293 in the Hackett Hill Area. These wetlands have seen some disturbance from the apartments/condos on Country Club Drive, but remain fairly intact with upland buffers.

A group of four wetlands (Wetlands 40-43) are located in the area between Dunbarton Road and Goffstown Road. Wetland 42, the largest wetland within the study area, is located along both sides of Black Brook, but the majority of this palustrine system is located on the west side of the brook. Wetland 42 is primarily a scrub-shrub wetland with various areas of open water with many important wetland functions and values observed during the field-reconnaissance. Additionally, multiple New Hampshire Natural Heritage Bureau (NHNHB) database records for rare, threatened, or endangered species have been observed in or within close proximity to Wetland 42.

2.4.2 Surface Waters

The Merrimack River, Black Brook, and Milestone Brook represent the three primary surface water bodies in the study area (Figure 2.4-1). The Merrimack River is the second largest river in New England with a total length of 116 miles and a watershed of 5,010 square miles, before it empties into the Atlantic Ocean near Newburyport, Massachusetts. The river flows through the City of Manchester along the easterly edge of the study area and adjacent to I-293. The river provided much of the water power used to operate the historic textile mill complex located along the river banks in Downtown Manchester. Today, the river is still used to supply hydroelectric power through the nearby Amoskeag Dam. The Amoskeag Dam is located near Exit 6 off of I-293 on the east side of the river. Below the dam, the river is free flowing with relatively swift currents for several miles.

Black Brook and Milestone Brook are tributaries to the Merrimack River that drain from the west with their watersheds primarily located in the communities of Manchester, Dunbarton and Goffstown. Black Brook flows beneath Front Street and I-293 and enters the Merrimack River just north of Exit 6. Milestone Brook flows beneath I-293 about 0.25-mile south of the Hackett Hill Road underpass.

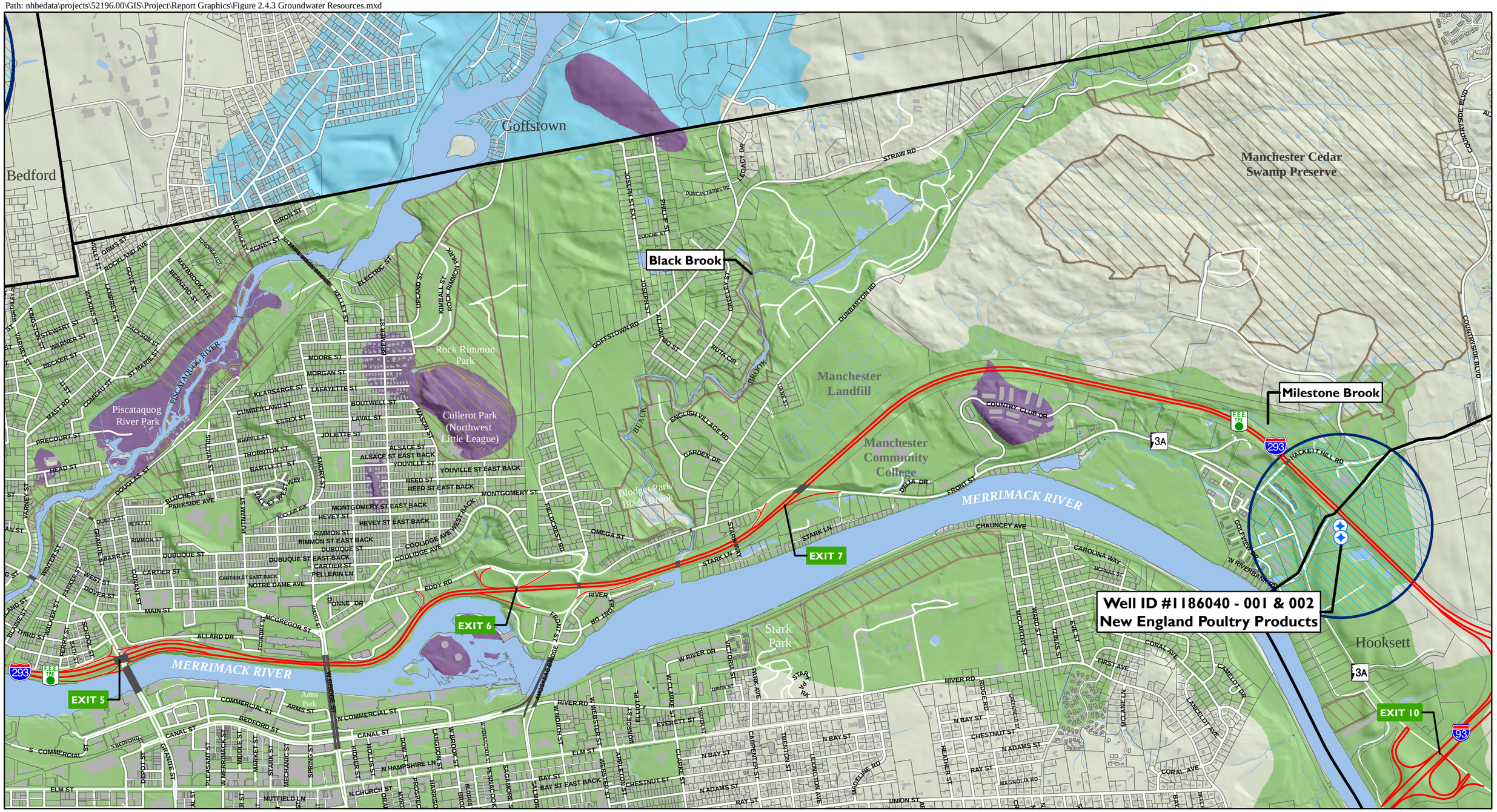
According to the New Hampshire Department of Environmental Services' (NHDES) 2012 303(d) list of impaired water bodies, the three water bodies have known water quality impairments indicating that the existing water quality is not sufficient to fully support all designated uses. For the Merrimack River, the primary water quality concern relates to elevated levels of *E. coli* bacteria, which can pose a potential human health risk for primary (i.e., swimming) and secondary (i.e., boating) recreational uses of the river. NHDES indicates that the elevated bacteria levels were detected within the impoundment behind the Amoskeag Dam and the potential source relates to releases of combined sewer overflows during wet weather events. The City of Manchester has developed a long-term capital improvement to minimize the number and frequency combined sewer overflow events in the future. Additionally, the Merrimack River is considered to be marginally impaired relative to supporting aquatic life due to previously detected elevated levels of aluminum, low pH and low dissolved oxygen saturation levels. The potential sources for these impairments are listed as unknown (NHDES 305(b)/303(d) list, 2010).

Black Brook and Milestone Brook are listed as impaired primarily due to previously detected elevated levels of iron and mercury, which could adversely affect aquatic life. The potential sources are listed as unknown. NHDES has indicated a target date of 2019 to complete a Total Maximum Daily Load (TMDL) study to address these water quality impairments of these brooks.

2.4.3 Groundwater Resources

Information on groundwater resources (**Figure 2.4-2**) in the form of aquifers mapped by the US Geological Survey, was retrieved from the NHGRANIT GIS database. The majority of the study area is underlain by a Stratified-drift Undifferentiated aquifer.

Path: nhbedata\projects\52196.00\GIS\Project\Report Graphics\Figure 2.4.3 Groundwater Resources.mxd



Legend

- Assessor's Tax Parcels
- Building
- Surface Water
- Stream
- Conservation/Public Land
- Bridge
- Town/City Boundary
- Public Water Supply
- Well Head Protection Area

USGS Aquifer Boundaries

- Glacial Lake Bottom Deposits
- Stratified-drift
- Till
- Non Aquifer Area

Note: The entire City of Manchester is located in the Source Water Protection Area (SWPA).

0 1,500 3,000 Feet

Vanasse Hangen Brustlin, Inc.

Manchester 16099
FEET/I-293, Exit 6-7 Planning Study

Figure 2.4-2
Groundwater Resources

Manchester, NH

New Hampshire DOT Department of Transportation

GIS data from NHDES were retrieved to determine whether the study area is located within a designated Well Head Protection Area (WHPA) or Source Water Protection Area (SWPA), or if there are any mapped public or private wells in the vicinity. This research revealed no WHPA within the study area and, according to the NHDES database, the only monitoring wells in the area are those associated with the landfill. Two non-transient, non-community wells associated with New England Poultry Product Inc., were identified just north of the study area. The entire City of Manchester is located in a SWPA watershed of the Pennichuck Water Works drinking water intake located in Nashua, NH.

2.4.4 Floodplains

All federal projects potentially impacting floodplains require an evaluation under Executive Order 11988, Floodplain Management (May 24, 1977). The regulation that sets forth the policy and procedures of this order is entitled Floodplain Management and Protection of Wetlands (44 CFR §9), which is under the authority of the Federal Emergency Management Agency (FEMA).

Information on the Regulatory Floodway and 100-year floodplain within the study area was obtained by reviewing the FEMA Digital Flood Insurance Rate Map (FIRM) mapping for Hillsborough County (Community Panels 33011C0236D, 33011C0238D, 33011C0376D). See **Figure 2.4-3**. The FIRM information also provides users with automated flood-risk data that can be used to locate Special Flood Hazard Areas (SFHA); the risk zones are depicted on a community's hardcopy FIRM maps. The FIRM mapping identifies three areas of floodplain resources associated with the Merrimack River, Black Brook, and Milestone Brook. FEMA mapping identifies both Regulatory Floodway and 100-year floodplain for the Merrimack River. Only 100-year floodplain has been identified for Black Brook and Milestone Brook and is identified as SFHA Zone A, indicating that no hydraulic analyses or base flood elevations have been established for either brook.

It is important to note that the flood insurance hydraulic analysis for this portion of the Merrimack River was completed in the 1970s, which means that the flood elevations could potentially change in this area under a revised analysis. As the design moves forward theses flows should be reevaluated with updated gage data from USGS and the Amoskeag Dam.

2.4.5 Farmland

Information on Important Farmland Soils as defined by the Farmland Protection Policy Act (FPPA) was retrieved from the NRCS Web Soil Survey for Hillsborough County. The Web Soil Survey contains current digital mapping and soil-unit attribute information on Prime Farmland, Statewide Important Farmland soils, and Farmland of local importance. In addition to the data provided by the NRCS, aerial photography was used to determine the presence or absence of active farmlands in the study area. NRCS farmland soils are shown in **Figure 2.4-4**.

Prime Farmlands

The NRCS database identified a small pocket of prime farmland soil within the overall study area. The prime farmland soil is on a parcel of land owned by Manchester Community College. The soil is classified as Agawam fine sandy loam and is primarily forested with a small portion located in an open area maintained by the College.

NRCS also mapped two pockets of Prime Farmland if drained. These areas are located in the wetland complex just east of the existing Exit 7 northbound off-ramp and much of the land associated with the Intervale Country Club.

Farmland of Statewide Importance

NRCS mapped three small pockets of Farmland Soil of Statewide Importance located in Manchester Cedar Swamp preserve of Hackett Hill.

Farmland of Local Importance

Farmland Soil of Local Importance can be found in northern stretches of the study area, north of Manchester Community College. The first area is located east of Front Street along the Merrimack River, in the vicinity of the Intervale Country Club. The soil in this area is classified as Suncook loamy fine sand. The majority of this area occurs in areas of residential development. The only non-developed areas occur on the grounds of the Intervale Country Club.

A larger pocket of Farmland Soil of Local Importance is located north of the Manchester Landfill between the Public Service of New Hampshire right-of-way (ROW) and the Washington Park Apartment complex. Soil in this area is classified as Windsor loamy sand and Deerfield loamy fine sand. A large portion of mapped Farmland Soil of Local Importance in this area has been disturbed, as I-293 bisects the area, and the area to the east has been developed by the Washington Park Apartment complex.

Soils mapped by the NRCS as Prime Farmland or Farmland of Local Importance in the study area consist primarily of industrial, retail, residential development, forested upland, and wetland habitats. Some areas designated by the NRCS as farmland based on soil type include waterway and vegetated wetlands and do not necessarily reflect those areas conducive to agricultural production. However, a Farmland Conversion Impact Rating may need to be prepared for review by the NRCS for compliance with the Farmland Protection Policy Act (FPPA). This is not expected to be a substantial issue for the advancement of transportation solutions in the future.

2.4.6 Rare, Threatened, or Endangered Species

Letters were sent both to the US Fish & Wildlife (USFWS) and the New Hampshire Natural Heritage Bureau (NHNHB) asking whether there were any records of rare species within the study area. A response from NHNHB was received on June 28, 2012 and from USFWS on June 20, 2012 (**See Appendix**).

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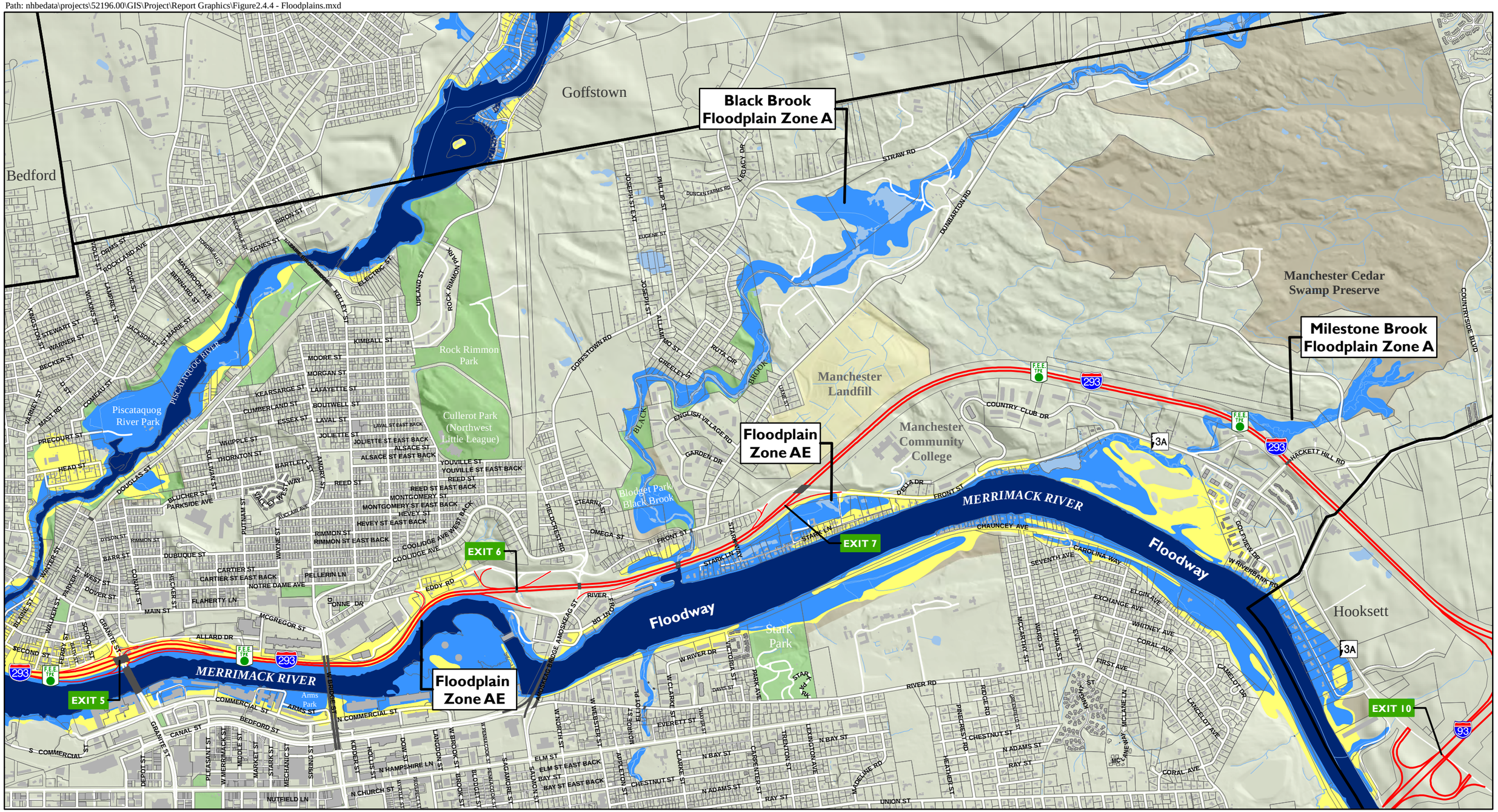

Legend

- Assessor's Tax Parcels
- Building
- Surface Water
- Stream
- City Park Land
- Conservation/Public Land
- Bridge
- Town/City Boundary

FEMA DFIRM Mapping

- 100-yr Floodplain
- 500-yr Floodplain
- Floodway

0 1,500 3,000 Feet

VHB Vanasse Hangen Brustlin, Inc.

Manchester 16099
FEET/I-293, Exit 6-7 Planning Study

Figure 2.4-3
FEMA Floodplain Mapping

Manchester, NH

New Hampshire DOT Department of Transportation

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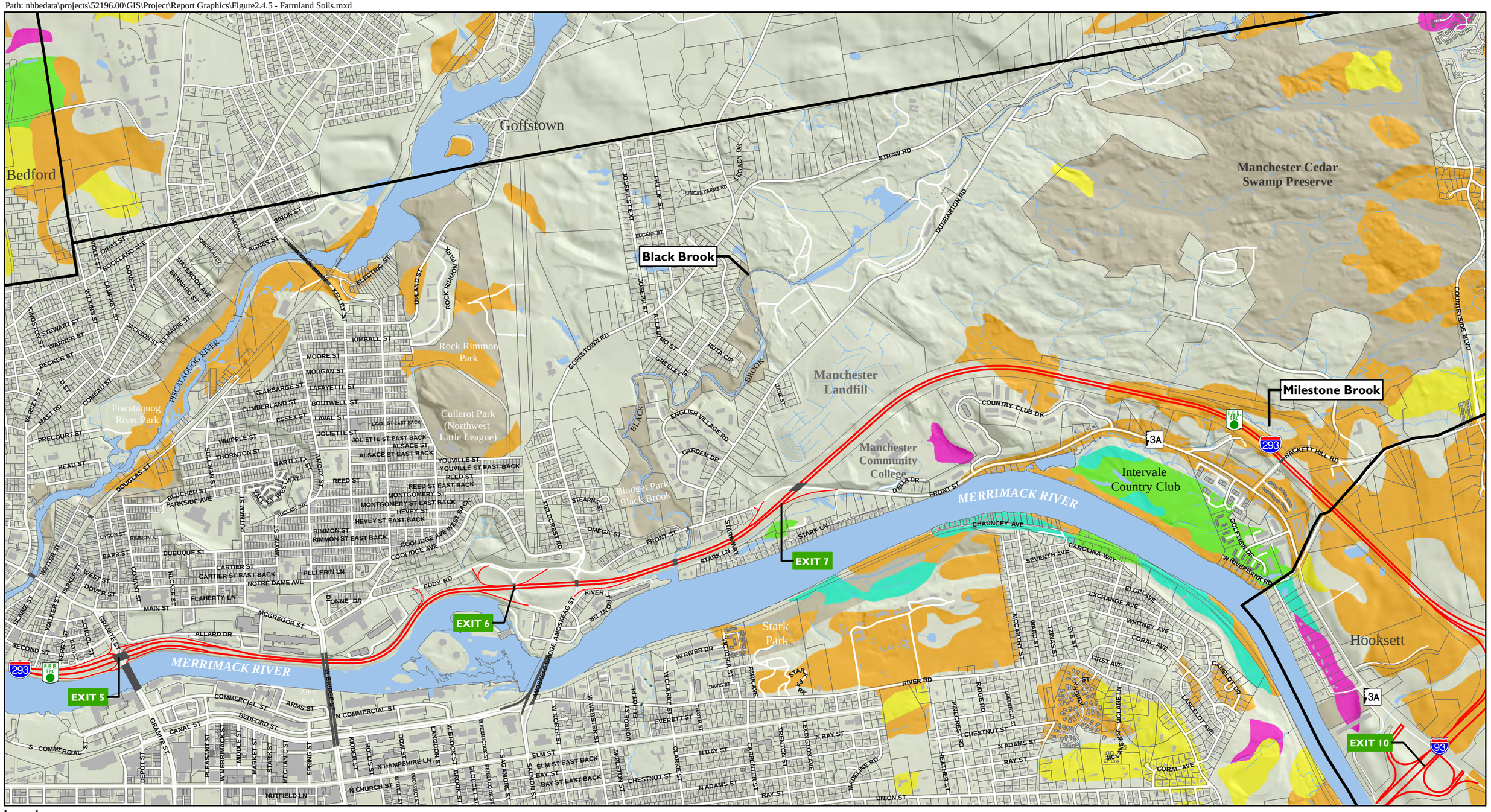


Vanasse Hangen Brustlin, Inc.

Manchester 16099
FEET/I-293, Exit 6-7 Planning Study

Figure 2.4-4
NRCS Farmland Soils

Manchester, NH

New Hampshire DOT Department of Transportation

The NHNHB database search turned up 26 database records of rare species and exemplary natural communities within the vicinity of the study area. Specifically, three Invertebrate Species, four Vertebrate Species, twelve 12 Plant Species, and six Natural Communities (**See Table 2.4-1**). NHNHB defines "vicinity" by applying a 1-mile buffer to an applicant's study area to identify potential populations. Of the 26 database records only 10 records are within a distance that could potentially be impacted by the project. For protection purposes, the NHNHB data sharing regulations prevent the rare species information to be displayed in any reports, unless at a scale of 1:100K or larger. This scale limitation in relationship to the study area does not allow for a graphic to be presented in this report at a reasonable scale.

Table 2.4-1 Rare, Threatened or Endangered Species

Species	State Status	Federal Status
Invertebrate Species		
Brook Floater (*Alasmidonta varicosa*)	Endangered	--
Persius Dusky Wing (*Erynnis persius persius*)	Endangered	--
Pine Barrens Zanclognatha Moth (*Zanclognatha martha*)	Species of Concern	--
Vertebrate Species		
Grasshopper Sparrow (*Ammodramus savannarum*)	Threatened	--
Perigrine Falcon (*Falco peregrinus anatum*)	Threatened	--
Pied-billed Grebe (*Podilymbus podiceps*)	Threatened	--
Redfin Pickerel (*Esox americanus americanus*)	Species of Concern	--
Plant Species		
Clasping milkweed (*Asclepias amplexicaulis*)	Threatened	--
Clustered sedge (*Carex cumulata*)	Threatened	--
Downy False Foxglove (Aureolaria virginica)	Endangered	--
Golden Heather (*Hudsonia ericoides*)	Endangered	--
Licorice goldenrod (*Solidago odora*)	Endangered	--
Lion's-foot rattlesnake root (*Nabalus serpentarius*)	Endangered	--
Long-spined sandbur (*Cenchrus longispinus*)	Endangered	--
Lopsided rush (*Juncus secundus*)*	Endangered	--
Narrow-leaved white-topped-aster *(Sericocarpus linifolius*)	Endangered	--
Sesile-fruited Arrowhead (*Sagitttaria rigida*)	Endangered	--
Smooth slender crabgrass (*Digitaria filiformis varlaeviglumis*)	Endangered	--
Wild Lupine (*Lupinus perennis*)	Threatened	--
Wright's spikesedge (*Eleocharis diandra*)	Endangered	--
Natural Communities		
Acidid riverbank outcrop		
Appalachian oak - pine rocky ridge		
Atlantic white cedar - giant rhododendron swamp		
Coastal conifer peat swamp system		
High-gradient rocky riverbank system		
Rich red oak rocky woods		

The letter from the USFWS concluded that there are presently no federally-listed or proposed, threatened or endangered species or critical habitat under the jurisdiction of the US Fish and Wildlife in the study area. Preparation of a Biological Assessment or further consultation with that agency under Section 7 of the Endangered Species Act is not anticipated.

2.4.7 Wildlife Habitat

The NH Fish and Game Department (NHFG) is responsible for managing and protecting resident wildlife species. NHFG has promulgated rules (FIS Chapter 1000) for the protection and management of these species. These rules pertain almost entirely to the exploitation of the species and not to the habitats. The rules set seasons, bag limits, and legal means for the take of game, fish, and furbearing species.

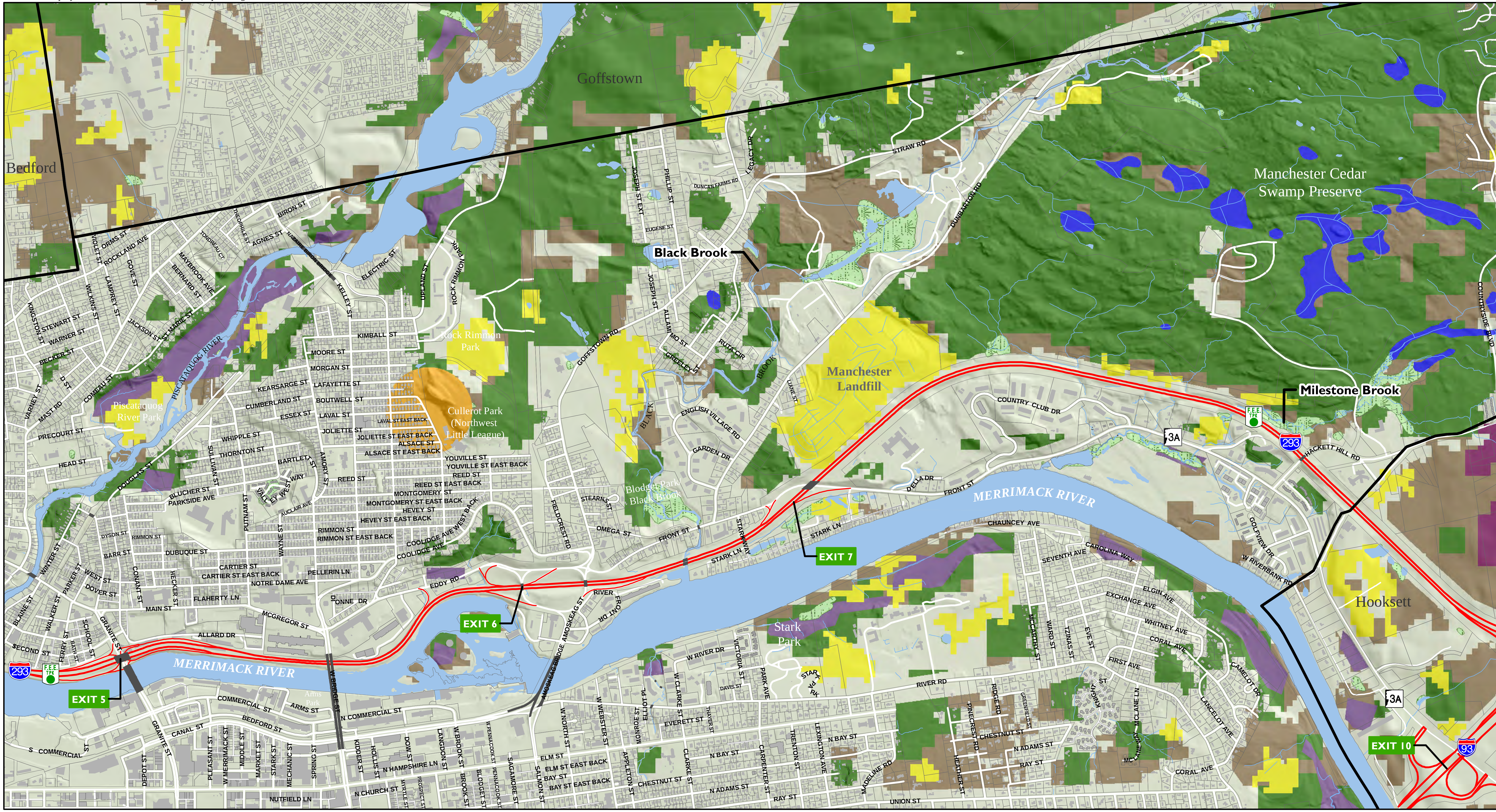
The USFWS is responsible for managing and protecting migratory wildlife species. Except for threatened and endangered species and their associated "critical habitats," federal protection of wildlife on private property is confined to regulations regarding the exploitation of species and does not extend to wildlife habitat. Both wildlife species and wildlife habitats are generally protected on Federal lands, including National Wildlife Refuges, National Parks and Monuments, and National Forests, none which are present in the study area.

The southern half of the study area is located within an urbanized area with dense development, which generally does not support substantial wildlife populations or contain important habitat. However, the Merrimack River, Black Brook, and the undeveloped land associated with the western edge of Hackett Hill and the Manchester Cedar Swamp Preserve are recognized wildlife corridors at both the state and regional levels.

A habitat map and ranked habitat map for the study area were compiled using digital GIS data from the NH Wildlife Action Plan (NHWAP, NH Fish and Game Department, 2010). See **Figure 2.4-5**. Habitat types found to exist within the project study corridor include:

- Appalachian-Oak-Pine Forest
- Floodplain Forest
- Grasslands
- Hemlock-Hardwood-Pine Forest
- Marsh and Shrub Wetlands
- Peatlands

The NHFG analyzed the habitat areas and developed a statewide three-tiered ranking scheme to identify the highest quality habitat in the state. **See Figure 2.4-6**. The Merrimack River, Hackett Hill, and the former Manchester Landfill are located within areas listed by the NHWAP as areas of "Highest Ranked Wildlife Habitat by Ecological Condition."



Legend

- Assessor's Tax Parcels
- Building
- Surface Water
- Stream
- Bridge
- Town/City Boundary

New Hampshire Fish & Game Wildlife Action Plan Habitats

- Hemlock-Hardwood-Pine Habitat
- Appalachian Oak-Pine Habitat
- Floodplain Forest
- Marsh/Wet Meadow/Shrub Swamp Habitat
- Grasslands
- Peatland Complex
- Pitch Pine Habitat
- Rocky Ridge & Talus Slope Habitat
- Area not considered to be priority habitat

0 1,500 3,000 Feet

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Manchester 16099
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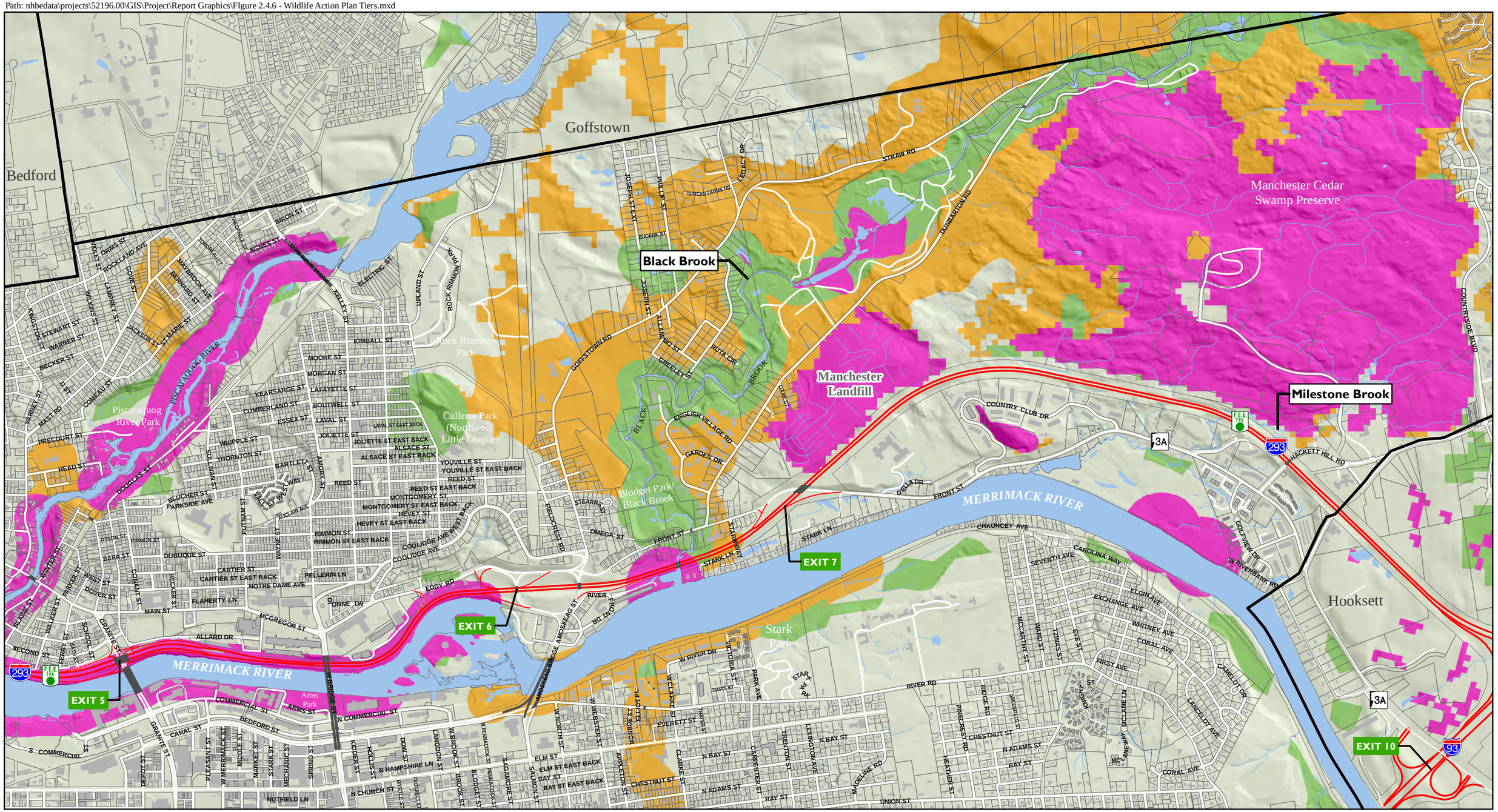
Figure 2.4-5
NHFG Wildlife Action Plan Habitats

Manchester, NH

New Hampshire DOT Department of Transportation

Path: nhbedata\projects\52196.00\GIS\Project\Report Graphics\FIgure 2.4.6 - Wildlife Action Plan Tiers.mxd



Legend

- Assessor's Tax Parcels
- Building
- Surface Water
- Stream
- Bridge
- Town/City Boundary

Ranked Habitat Tiers

- Tier 1 - Top Ranked Habitat in the State
- Tier 1 - Top Ranked Habitat in Biological Region
- Tier 3 - Supporting Landscape
- Area not considered to be priority habitat

0 1,500 3,000 Feet

Vanasse Hangen Brustlin, Inc.

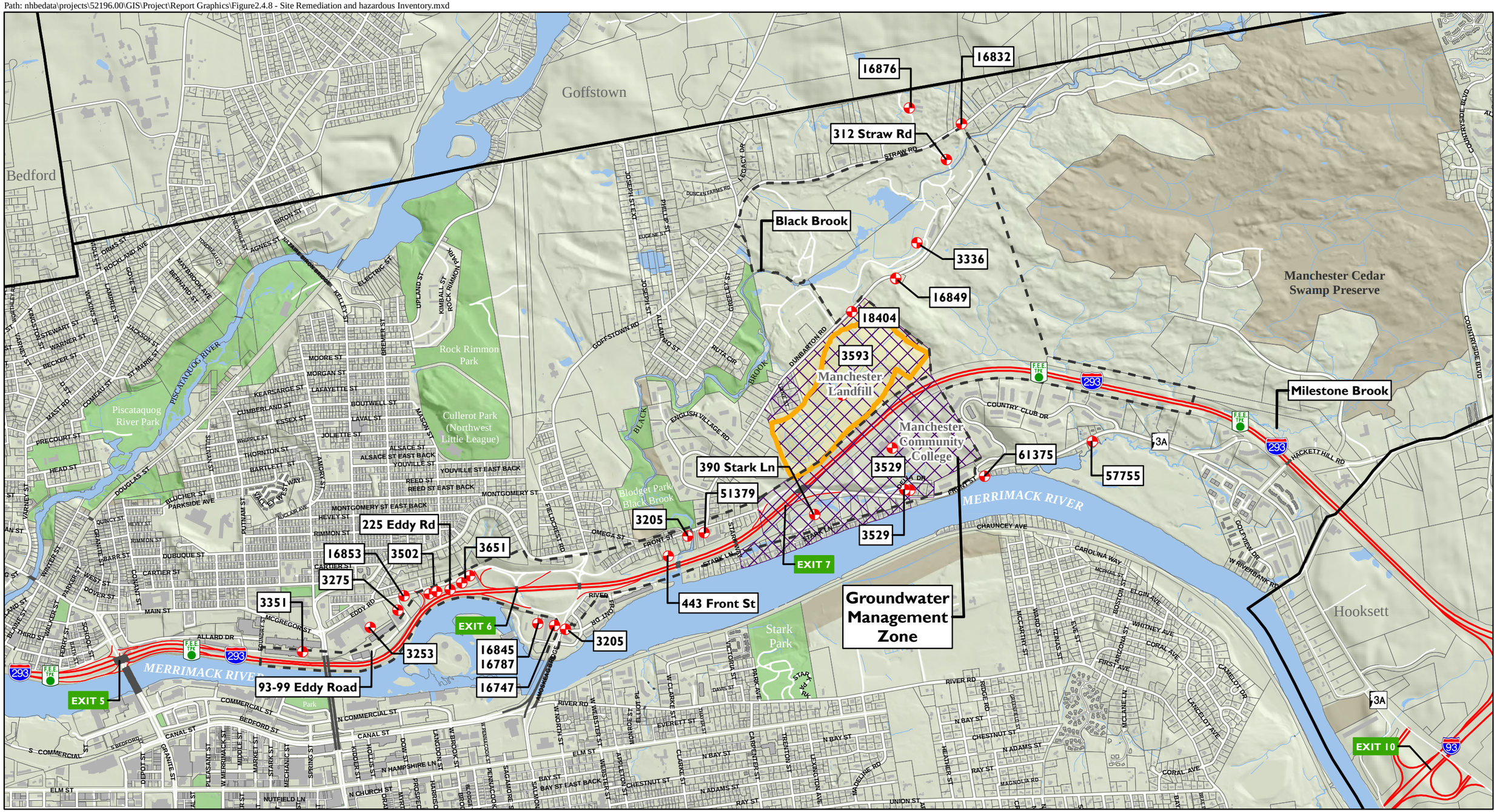
Manchester 16099
FEET/I-293, Exit 6-7 Planning Study

Figure 2.4-6
NHFG Wildlife Action Plan Habitat Tiers

Manchester, NH

New Hampshire DOT Department of Transportation

Path: nhbedata\projects\52196.00\GIS\Project\Report Graphics\Figure2.4.8 - Site Remediation and hazardous Inventory.mxd



Legend

- OHM Project Study Area
- Assessor's Tax Parcels
- Building
- Surface Water
- Stream
- City Park Land
- Conservation/Public Land
- Bridge
- Town/City Boundary
- Potential OHM Locations (Labeled by NHDES Master ID or Street Address)
- Landfill
- Landfill Groundwater Management Zone

0 1,500 3,000 Feet

VHB Vanasse Hangen Brustlin, Inc.

Manchester 16099
FEET/I-293, Exit 6-7 Planning Study

Figure 2.4-7
Potential OHM Locations

Manchester, NH

New Hampshire DOT Department of Transportation

Additionally Black Brook and its associated watershed is identified as "Highest Ranked Habitat in Biological Region."

2.4.8 Hazardous Material

VHB conducted a review of available databases to determine properties with oil and/or hazardous materials (OHM) concerns within anticipated work in the study area. Environmental Data Resources, Inc. (EDR) provided VHB with a database report summarizing government and state records available within a one-mile radius of the study area. **Table 2.4-2** summarizes the report findings. VHB also conducted a review of the NHDES One Stop Database available online. The GIS tool was used to generate a list of properties of concern located within or in close proximity to the study area.

Table 2.4-2 Properties with Oil and/or Hazardous Materials

Database	Number of Locations
NPL sites	0
CERCLIS sites	0
CERCLIS NFRAP sites	1
RCRA TSD	0
RCRS CORRACTs	0
RCRA Generators	20
State Hazardous Waste sites	24
NH Spills	2
NH Institutional Control	5
Facility Index System (FINDS)	42
NH Solid Waste/Landfill	2
Registered USTs	52
NH LUST	34
NH AIRS	4
FIFRA/TSCA Tracking System	1
Emergency Response	0
NH AST	6
Federal Land use	0
NH Brownfields	5

Properties determined to have the potential to impact the study are detailed in **Table 2.4-3**. Remaining properties are not expected to be an issue within the study area based on proximity to the site, regulatory status, nature of contamination, and/or inferred groundwater flow direction.

NHDES One Stop Database Findings

Several sites were noted that may have the potential to impact site environmental media and include active gas stations, electrical substations, industrial manufacturers, a closed landfill, and active NHDES remediation sites (**Figure 2.4-7 and Table 2.4-3**). Of particular note are the following active NHDES cases:

- 194/195 McGregor Street (NHDES Master ID 3351). A plume of chlorinated solvents in groundwater exists within the study area at this location. The contaminant concentrations are in excess of the Ambient Groundwater Quality Standards (AGQS), and a Groundwater Management Permit (GMP) has been assigned to the site. Groundwater at the site is located at depths ranging from 0.04 to 15.67 feet below the tops of well casings. Indoor air concentrations of contaminants measured in a nearby building have been detected above commercial screening levels.
- A gasoline filling station at 495 Front Street (NHDES Master ID 3488). The property abuts the study area directly to the west and is the location of a former release of gasoline. A GMP is in place at the property, and select petroleum constituents have been measured in groundwater in excess of AGQS. Groundwater at the site is located at depths ranging from approximately 10 to 18 feet below the tops of well casings.
- The Manchester Municipal Landfill located at 625 Dunbarton Road (NHDES Master ID 3593). Groundwater at this property has been impacted by landfill leachate, which is in direct contact with the groundwater. Metals and volatile organic compounds are the primary contaminants at the remediation site, which is managed under a GMP. The Groundwater Management Zone (GMZ) extends from an area south of Dunbarton Road in a northeast direction to the Merrimack River, crossing I-293.
- A gasoline station located at 245 Eddy Road (NHDES Master ID 3651). A gasoline release at the property has impacted groundwater, which ranges from approximately 7 to 10 feet below the tops of well casings. The property is located within the study area.

VHB conducted a field reconnaissance of the study area on September 27, 2012. It should be noted that the interiors of site structures were not observed. Properties noted as a concern during the field reconnaissance are detailed in **Table 2.4-4**. Although many of these properties are also listed on **Table 2.4-3,** there were five (5) additional locations identified, where material use and/or storage practices may have the potential for OHM concern.

Table 2.4-3 Properties Determined to have Potential Impacts

Master ID	Site Name	Address		Distance Relative to Study Area
3205	Gas Station	49 Amoskeag St	"Regulatory Action Completed - DES File Closed" Active USTs	Within Study Area
3237	Residential Site	26 Delia Dr	"Regulatory Action Completed - DES File Closed" No Active USTs	150 Feet East
3253	Industrial Site	345 McGregor St	"Regulatory Action Completed - DES File Closed"	200 Feet West
3275	Bottling Facility	99 Eddy Rd	"Regulatory Action Completed - DES File Closed" No Active USTs	Within Study Area
3336	Industrial Site	888 Dunbarton Rd	"Regulatory Action Completed - DES File Closed"	Within Study Area
3351	Industrial/Commercial Site	194/195 McGregor St	Active NHDES Site No Active USTs	Within Project Area
3502	Gas Station	210 Eddy Rd (also known as 157 Eddy Rd)	UIC Registered 2007 "Regulatory Action Completed - DES File Closed"	Within Study Area
3529	Manchester Community College	1066 Front St	Active USTs	Within Study Area
51379	Auto Repair	575-599 Front Street	N/A	Abuts to West
3488	Gas Station	495(493) Front Street	Active NHDES Site Active USTs	Abuts to West
3593	Manchester Municipal Landfill	625 (or 513) Dunbarton Rd	Active NHDES Site	Within Study Area
3651	Gas Station	245 Eddy Rd	Active NHDES Site Active USTs	Within Study Area
16747	Hotel	21 Front St	"Regulatory Action Completed - DES File Closed"	Abuts to East
16787	Electrical Substation	6 Fletcher St	"Regulatory Action Completed - DES File Closed"	Abuts to East
16832	Residential Site	245 Straw Rd	"Regulatory Action Completed - DES File Closed"	Abuts to West
16845	Amoskeag Hydro Station	W. Salmon St	"Regulatory Action Completed - DES File Closed"	Abuts Site to East
16849	Electrical Substation	833 Dunbarton Rd	Active AST	Within Study Area
16853	Electrical Substation	149 Eddy St	Active AST	Abuts to West
16876	Sendashi Pet Resort/Kennel	355 Straw Rd	UIC Registered 1998	500 Feet West
57755	Residential Site	1625 Front St	"Regulatory Action Completed - DES File Closed"	750 Feet East
61375	Sullivan Property	1164 Front St	Unknown	Abuts to the East

Table 2.4-4 Properties of Concern at Time of Field Review

Address	Property Use	Concern Observed on Property	Listed on Table 2.4-3?	Distance Relative to Study Area
6 Fletcher Street	Electrical Substation	Large pad-mounted transformers likely contain OHM	Yes	Abuts to East
26 Delia Drive	Residential	One 55-gallon drum and 5-gallon buckets stored next to shed	Yes	150 Feet East
49 Amoskeag Street	Gas Station	Petroleum handling and storage	Yes	Within Study Area
93-99 Eddy Road	Industrial Buildings with Commercial Tenants	May have historic uses of concern/Transformers	Yes (Partial)	Within Study Area
149 Eddy Road	Electrical Substation	Large pad-mounted transformers likely contain OHM	Yes	Abuts to West
194-195 McGregor Street	Industrial Buildings with Commercial Tenants	May have historic uses of concern	Yes	Within Study Area
210 Eddy Road	Gas Station	Petroleum handling and storage	Yes	Within Study Area
225 Eddy Road	Landscape Supply	Fill material with unknown origin	No	Within Study Area
245 Eddy Road	Gas Station	Petroleum handling and storage	Yes	Within Study Area
245 Straw Road	Residential	55-gallon drum stored outside garage	Yes	Abuts to West
312 Straw Road	Residential/Construction Storage	At least three 55-gallon drums stored outside	No	Within Study Area
345 McGregor Street	Industrial Buildings with Commercial Tenants	May have historic uses of concern	Yes	200 Feet West
390 Stark Lane	Communications Towers	Possible storage of oils on Site	No	Abuts to East
443 Front Street	Residential/Construction?	Storage of materials at rear of lot	No	Abuts to West
495(493) Front Street	Gas Station and Auto Repair	OHM handling and storage	Yes	Abuts to West
575-599 Front Street	Auto Repair	OHM handling and storage	Yes	Abuts to West
833 Dunbarton Road	Electrical Substation	Large pad-mounted transformers likely contain OHM	Yes	Within Study Area
888 Dunbarton Road	Aggregate Industries	Large piles of fill material and AST noted on Site, industrial use	Yes	Within Study Area
625 Dunbarton Road	Manchester Landfill/Gas Extraction Facility	Transfer station and closed landfill	Yes	Within Study Area
Intersection of Stark Lane and Front Street	Monitoring Wells	Reason for wells unknown	No	Abuts to East

2.5 Cultural and Community Resources

2.5.1 Historic/Archaeological

VHB conducted a cultural resources survey within the study area, consisting of two components. The first component was the identification of previously recorded properties, compiled at the New Hampshire Division of Historical Resources (NHDHR) and the City of Manchester. The second component consisted of a windshield survey of properties located within the areas potentially affected by the project and those that may have indirect visual effects. VHB cultural resource staff performed a site file search at NHDHR for recorded above-ground properties on July 20, 2012, to gather information on previously documented resources in the study area. Generally speaking, the site file search was limited to properties located within 0.25-mile radius of the I-293 corridor from Exit 5 to approximately one mile north of existing Exit 7. Additionally, the site file search was expanded to include the project corridor between Front Street, in the vicinity of the Manchester Community college, and Goffstown Road (**See Figure 5.2-1**). Furthermore, the search was limited to properties located on the west side of the Merrimack River.

One National Register-listed district and one National Register-certified district are located within the study area vicinity. There are seven individually recorded properties located within the study area vicinity. Of these seven recorded properties one property is listed in the National Register, one property is listed in the State Register, one property was determined individually eligible for the National Register by NHDHR, two properties have been determined eligible by NHDHR as part of a district (McGregorville/Notre Dame district), one property was determined not eligible for the National Register, and for one property a National Register nomination form was prepared but the property was never formally listed. In addition, two project area forms on file at NHDHR cover areas located in the vicinity of the study area. The results of the site file search are summarized in **Table 2.5-1** and depicted on **Figure 2.5-1**. (See **Appendix** for a complete listing of above-ground resources as identified in the NHDHR Request for Project Review.)

The City of Manchester maintains GIS information for historic above-ground resources located within the city limits, including National Register districts and locally-designated districts subject to specific zoning regulations, individual National Register-listed properties, properties determined eligible for the National Register, and local historic sites. The City's GIS information was merged with the results of the NHDHR site file search for a complete picture of all properties located within the study area.

In addition to the results of the site file research, VHB cultural resource staff, in consultation with NHDHR, anticipates that at least one local historic district and several historic properties could be identified along Front Street, between Goffstown Road and Exit 7. None of these properties have been previously inventoried. NHDHR staff recommend a Project Area Form be completed for the study area once an Area of Potential Effect (APE) can be established. Working with NHDHR, VHB developed a draft APE boundary for the current study area, which should be re-evaluated in the next phase of the project.

Table 2.5-1 Previously Recorded Above-ground Properties*

NH DHR Property Name/ Historic District Name	NH DHR Inventory #	National Register-listed, Eligible, or Not Eligible	Date of Determination (mm/dd/yy)	National Register Criteria of Significance (if applicable)
Amoskeag Millyard Historic District	N/A	Certified NR district	05/31/12	A, C, D; potentially B
333 Front Street	MAN1089	NR Not Eligible individually	11/08/95	N/A
Martin-Stearns House, 367 Front Street	MAN1088	NR Eligible individually	04/21/99	C
412 Notre Dame Avenue	MAN0292	Within potential Eligible district/ potentially Eligible individually (more information needed)	09/09/09	None noted, likely A and C for district
404 Notre Dame Avenue	MAN0290	Within potential NR Eligible district	06/24/09	None noted, likely A and C for district
Manchester Exit 5 Study Area	N/A for area, includes MAN0028, MAN0063, and MAN0029	Not Eligible as NR district, but contains portion of Amoskeag Millyard Historic District within boundaries	02/09/00	N/A
Granite Street Area	MAN0021-MAN0024	Not Eligible as NR district, but contains portion of Amoskeag Millyard Historic District within boundaries	03/28/01	N/A
418-420 Notre Dame Avenue	N/A	NR listed	10/31/96	A and C
Eugene and Marie Quirin House, 250 Coolidge Avenue	MAN1039	Potentially NR Eligible individually (more information needed)/ SR-listed	02/08/06	A and C; potentially B
Amoskeag Manufacturing Company Housing Districts	N/A	NR listed	09/23/82	None noted, likely A and C
Amoskeag Federal House, moved to 225 Eddy Road	N/A	NR form prepared but property is not listed	NR form prepared 05/20/74	None noted/ if Eligible, likely A and C

* Properties within 0.25-mile of study area.

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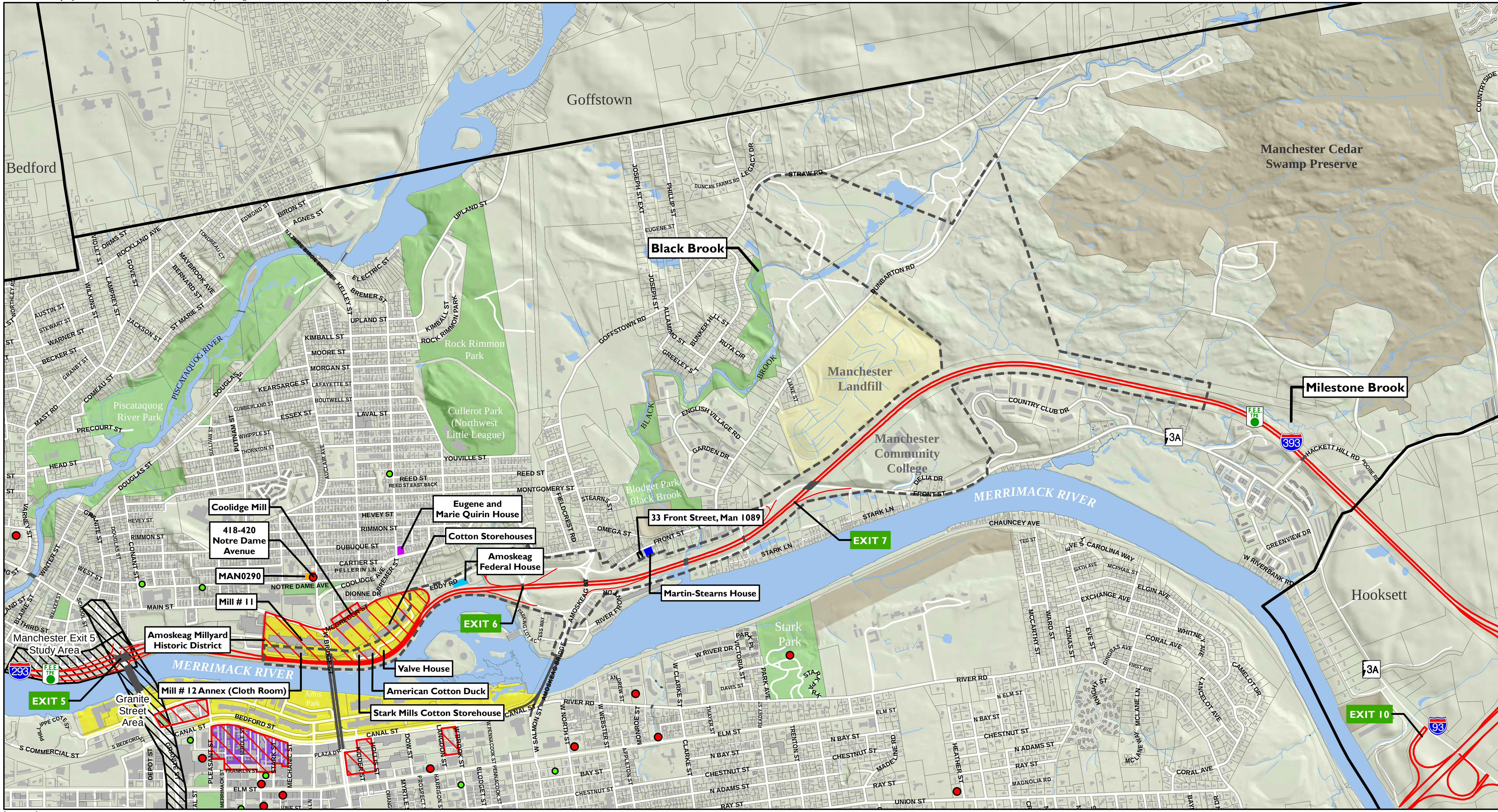

Legend

- Cultural Resource Study Area (Approximate Limits)
- Assessor's Tax Parcels
- Building
- Surface Water
- Stream
- City Park Land
- Conservation/Public Land
- Bridge
- Town/City Boundary

Preliminary NHDR Aboveground Research Results
Property Designation Status

- Certified NR District; NR Listed
- NR Eligible Individually
- Potentially NR Eligible/SR-Listed
- Within Potential Eligible District/Potentially Eligible Individually
- Not NR Eligible
- NR Form Prepared but Property is not Listed

City of Manchester Districts Under Zoning Ordinance

- Amoskeag Corporation Housing Historic District
- Amoskeag Millyard Historic District

City of Manchester Identified Historic Sites

- NR Listed
- NR Eligible (Recommended Eligible by Preparer of Documentation)

0 1,500 3,000 Feet

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Manchester 16099
FEET/I-293, Exit 6-7 Planning Study

Figure 2.5-1
Cultural Resource Areas

Manchester, NH

New Hampshire DOT Department of Transportation

Archaeological Resources

A site file search was conducted at the NHDHR offices on July 20 and July 23, 2012 to identify previously recorded archaeological sites and their associated forms, as well as completed archaeological study reports that could assist in the identification and understanding of archaeologically sensitive areas in the study area. (See Appendix.) A total of 45 sites have been recorded in the five-kilometer buffer, including prehistoric, historic, and multi-component sites. By far, the vast majority of the recorded sites (including prehistoric and historic) are located adjacent to, or within close proximity of the Merrimack River. It should be noted that the largely undeveloped area at the north end (Hackett Hill area) of the study area has no recorded archaeological sites in the vicinity. However, this should not be construed as an indication of a lack of archaeological potential; rather, this likely reflects the lack of investigation and survey of the area.

Previously Recorded Archaeological Sites

Amoskeag Falls

The Amoskeag Falls served as a main source of sustenance during the earliest settlement of the area and provided the impetus for the continuation of that development during the historic era when industrial advantages joined transportation benefits of commercial and residential development along the river. A concentration of approximately a dozen prehistoric and multi-component sites has been located in the immediate area of Amoskeag Falls. A number of these sites were originally noted in the 1930s and 1940s and surveyed in the late 1970s and 1980s by the New Hampshire Archaeological Society (NHAS) as part of the NH State Conservation and Rescue Archaeology Program (SCRAP). Although several of the sites had been discussed in publications of the archaeological community, by the time they were formally investigated during the late 20th century, most of these sites had been destroyed by development.

Other sites have been recorded more recently (1980s-present) as part of field school programs, cultural resource management project surveys, or independent investigations. These sites include three recommended by the surveyors as eligible for the National Register one site evaluated as potentially significant, and three sites recommended as not eligible. The sites recommended as eligible include the multi-component site 27-HB-362, the historic site 27-HB-377, and 27-HB-229, a prehistoric site. The form for 27-HB-362 notes that future data recovery from the site has the potential to fill gaps of understanding left by the destruction of other sites previously located near the Amoskeag Falls. A fourth site located in the Amoskeag Falls vicinity has been assessed as potentially significant. The prehistoric site 27-NH-413 was surveyed by the State Archaeologist quite recently, after an artifact find by a landowner. The form notes the "high research" potential of the site and the National Register eligibility evaluation section notes the site's eligibility under National Register Criterion D, which recognizes the site's potential to yield significant information in the future. However, the evaluation section leaves the National Register eligibility column (i.e., where the evaluator chooses between individually eligible, eligible in a district, not eligible, or more information needed) blank and there is no official DOE. Three additional historic sites located near the falls (27-HB-364, 27-HB-367 and 27-HB-368) were recommended not eligible for the National Register. Site 27-HB-364 was considered not eligible due to lack of integrity of the site, while excavations at 27-HB-367 are considered to have exhausted the recovery potential of the site.

(Clyde) "Berry Sites"

Nearly half of the recorded sites were surface collected by local historian Clyde F. Berry during the 1930s. The artifacts are kept at the NHAS and the 1980s and 1990s preparation of forms that are in the NHDHR files appears to be part of an effort to have these sites formally recorded at NHDHR, rather than as part of a systematic, comprehensive effort to update or assess the integrity of the sites. That being said, a few of the Berry sites have been investigated more recently, especially during the 1980s in affiliation with the NHAS and SCRAP. These recently-investigated sites are noted as likely destroyed based on reports of future development noted in the forms. Aside from the small number of recorded Berry sites that have been the subject of more recent surveys, no recent information about the Berry sites is available and their integrity has not been assessed. These sites are located throughout the five-kilometer radius, and include some of the Amoskeag Falls area sites.

Additional Significant Recorded Sites

One additional archaeological site has been determined eligible for the National Register by the NHDHR, in a Determination of Eligibility dated November 3, 1992. Site 27-HB-030 is located near the outer edge of the five-kilometer buffer, southwest of the study area. Although plowing has occurred at this prehistoric site, activity areas within the site are still distinguishable, suggesting the data potential for a site that may be associated with Middle Archaic and Woodland period occupations of the Amoskeag Falls region.

NHDHR indicated that the Amoskeag Falls area is one of the most important archaeological areas in the state – first evidence of pottery, a Native American cemetery, and deposits go down to two meters. NHDHR suggested the preparation of a Phase 1A report be completed as soon as possible to identify potential areas of sensitivity for archaeological resources. NHDHR also noted that during the Exit 5 (Granite Street) interchange improvements, a site was found underneath I-293, noting that sensitivity could be far-reaching for any additional roadway improvements.

2.5.2 Parklands and Recreation

Parklands and recreational areas are protected by various federal statutes that may apply to future phases of the Study if funding is provided by the FHWA.

Conservation Land

Based on a review of the most recent NHGRANIT Conservation/Public Lands database, two occurrences of existing conservation land are found within close proximity to the study area. Specifically, the Samuel Blodget Park and the Manchester Cedar Swamp Preserve are within close proximity.

- Blodget Park located off Front Street, is an approximately 60-acre park that has been protected by a permanent conservation easement by the City of Manchester. The

management status protects more than 50% of the area from conversion of natural cover, but subject to extractive uses of either a broad-scale low-moderate intensity type (such as timber harvest) or localized-scale high intensity type (e.g., mining).

- Manchester Cedar Swamp Preserve located off Hackett Hill Road is approximately 600 acres and held in easement by The Nature Conservancy. The property was acquired partially through the Land and Community Heritage Investment Program (LCHIP).

Section 6(f) LWCF

Properties that have been acquired or improved with LWCF funding are protected under Section 6(f) of the Land and Water Conservation Fund Act. No Section 6(f) properties are located in the study area.

Recreational Resources

Based on a preliminary field review, at least four recreational resources are within close proximity to the study area, which may qualify as park land or recreational area under Section 4(f) of the National Department of Transportation Act of 1996. These resources include Samuel Blodget Park, Lafayette-Simpson Park, Arms Park (Riverfront Park), and Martineau Park.

- Blodget Park (located off Front Street) provides nature trails and fishing opportunities along Black Brook.
- Lafayette-Simpson Park encompasses over 2 acres of land adjacent to Notre Dame Avenue. The park is bisected by Amory Street, spanning two tracts of land. The park is also home to several works of sculpture.
- Arms Park (Riverfront Park) is located on the east side of the Merrimack River, just south of West Bridge Street. The park contains a scenic walk by the river and is also part of the Heritage Trail.
- Martineau Park, a small triangle of land spanning less than 0.3 acre, lies between Montcalm Street and Dionne Drive on the west side of Manchester. This secluded park offers benches and a cobblestone walkway.

2.5.2 Noise

The FHWA[3] and NHDOT[4] have established noise policies to protect the public health and welfare from excessive vehicle traffic noise. Traffic noise can adversely affect human activities such as communication, sleep, work or recreation. Certain highway projects can exacerbate noise issues because of changing highway geometry, traffic volumes or traffic speed. While a full noise impact assessment is beyond the scope of this planning study, a preliminary review of existing noise conditions in the study area was conducted.

[3] *Procedures for Abatement of Highway Traffic Noise and Construction Noise*, Federal Highway Administration's 23 CFR, 772.

[4] *Policy and Procedural Guidelines for the Assessment and Abatement of Highway Traffic Noise for Type I Highway Projects*, New Hampshire Department of Transportation, July 2011.

A first step in the evaluation of possible noise impacts involves identification of "sensitive receptors" - locations that have indoor or outdoor activities that might be sensitive to highway noise. These can include residences, schools, churches, hospitals and park lands. **Figure 2.5-2** depicts more than 400 receptor locations that were identified during field work and a review of assessing records completed by the Study Team, indicative of the densely populated character of the study area.

Most of the receptor locations (residences) fall into the FHWA's "Activity Category B," which has a noise abatement criterion of 66 decibels (dBA). Other land uses, such as commercial buildings (i.e., those that do not involve temporary overnight residence), are in FHWA "Activity Category C" which has a noise abatement criterion of 72 dBA.

A simplified sound level program was conducted to obtain a sampling of the existing sound levels in the study area. The noise monitoring was conducted at six receptor locations, typically residences, in July 2012. These noise measurements were collected in conformance with the FHWA noise monitoring guidelines[5]. Noise sources in the study area included vehicles on I-293 and vehicles on local roadways.

Figure 2.5-2 presents the location of the noise monitoring sites and **Table 2.5-2** presents results of the noise monitoring.

Table 2.5-2 Existing Sound Levels (dBA)

Monitoring Station	Location	Existing Sound Level	Noise Abatement Criteria (NAC)
M1	Stark Way	67.1[1]	66
M2	Coolidge Avenue	62.2	66
M3	Eddy Road	66.9[1]	66
M4	Washington Park	61.1	66
M5	Stark Lane	66.7[1]	66
M6	River Front Drive	52.3	66

Note: [1] The sound level approaches, is at, or exceeds the FHWA noise abatement criterion.

Note that half of the monitoring stations were found to have existing noise levels at or above the FHWA Noise abatement criterion. This confirms the concern expressed by many local residents, who indicate that the existing highway noise impacts the quality of life in local neighborhoods.

Further work on this issue will be conducted during the NEPA phase of the project. NHDOT and FHWA noise impact assessment procedures for Type I[6] projects will be used to predict existing and future highway noise levels, to determine project noise impacts, and to evaluate the feasibility of noise mitigation measures in the study area.

[5] *Measurement of Highway-Related Noise*, US Department of Transportation, Federal Highway Administration, FHWA-PD-96-046, May 1996.

[6] A Type I project is a highway project that results in the construction of a new highway or the physical alteration of an existing highway that substantially changes either the horizontal or vertical alignment or increases the number of through travel lanes.

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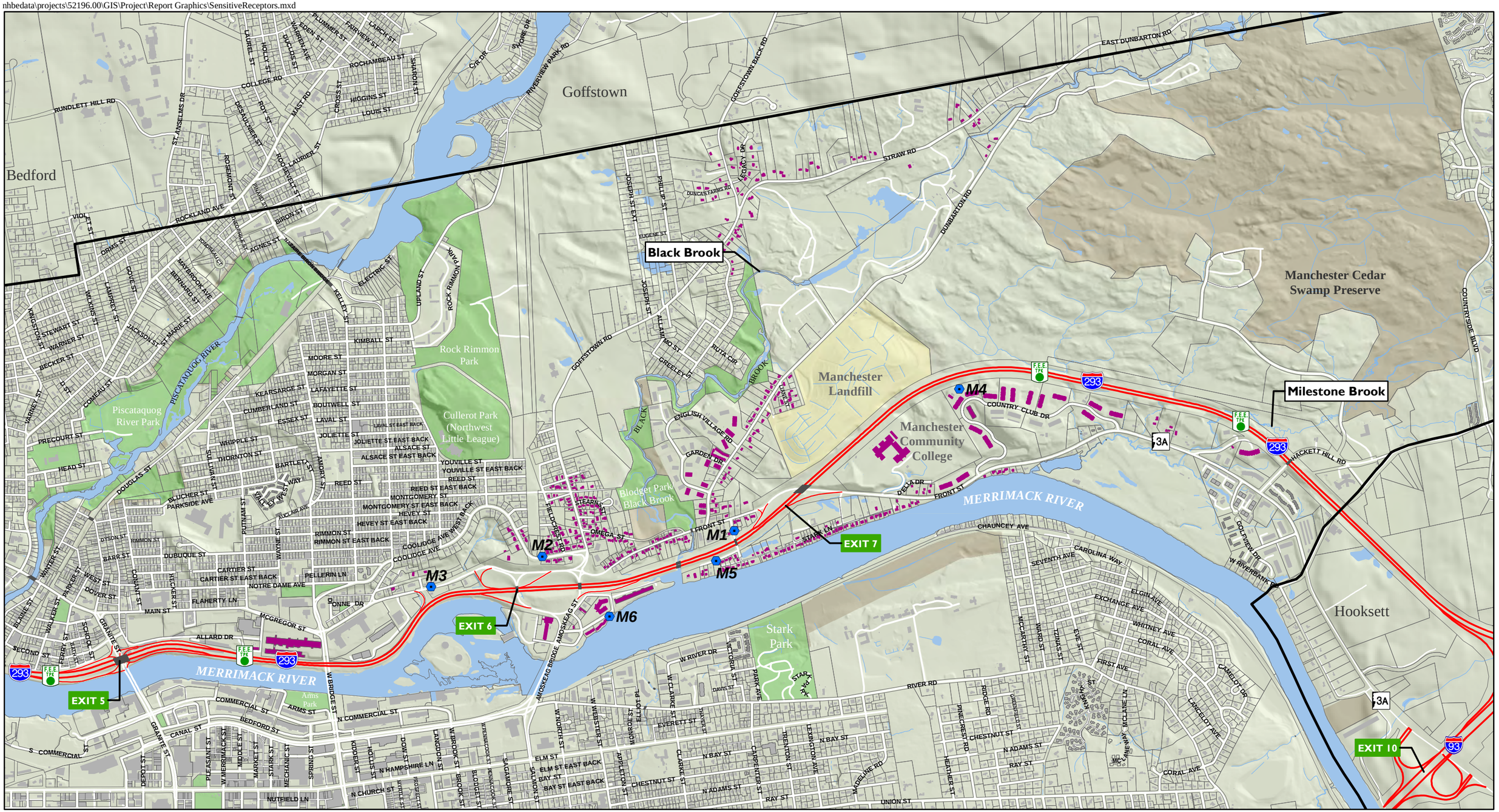

Legend

- Assessor's Tax Parcels
- Building
- Surface Water
- Stream
- City Park Land
- Conservation/Public Land
- Bridge
- Noise Receptors within Study Area
- Noise Monitoring Location

0 1,500 3,000 Feet

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Figure 2.5-2
Noise Receptors

Manchester, NH

New Hampshire DOT Department of Transportation

3 Future Conditions

3.1 Introduction

This chapter describes the methodologies and procedures used to forecast the existing 2012 traffic volumes to the Study's future design year of 2035. Traffic volume projections for the Study account for normal traffic growth anticipated for the region, as well as a limited evaluation of potential secondary growth attributed to the Hackett Hill property resulting from an alternative that relocates Exit 7 with a full interchange. The following describe the traffic volume forecasting procedures used to develop the 2035 traffic volumes for the Study.

3.2 2035 Design Hour Volume

As discussed in Section 2.3.2, the SNHPC maintains a regional travel demand model that is based on the 2010 Census and the Commission's socio-economic database. In addition to this base year condition, the SNHPC uses the model to forecast growth within the region for planning purposes. Forecast year 2035 daily traffic volumes obtained from the model were used to predict a rate at which traffic can be expected to grow. A review of the 2010 and 2035 daily volumes assigned to the roadway links within the SNHPC regional model revealed a projected average annual growth rate of 0.85 percent, which is consistent with historical US Census population growth trends between 1980 and 2010 within the surrounding communities of Manchester, Hooksett, and Goffstown. Therefore, for the purpose of this Study, a slightly higher but still modest 1.0 percent average annual background growth rate was used to project the future year 2035 traffic volume demand. This annual growth rate represents an overall growth rate of 25.7 percent for the 23-year forecast period. **Figures 3.2-1** and **3.2-2** show the projected 2035 No Build weekday morning and evening peak hour volumes along I-293, Exits 6, Exit 7, and at other major intersections servicing the study area.

3.3 2035 No Build Traffic Operations

Level of service analyses, similar to those conducted for the existing conditions, were performed for the future 2035 No Build condition. The 2035 No Build condition reflects the continuation and perpetuation of the existing transportation infrastructure within the study area. This section summarizes the results of the 2035 No Build operational analyses for the key freeway, ramp merge, ramp diverge, and ramp weave segments, as well as the signalized and unsignalized intersections.

3.3.1 Mainline (Freeway and Ramps)

Capacity analyses performed for the existing I-293 freeway segments and ramps under the future year 2035 traffic volume forecast show substantial degradation in traffic operations, even with a modest level of growth from the 2012 traffic levels. By the future year 2035, many of the freeway segments and ramp junctions are expected to degrade to LOS E or F. Consistent with existing commuter patterns on I-293, traffic operations are projected to be most congested in the southbound direction during the morning peak hour and in the northbound direction during the evening peak hour. **Table 3.3-1** summarizes the 2035 freeway and ramp capacity analysis results. The 2012 analysis results have also been provided in the table for comparison purposes.

Table 3.3-1 2012 & 2035 No Build Freeway and Ramp Analysis

		Peak	Level of Service	
Location	Facility	Period	2012	2035
I-293 Northbound Exit 5 to Exit 6	Freeway	AM	B	C
		PM	D	F
I-293 Northbound Exit 6	Off Ramp (diverge)	AM	B	C
		PM	D	F
I-293 Northbound Exit 6	On Ramp (merge)	AM	B	B
		PM	D	E
I-293 Northbound Exit 6 to Exit 7	Freeway	AM	B	B
		PM	D	E
I-293 Northbound Exit 7	Off Ramp (diverge)	AM	B	B
		PM	D	F
I-293 Northbound Exit 7 to I-93	Freeway	AM	A	B
		PM	C	D
I-293 Southbound I-93 to Exit 7	Freeway	AM	B	C
		PM	B	C
I-293 Southbound Exit 7	On Ramp (merge)	AM	C	D
		PM	B	C
I-293 Southbound Exit 7 to Exit 6	Freeway	AM	C	D
		PM	C	C
I-293 Southbound Exit 6	Weave	AM	E	F
		PM	C	D
I-293 Southbound Exit 6 at Eddy Rd	On Ramp (merge)	AM	D	E
		PM	C	D
I-293 Southbound Exit 6 to Exit 5	Freeway	AM	D	E
		PM	C	D

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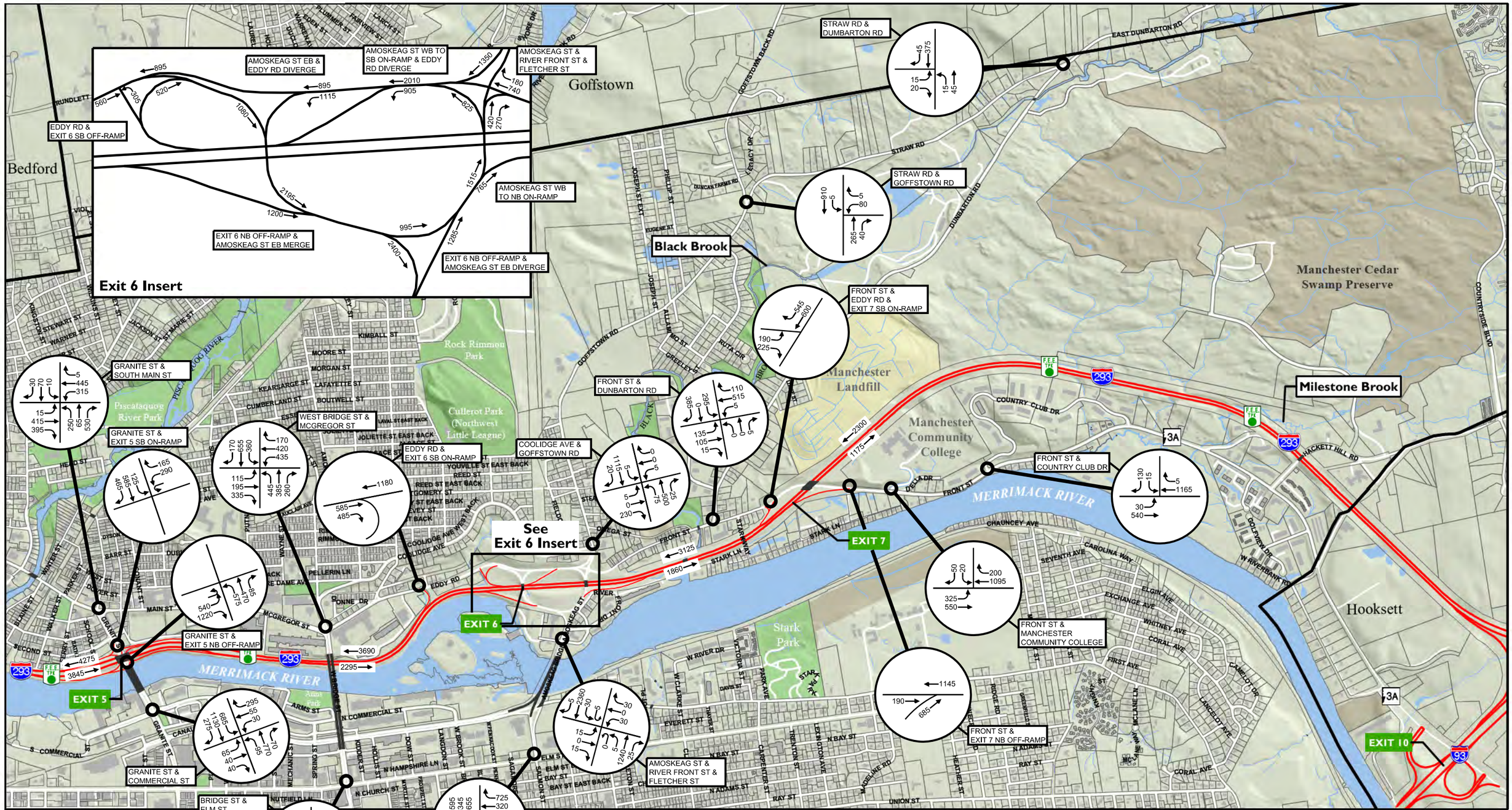

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Figure 3.2-1
2035 No Build Weekday Morning Peak Hour Traffic Volumes

Manchester, NH

New Hampshire DOT Department of Transportation

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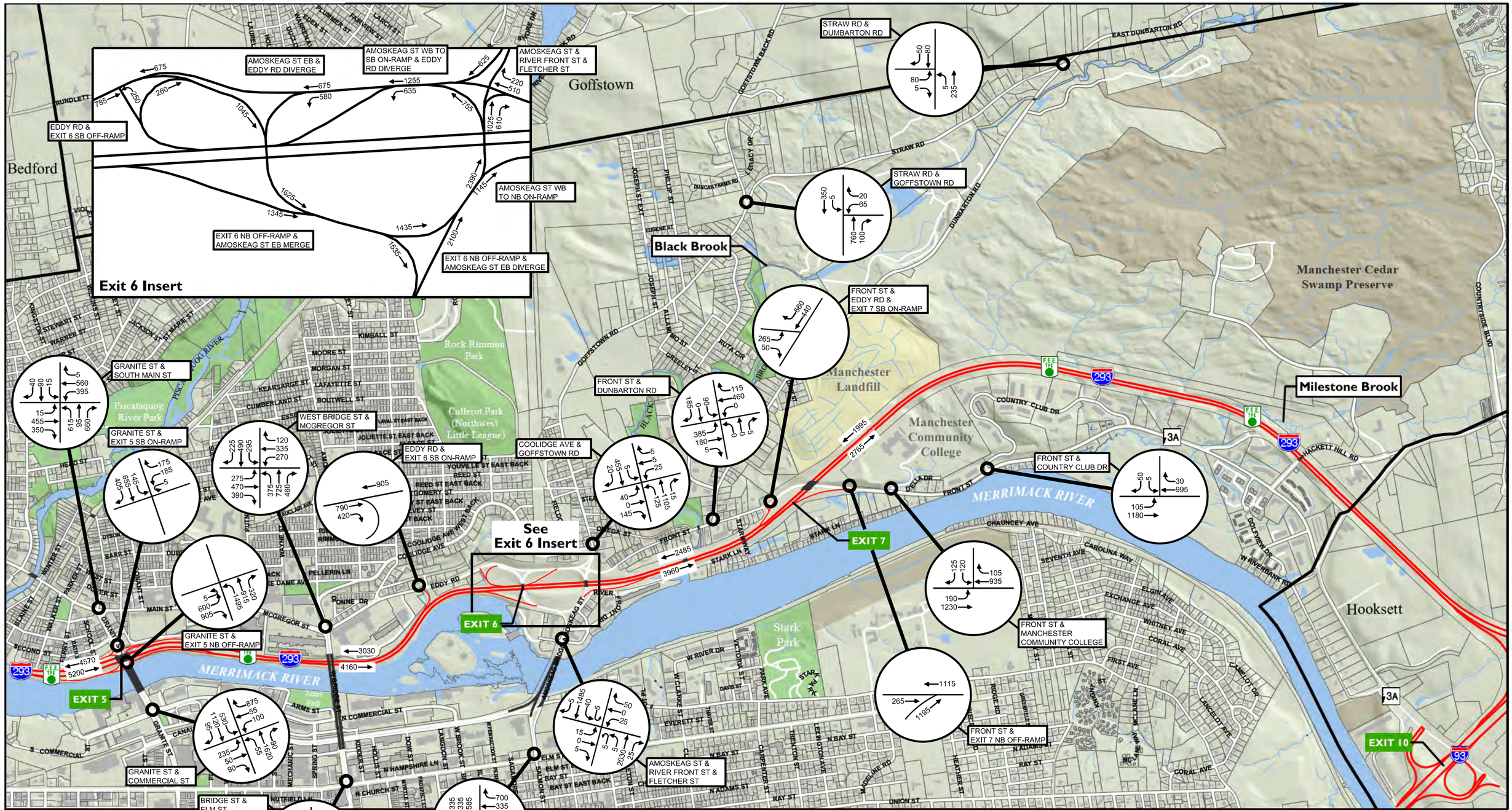

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Figure 3.2-2
2035 No Build Weekday Evening Peak Hour Traffic Volumes

Manchester, NH

New Hampshire DOT Department of Transportation

3.3.2 Signalized Intersections

By the forecast year of 2035, all but two of the nine signalized intersections (Amoskeag Street at Goffstown Road/Front Street and Amoskeag Street at River Road/Fletcher Street) are expected to operate at a LOS D or worse. As shown in **Table 3.3-2**, several study area intersections are expected to degrade to a LOS F and/or have a v/c greater than 1.00 indicating that the volume exceeds capacity.

Table 3.3-2 2035 No Build Signalized Intersection Analysis

	Peak	2035 No Build		
Location	Period	v/c*	Delay**	LOS***
Granite Street at	AM	0.92	51	D
Main Street	PM	1.08	89	F
Granite Street at	AM	0.96	41	D
I-293 Exit 5	PM	1.04	50	D
Granite Street at	AM	0.86	88	F
Commercial Street	PM	1.05	128	F
McGregor Street at	AM	1.09	97	F
Bridge Street/Amory St	PM	1.00	60	E
Bridge Street at	AM	0.67	32	C
Elm Street	PM	0.87	44	D
Amoskeag Street at	AM	0.77	8	A
Goffstown Rd/Front St	PM	0.86	16	B
Amoskeag Street Traffic Circle	AM	0.77	19	B
(I-293 Northbound Approach)	PM	1.16	102	F
Amoskeag Street at	AM	0.83	13	B
River Front Dr/Fletcher St	PM	0.79	11	B
Salmon Street at	AM	0.91	38	D
Elm Street	PM	1.07	67	E

* Volume to capacity ratio.

** Delay in seconds per vehicle.

*** Level of service.

3.3.3 Unsignalized Intersections

Similar to the freeway facilities and the signalized intersections, traffic operations at the unsignalized intersections will continue to deteriorate as traffic volumes increase. Under the 2035 No Build condition, delays are expected to be predominantly in the LOS E and F range for vehicles exiting from the unsignalized side streets onto the primary roadways servicing I-293 including Eddy Road, Amoskeag Road, Goffstown Road, and Front Street. **Table 3.3-3** summarizes the 2035 No Build unsignalized intersection capacity analysis results.

Table 3.3-3 2035 No Build Unsignalized Intersection Analysis

	2035 No Build AM			2035 No Build PM		
Location / Movement	Demand*	Delay**	LOS***	Demand	Delay	LOS
Exit 6 Southbound Off-Ramp at Eddy Road						
Exit 6 Southbound Off-Left	305	#	F	250	#	F
Exit 6 Southbound Off-Right	520	88	F	260	37	E
Exit 6 Northbound Off-Ramp at Amoskeag						
Exit 6 Northbound Off Ramp	1200	#	F	1345	#	F
Amoskeag Westbound Slip Lane at Eddy Road						
Amoskeag Westbound Slip Lane	825	#	F	755	#	F
Goffstown Road at Coolidge Ave						
Goffstown Road Eastbound	1140	0	A	480	1	A
Goffstown Road Westbound	600	2	A	1245	5	A
Coolidge Ave Northbound	235	120	F	185	#	F
Business Drive Southbound	5	#	F	35	#	F
Front Street at Dunbarton Rd						
Dunbarton Road Eastbound	680	#	F	275	#	F
Retail Drive Westbound	10	109	F	5	10	A
Front Street Northbound	265	6	A	570	9	A
Front Street at Exit 7 SB On-Ramp						
Front Street Northbound	415	#	F	315	68	F
Front Street at Exit 7 NB Off-Ramp						
I-293 Exit 7 NB Off-Ramp Approach	685	29	D	1195	#	F
Front Street at Manchester Community College						
Community College Exit	70	#	F	245	#	F
Front Street at Country Club Drive						
Country Club Dr Exit	145	48	E	55	36	E
Front Street Northbound	570	2	A	1285	8	A
Goffstown Road at Straw Road						
Straw Road Southbound	85	37	E	85	33	D
Dunbarton Road at Straw Road						
Straw Road Northbound	35	12	B	85	12	B

* Demand in vehicles per hour.

** Delay in seconds per vehicle. # Delay greater than 3 minutes.

*** Level of service.

3.4 Other Area Growth Potential

In addition to the anticipated local and regional traffic growth that is projected for the year 2035 by the regional travel demand model (described in Section 3.2), there are opportunities within the study area for specific land development that if developed, could generate concentrated traffic demand in the vicinity of that development. One of these potential development areas is the Hackett Hill property (**Exhibit 3.4-1**).

The City of Manchester acquired the Hackett Hill property in 1988 from the University of New Hampshire. The property, which consists of approximately 833 acres, is located on the north end of the study area west of I-293 and extends from Dunbarton Road to Hackett Hill Road. The Hackett Hill Master Plan, which the City prepared in 2000, describes a plan with the potential for approximately 1,290,000 square feet of office space in a corporate campus environment. More recently, and based on market demand, city officials anticipate more of an office/light industrial build-out scenario.

Applying trip-generation rates published by the Institute of Transportation Engineers (ITE) in *Trip Generation*[7] (ITE Industrial Park - Land Use Code 130), it is estimated that the full build-out of the Hackett Hill property could generate approximately 1,085 (890 entering and 195 exiting) vehicle-trips during a weekday morning peak hour and approximately 1,110 (235 entering and 875 exiting) vehicle-trips during a weekday evening peak hour.

The Hackett Hill Master Plan states that the development of the property would require improved access, which would ultimately involve the relocation of the existing Exit 7 interchange. As some of the alternatives that are under consideration for this study involve the relocation of Exit 7, a key question to consider in the NEPA phase of the project is how or if the development potential of the Hackett Hill property is driving the transportation decision to relocate the interchange.

The Town of Goffstown also has land that could benefit from improved connectivity. Several years ago the Town of Goffstown established an industrial zone (**Exhibit 3.4-2**) in the northeast section of town bordering the City of Manchester. However, the industrial zoned land remains undeveloped because Goffstown Road, within the City of Manchester and the primary connection to I-293 restricts truck activity. The Town of Goffstown is hopeful that improved connectivity between the industrial zoned land and I-293 will accelerate development of this land.

[7] *Trip Generation, Eighth Edition*, ITE, Washington, DC, 2008.

Exhibit 3.4-1
City of Manchester's Hackett Hill Master Plan

Exhibit 3.4-2
Town of Goffstown's Industrial Zone

4 Alternatives Development

4.1 Introduction

Having identified the existing and potential future capacity and safety deficiencies and having solicited input from the public and the Technical Advisory Committee on defining the study area problems, issues and constraints, and potential solutions, a range of alternatives were developed. This chapter describes the range of alternatives aimed at addressing the safety and mobility needs of the study corridor. The alternatives include the No Build alternative, Transportation Demand Management (TDM), Transportation System Management (TSM), and a range of long-term mainline and interchange Build alternatives.

4.2 No Build

The No Build alternative reflects the perpetuation of the existing transportation infrastructure within the study area. Therefore, the No Build alternative does not consider any physical alteration to the existing transportation system. However, the alternative does include the same level of traffic growth out to the future design year of 2035 as each of the Build alternatives. The No Build serves as a benchmark to compare the benefits and impacts of the Build alternatives.

4.3 Transportation Demand Management

Transportation Demand Management (TDM) encompasses a wide range of strategies designed to change personal travel behavior. The result is a reduction in demand for automobile use and in the need to construct additional roadway capacity. This is accomplished through measures that reduce the number and length of drive-alone trips or move trips out of the peak roadway congestion times. TDM measures focus on incentives (or disincentives) to drivers who drive alone that will encourage them to change their travel behavior to ride-share or use other modes of travel.

Given the commitment of local communities and the NHDOT to a multimodal approach to meeting the area's transportation needs in favor of solely relying on the continued construction of new and wider roadways, TDM actions are presented in this Study as not an either /or alternative but rather actions that could be implemented regardless of other physical modifications to the transportation system. Following are some examples of TDM measures:

- **Alternative Work Schedules:** This measure allows employees to utilize flex time, compressed work weeks, staggered work hours, and telecommuting. Flex time and staggered work hours have the effect of shifting some trips outside of peak congestion periods; compressed work weeks and telecommuting have the effect of eliminating some work trips.
- **Carpool /Vanpool Programs:** In this type of program, a transportation coordinator works with employees to create carpools and vanpools. Employers can provide preferential parking for carpool vehicles.
- **Secure Bicycle Facilities and Associated Amenities:** The provision for secure bicycle-parking facilities and on-site showers and lockers promotes cycling to work.
- **Financial Incentives and Parking Costs:** These types of measures may call for higher parking fees for single-occupancy vehicles, reduced parking fees for carpools and vanpools, transit subsidies (e.g., free or employer-subsidized monthly passes), and other financial incentives.
- **Site Walk Access Improvements:** This measure examines the difference in walking time associated with travel to and from the workplace as a result of work site access changes. Walking time includes the time to walk from a parking lot or bus stop to an employee's actual work site. Walk access time can be affected by policies such as preferential parking for carpools and vanpools or through improvements to the work site or area that renders access to public transit easier.

The NHDOT's website (http://www.nh.gov/dot/traveler/index.htm) provides access to healthy, economical, and eco-friendly alternatives to commuting in a single-occupant automobile. The site provides a wealth of information on carpooling, park and rides locations, trip planning, ridesharing services, and real-time information of construction activities and traffic delays. It also provides educational information on bicycle and pedestrian news, events, and safety as well as providing bicycle maps.

In addition to these existing TDM programs that are currently available to area commuters through the NHDOT website, the City of Manchester and the Towns of Goffstown and Hooksett can provide incentives to encourage employer-based programs through local land-use ordinances and regulations. For example, the towns could implement a traffic-impact fee system that would allow each municipality to assess private development projects an impact fee based on the number of vehicle trips that would be generated by the development. The incentive comes from applying credits to the fee for the developer's commitment to various levels of TDM actions.

Aside from impact fees, municipal site plan regulations should encourage pedestrian and bicyclist mobility through site design (i.e., sidewalks, multiuse paths and trails, and limiting convenient parking) and by providing amenities such as bicycle storage, locker rooms, and shower facilities in buildings. Property owners and employers should be encouraged to promote ridesharing and the use of public transportation, through postings of maps and other information on internal employee bulletin boards and company websites. Employers could also provide employees with subsidized public-transportation passes.

There are currently a number of public transportation initiatives under study or being considered that could reduce the future demand of single-occupant vehicles within the study area.

The Manchester Transit Authority recently began running bus service between Concord and the Manchester-Boston Regional Airport. This service is being implemented for an initial one-year period while the Southern New Hampshire Planning Commission (SNHPC) and the Central New Hampshire Planning Commission (CNHPC) conduct a ridership demand study.

The New Hampshire Rail Transit Authority is pursuing the implementation of passenger rail service on the New Hampshire Main Line (Capitol Corridor) extending from North Station in Boston, MA to Concord, NH including station stops in downtown Manchester and the Manchester-Boston Regional Airport. This service is being pursued as the first phase of a Boston to Montreal rail service. It is anticipated that such a project would be sponsored and funded by the State of New Hampshire. Additionally, the NHDOT has secured federal funding that would allow New Hampshire to comprehensively study the feasibility, costs, and benefits of expanding passenger rail service.

There is a wide-range of TDM strategies and actions that have the potential to reduce vehicular travel demand. These actions will be further developed and evaluated in more detail under Part B of the study (Environmental Documentation).

4.4 Transportation System Management

Transportation System Management (TSM) strategies are generally low cost, easy to implement actions aimed at optimizing the performance of the existing transportation system. Some examples of TSM actions include traffic signal coordination, access management, and incident management.

Based on feedback from the public NHDOT forces cut back growth along the east side of I-293, south of the Exit 6 northbound off-ramp. This low cost and easy to implement action had an immediate effect of improving driver sight lines as motorists approach the interchange. In addition, the NHDOT is evaluating opportunities to install dynamic message boards along I-293 aimed at alerting southbound motorists of peak period congestion at the Exit 6 ramps. Other actions being considered include increasing the storage capacity of the Exit 6 northbound off-ramp by widening the ramp to provide two-lanes, with possible traffic signal enhancements at Amoskeag Street.

4.5 Long-Term Build Alternatives

The first step toward the development of conceptual alternatives to address the safety and mobility needs was to establish, on a macro-scale level, the environmental, socio-economic, cultural, topographical and basic engineering constraints for the study area. Available information from various resources, was collected. Base mapping of the study area was prepared depicting the existing infrastructure, permanent features, water bodies, as well as existing topography. Available resource information such as wetlands, surface and groundwater, floodplains, historic resources, archeological resources, hazardous material sites, and property and ROW boundary lines were added to the mapping.

Initial design criteria, that would serve toward the development of a range of viable alternatives, were established for new roadways, as well as existing highways and local streets that would be reconstructed. The combination of resource information, physical and topographical constraints, and initial design criteria formed a basis for the brainstorming of potential alternatives. The applicable regulations, guides, policies and references that would provide the foundation for developing the conceptual studies were also established early in the development process.

The primary references include:

- A Policy on Geometric Design of Highways and Streets, AASHTO, "Green Book"
- New Hampshire Department of Transportation Highway Design Manual Volumes 1 and 2
- Roadside Design Guide AASHTO 4th edition 2011
- Roundabouts and Informational Guide NCHRP Report 672, 2012

Design criteria established for the purpose of developing horizontal and vertical roadway geometry are presented in the following table:

Table 4.5-1 Design Criteria

Roadway Section	Design Speed (mph)	Lane Width (feet)	Right Shoulder Width (feet)	Left Shoulder Width (feet)	Grade (Percent max.)[4]	Min. Horiz. Curve Radius (feet)	Cross-slope (percent maximum)	Stopping Sight Distance (level roadway feet)
I-293 Mainline[1]	55	12	10[3]	10[3]	3	960	8	495
I-293 Mainline	70	12	10[3]	10[3]	3	1810	8	730
Interchange Ramps	30 to 50	12 to 16	2 to 10	2	6	231 & 833	6	200 to 425
Front Street /NH 3A	30 to 40	11 to 12	4 to 5	4 to 5	4	250 & 533	4	200 to 305
Eddy Road	30 to 35	11 to 12	4 to 5	4 to 5	6	250 & 371	4	200 to 250
Amoskeag Street	30 to 35	11 to 12	4 to 5	4 to 5	4	250 & 371	4	200 to 250
Goffstown Road @ Exit 6	30	11 to 12	4 to 5	4 to 5	6	250	4	200
Exit 7 New Connector[2]	30 to 40	12	4 to 10	4 to 10	6	250 & 533	4	200 to 305
Exit 7 New Connector	40	12	4 to 10	4 to 10	6	444	8	305
Dunbarton Road	40	12	4	4	6	444	8	305
Dunbarton Road Connector	30	12	4	4	6	250	4	200

Structures Height – 16'-6" over major roadways and 14'-6" over minor roadways; Minimum grade = 1 percent

[1] Between I-293 Exit 5 and Exit 6
[2] Vicinity of interchange or intersection with Front Street
[3] 12 feet with barrier or guard rail; 4 feet w/ 2 lanes
[4] Minimum grade = 0.5 percent

The 3.5 mile study section of I-293 was divided into three roadway segments where improvement strategies to address the safety and capacity needs could be developed and then easily compared. These study area segments described below include a Mainline Segment, an Exit 6 Segment and an Exit 7 Segment.

- *I-293 Mainline Segment* consists of a traffic evaluation that will retain the existing four lanes along the entire 3.5-mile I-293 study corridor together with interchange upgrades and alternatives that consider widening and reconstructing the southerly 0.8-mile section of the I-293 study area;
- *Exit 6 Segment* considers new interchange alternatives along with the widening of a 0.8-mile section of the I-293 mainline at Exit 6;
- *Exit 7 Segment* includes two options that either reconstruct the existing Exit 7 partial interchange at Front Street to a fully directional interchange or relocate and construct a new Exit 7 interchange to the north. Both options involve widening I-293 approximately 1.3-miles or 1.9-miles, respectively.

4.5.1 Mainline Alternatives

The Mainline Segment involves three alternatives. Alternative 1 involves a traffic evaluation that will retain the existing four lanes along the entire 3.5-mile I-293 study corridor, together with interchange upgrades to improve safety and traffic operations. Alternative 2 and Alternative 3 involve the southerly section of the study corridor and are approximately 0.8 miles in length. These two alternatives begin just north of the Granite Street Exit 5 interchange and follow the existing I-293 corridor between the Historic Millyard District on the west and the Merrimack River on the east. The segment passes under the West Bridge Street Bridge before ending just south of Exit 6.

The Exit 6 I-293 Segment lies between the Mainline just south of Exit 6 and ending approximately 0.1 mile north of the I-293 bridge over Black Brook. The Exit 6 Segment considers interchange alternatives 4, 5, 5A, 6 and 7.

The Exit 7 I-293 Segment covers a 1.9-mile section of the study corridor beginning just north of the I-293 bridge over Black Brook and includes five alternatives. Alternative 8 involves reconstructing Exit 7 at its current location while Alternatives 9A, 9B, 10A and 10B will eliminate the existing interchange and construct a new fully directional interchange just north of Manchester Community College. Alternatives 10A and 10B include extending the Dunbarton Road connector across Black Brook to the Goffstown Road/Straw Road intersection.

For the Mainline Segment, both Alternative 2 and Alternative 3 evaluate a 0.8-mile section of the I-293 Mainline Segment beginning just north of Exit 5 and ending just south of existing Exit 6. Both alternatives look at widening and reconstructing I-293 from a four-lane divided highway, approximately 90 feet of total pavement width, to a modern six-lane divided highway, approximately 122 feet of total width. The existing alignment is severely constrained as it winds itself between the Merrimack River on the east, the historic district of the Millyard on the west. The large pier foundations carrying West Bridge Street over I-293 and the Merrimack River are an additional constraint.

Alternative 2 examines shifting the widening primarily to the east toward the Merrimack River to minimize impacts to the historic properties on the west. Alternative 3 shifts the widening to the west into the historic Millyard properties to minimize impacts to the Merrimack River. The northerly ends of the Mainline Segment for both Alternatives 2 and 3 are similar with the widening shifting to the west to avoid the Merrimack River.

Alternative 1

Alternative 1 considers maintaining the existing four travel lanes (two lanes per direction) along the entire 3.5 mile I-293 study corridor together with interchange upgrades to improve safety and traffic operations. Effectively, the alternative considers whether the anticipated future design year traffic volume demand can be accommodated within the existing carrying capacity of the I-293 mainline.

Alternative 2

The Alternative 2 (**Figure 4.5-1**) widening essentially holds the existing westerly edge of the I-293 pavement as it curves around the American Cotton Duck historic property. This design control shifts the widening improvements easterly toward the Merrimack River. The proposed highway widening for Alternative 2 involves establishing horizontal and vertical alignments that:

- Minimize any reconstruction of the Exit 5 area, which was designed to accommodate a future widening of six lanes.
- Minimize impacts to the historical properties along the west side of I-293 between the Exit 5 southbound off-ramp and the West Bridge Street bridge by constructing a retaining wall/barrier separating the I-293 southbound traffic from the historic properties.
- Avoid impacts to the West Bridge Street bridge piers that are close to the I-293 corridor by use of a highway barrier.
- Avoid impacts to the historic American Cotton Duck property by maintaining the existing edge of pavement along I-293 and widening primarily to the east. The easterly widening and alignment shift would allow the American Cotton Duck property to maintain its current commercial operations and parking layout.
- Minimize impacts to the Merrimack River and its associated 100-year floodplain by utilizing a combination of steepened stone slopes and retaining walls. In areas where the river could be substantially impacted by the widening, cantilever retaining walls (approximately 1,500 to 2,000 feet) would be employed, to mitigate impacts. As a result a portion of I-293 is extended over the river.

Alternative 3

Alternative 3 (**Figure 4.5-2**) tries to minimize/avoid all impacts along the Merrimack River and its 100-year flood plain while minimizing/avoiding impacts to the American Cotton Duck historic property. The proposed highway layout for Alternative 3 is similar in some respects to Alternative 2, and involves establishing horizontal and vertical alignments that:

- Minimize any reconstruction of the Exit 5 area, which was designed to accommodate a future widening of six lanes.
- Minimize impacts to the historical properties along the west side of I-293 between the Exit 5 southbound off-ramp and the Bridge Street overpass by constructing a retaining wall/barrier separating the I-293 southbound traffic from the historic properties.
- Avoid impacts to the West Bridge Street bridge piers that are close to the I-293 corridor, by use of a highway barrier.
- Avoid impacts to the historic American Cotton Duck property. Alternative 3 would shift the I-293 widening primarily to the west such that the new highway would be approximately 10 feet from the American Cotton Duck building's walkway. The parking and commercial operations that currently exist along the east side of the American Cotton Duck building would no longer be feasible.
- Minimize impacts to the Merrimack River and its associated 100-year floodplain by utilizing a combination of steepened stone slopes and retaining walls.

4.5.2 Exit 6 Interchange Alternatives

A range of interchange ideas were evaluated for their feasibility and practicality in addressing the deficiencies of the Exit 6 topside-traffic circle. The congestion and weaving conflict points were eliminated in order to meet the Exit 6 capacity demands.

The development process for a new interchange at Exit 6 considered constructible design layouts that would minimize and/or eliminate impacts to:

- Commercial properties, residential properties, and driveways that currently exist adjacent to Exit 6.
- The existing Amoskeag Bridge over the Merrimack River.
- The Merrimack River and 100-year floodplain.
- Existing transmission lines crossing I-293.
- Existing wetland areas adjacent to Black Brook.
- Historic Resources

Each concept was first evaluated from an engineering feasibility and traffic operations perspective to aid in establishing the basic number of lanes, intersection layout, and the feasibility of construction. If the interchange concept looked feasible, the engineering and design was further advanced and a more detailed traffic operations analysis was completed.

Each alternative for Exit 6 includes a 0.8-mile section of the I-293 mainline, beginning approximately 0.4 miles south of the existing Goffstown Road/Amoskeag Street overpass at Exit 6, and extending 0.8 miles ending just north of the I-293 Black Brook bridge. To accommodate the footprint for each of the new interchange alternatives, in conjunction with the widening and reconstruction of I-293 from four lanes to six lanes, the proposed I-293 mainline centerline shifts westerly approximately 30 feet. The westerly centerline shift allows for development of a wider I-293, offers opportunities to maintain traffic during construction, and provides for a range of reasonable interchange layouts while minimizing impacts to businesses and residences and the Merrimack River.

In addition, early in the conceptual development phase, the preliminary traffic operational analyses suggested two possible mainline design alternatives. The alternatives manage the heavy southbound mainline traffic through Exit 6 in combination with accommodating the heavy southbound ramp traffic. The first layout maintains mainline lane continuity by carrying the three mainline southbound lanes through the interchange area and adding an

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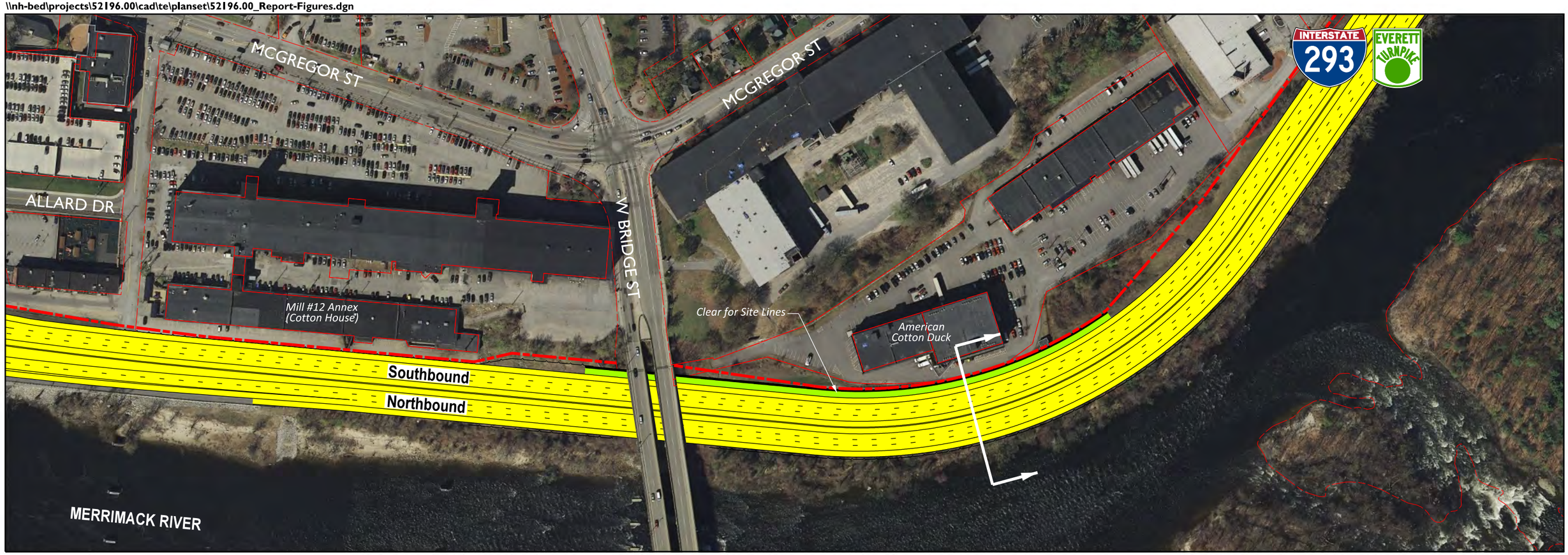

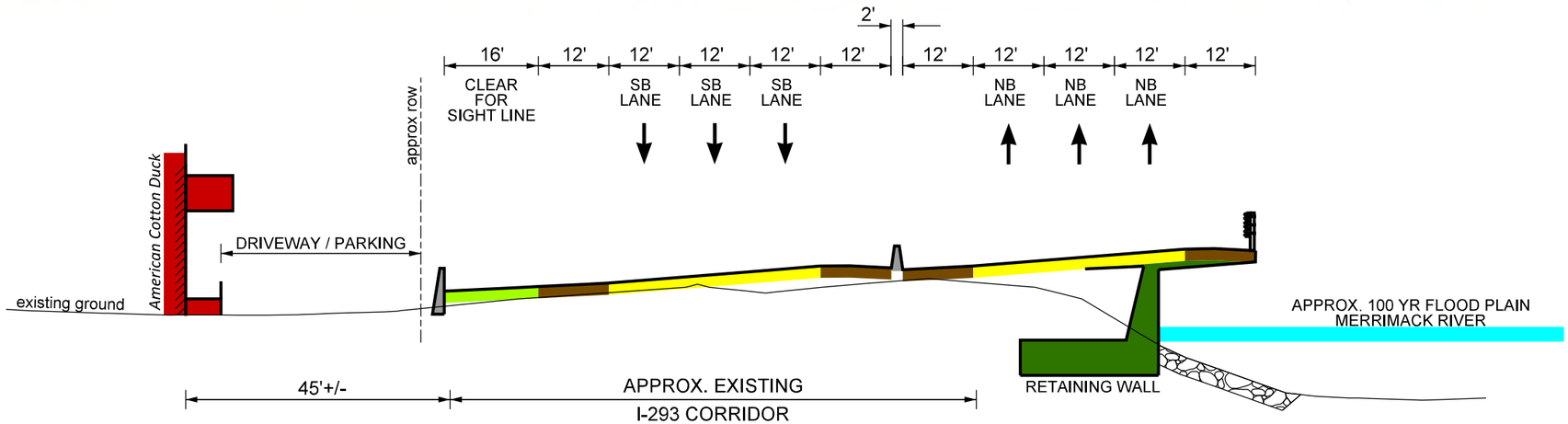

LEGEND

- **- Pavement**
- **- Bridge**
- **- Median / Grass Panel**
- **- Existing ROW**
- **- Proposed ROW**
- **- Signal**

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Figure 4.5-1
Alternative 2
FEET Widen to the East

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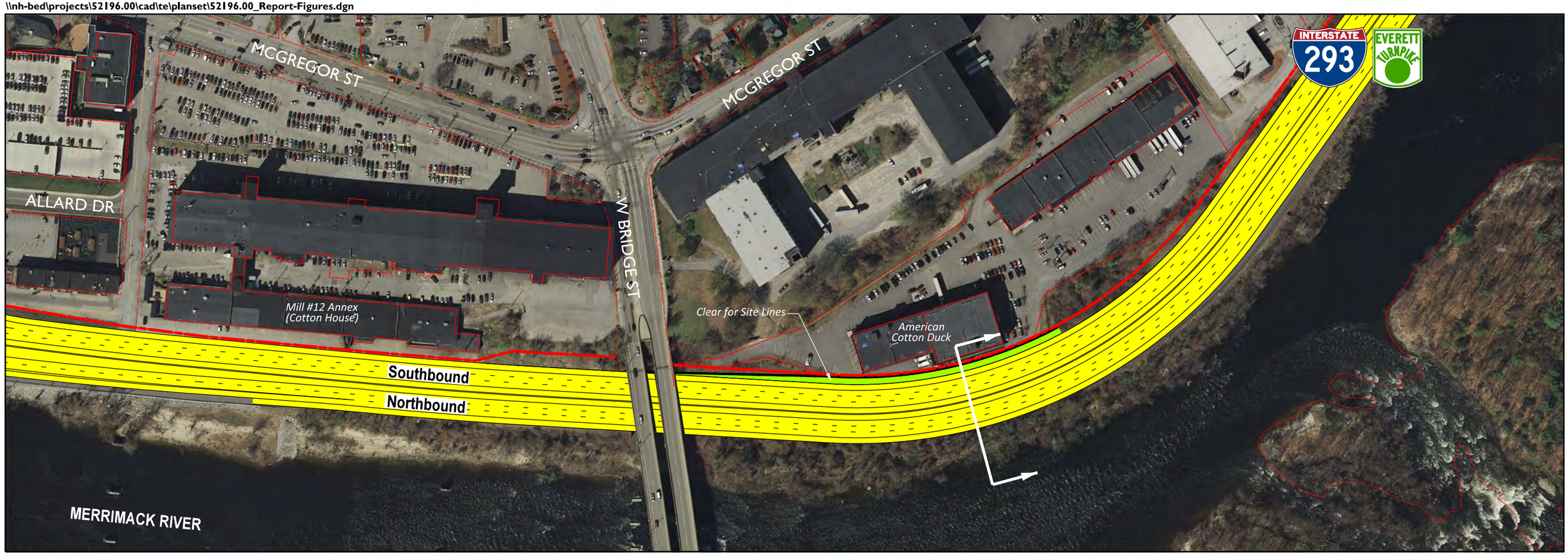

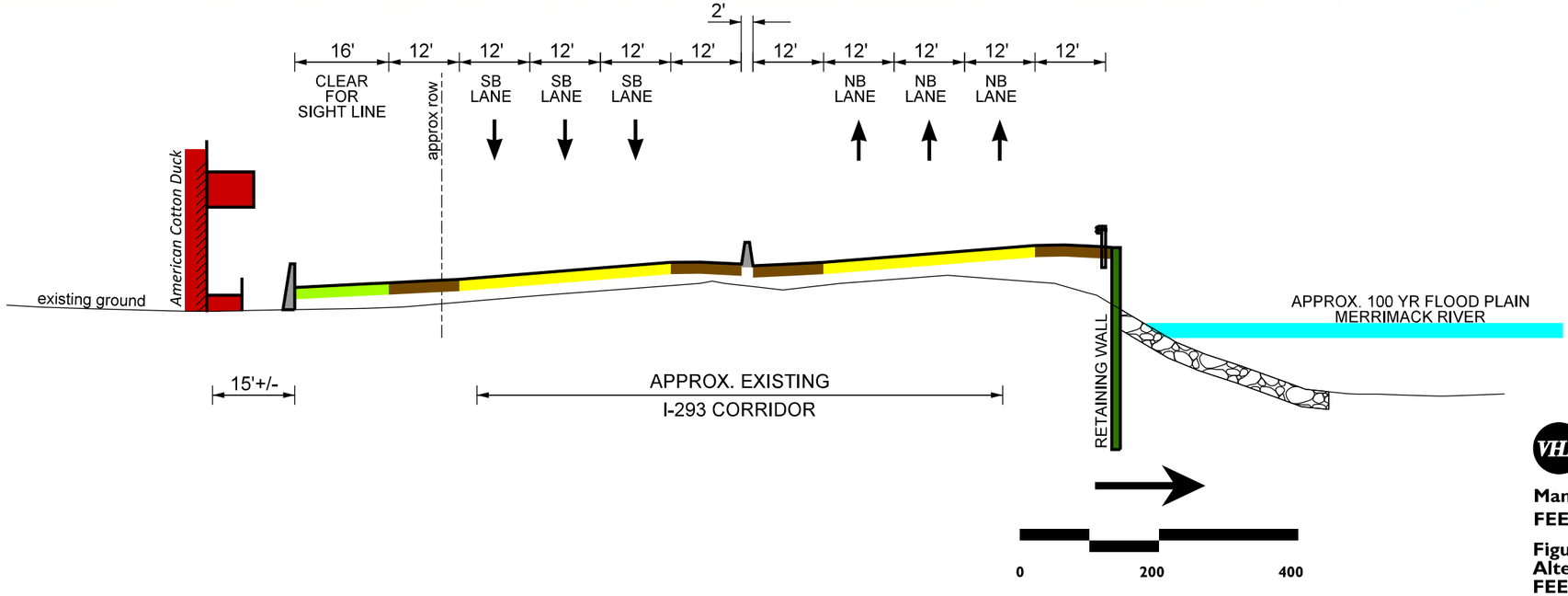

LEGEND

- Pavement
- Bridge
- Median / Grass Panel
- Existing ROW
- Proposed ROW
- Signal

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Figure 4.5-2
Alternative 3
FEET Widen to the West

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auxiliary lane, or fourth lane, where the southbound on-ramp merges with I-293. The fourth lane would extend approximately 0.8 mile to the south to Exit 5.

The second design layout calls for the outer lane of the three mainline travel lanes to be dropped just south of the proposed Exit 6 off-ramp and extend only two southbound travel lanes through the interchange area. A third lane would then be added where the heavy volume of traffic from the southbound on-ramp merges with the mainline. The three lanes would be then carried southerly to Exit 5. In order to minimize the overall mainline footprint and inherent additional impacts associated with adding an auxiliary or fourth southbound lane between Exit 6 and Exit 5, the first layout was carried forward for all the alternatives at Exit 6.

For Exit 6, Alternatives 4, 5, 5A, 6 and 7 were considered feasible and are described below.

Alternative 4

Alternative 4 (**Figure 4.5-3**) evaluates a Single Point Urban Interchange, typically referred to as a SPUI. The proposed SPUI at Exit 6 is similar to one constructed at I-293/Exit 5 at Granite Street in 2008. However, unlike the Exit 5 SPUI where I-293 passes over the interchange, I-293 would pass below the Exit 6 SPUI interchange. The SPUI intersection would be controlled by a single traffic signal at the center of the interchange to direct traffic along Goffstown Road, as well as all turns to and from the highway ramps. The major advantages of a SPUI-type interchange are a more compact layout, requiring less ROW, and providing greater efficiency by allowing the left turns to operate concurrently through its one signal as opposed to the two signals of a traditional diamond interchange design.

Alternative 4 includes three (3) additional major design features that will work in concert to manage efficient traffic flow, while maintaining connectivity to all existing roadways at Exit 6. First, the Goffstown Road/Eddy Road/Front Street intersection will be reconfigured to allow Goffstown Road to bridge over Front Street/Eddy Road and connect directly to the SPUI bridge and Amoskeag Street. By separating this intersecting traffic, the conflicts and congestion adjacent to the SPUI interchange will be eliminated, allowing safer and more efficient traffic flow at the SPUI.

Second, a new connector road and overpass, near the existing Eddy Road and Amoskeag connector, will link Eddy Road and Front Street to Amoskeag Street. Traffic signal control will be required at Eddy Road and Amoskeag Street intersections. The third design element would retain the existing I-293 southbound on-ramp (right-turn traffic only) opposite the intersection of Eddy Road and Lorraine Street near McGregor Street. The ramp is being retained because the other southbound on-ramp located at Amoskeag Street is over 0.5 mile to the north. Rather than traveling this distance, motorists might choose to travel south along Eddy Road and McGregor Street to enter I-293 at Exit 5. Retaining the ramp is expected to minimize this potential impact to the local street system. The existing T-type Coolidge Avenue intersection to Goffstown Road and the four-way signalized intersection connecting River Front Drive and Fletcher Street to Amoskeag Street are also retained.

Alternative 4 includes construction of 0.5 mile of Eddy Road and Front Street; 0.25 mile of a new connector linking Eddy Road to Amoskeag Street, 0.2 mile of Goffstown Road and Coolidge Avenue, 0.2 mile of Amoskeag Street, 1.2 miles of interchange ramps, 0.8 mile of I-293, four bridges (SPUI over I-293; connector over I-293, Goffstown Road over Front Street/ Eddy Road, and I-293 over Black Brook), 0.5 mile of retaining walls, and four signalized intersections.

Alternative 5

Alternative 5 (**Figure 4.5-4**) evaluates an Urban Diamond Interchange at Exit 6. Alternative 5 has two basic design features. The first will develop a new urban diamond interchange connecting Eddy Road to the west and Amoskeag Street to the east. The northbound and the southbound ramps will form two separately controlled signalized intersections. The interchange connector road will join Amoskeag Street at a T-type signalized intersection. The second element will include a new separate bridge structure over I-293 carrying two-way traffic, linking Goffstown Road and Amoskeag Street. The existing Front Street connection to Goffstown Road will be maintained with a T-type signalized intersection. The existing four-way signalized intersection connecting River Front Drive and Fletcher Street to Amoskeag Street will also be retained.

Alternative 5 includes construction of 0.5 mile of Eddy Road/Amoskeag Street connector, 0.25 mile of a new connector linking Eddy Road to Amoskeag Street, 0.2 mile of Goffstown Road and Coolidge Avenue, 0.2 mile of Amoskeag Street, 1.1 miles of interchange ramps, 0.8 mile of I-293, three bridges (Eddy Road/Amoskeag Street diamond interchange connector over I-293, Goffstown Road/Amoskeag Street over I-293, and I-293 over Black Brook), 0.2 mile of retaining walls, and five signalized intersections.

Alternative 5A

Alternative 5A (**Figure 4.5-5**) is an Offset Diamond Interchange. The layout for Alternative 5A will separate the Exit 6 northbound and southbound ramp connections from the local roadways. The northbound ramp connections will intersect Amoskeag Street while the southbound ramp connections will intersect Eddy Road. The ramp intersections are approximately 0.5 mile apart allowing for opportunities to introduce additional directional ramps while improving the traffic operations due to the intersection separation.

To the north, Goffstown Road and Amoskeag Street will be connected with a new bridge over I-293 carrying two-way traffic. The Coolidge Avenue connection to Goffstown Road will remain. Eddy Road will be modified to a two-way roadway intersecting Goffstown Road, opposite Front Street, at a signalized intersection.

The existing four-way signalized intersection connecting River Front Drive and Fletcher Street to Amoskeag Street will be retained. The northbound off-ramp will intersect Amoskeag Street at a signalized intersection, while the northbound on-ramps will be directional, with the eastbound and westbound traffic from Goffstown Road and Amoskeag Street connecting directly to I-293. To the south at Eddy Road, the southbound off-ramp traffic will be free flow for vehicles exiting to Eddy Road northbound, while vehicles heading

HEVEY ST EAST BACK
RIMMON ST
QUIRIN ST
COOLIDGE AVE
LORRAINE ST
EDDY RD
LEYTE ST
LEYTE ST
FIELDCREST RD
COOLIDGE AVE
GOFFSTOWN RD
PROVENCHER ST
OMEGA ST
BLACK BROOK
FRONT ST
Southbound
Northbound
RIVER FRONT DR
MERRIMACK RIVER
FLETCHER ST
AMOSKEAG ST
AMOSKEAG BRIDGE
INTERSTATE 293
EVERETT TURNPIKE

LEGEND

- Pavement
- Bridge
- Median / Grass Panel
- Existing ROW
- Proposed ROW
- Signal

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Figure 4.5-3
Alternative 4
Single Point Urban Interchange (SPUI)

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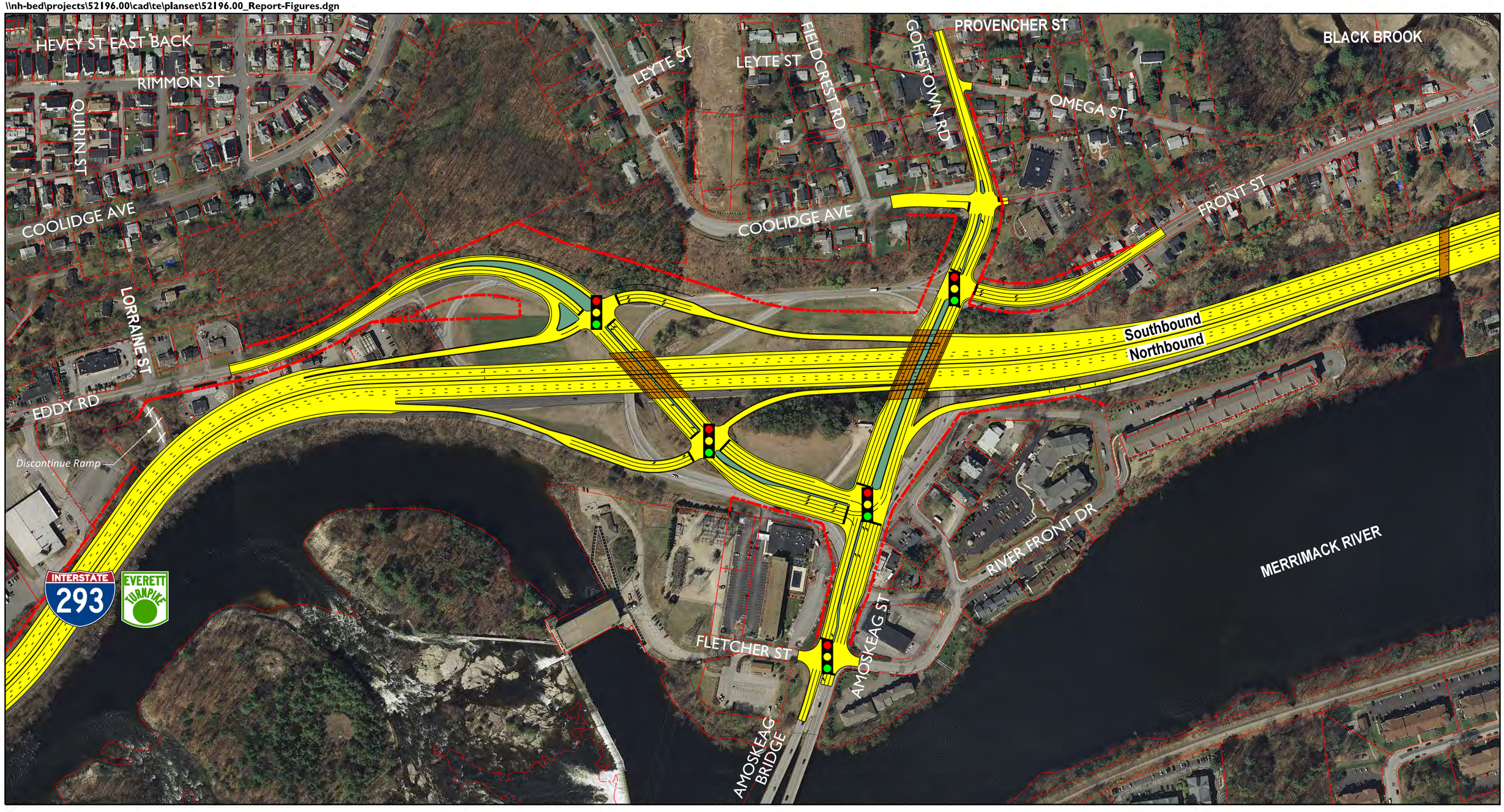

LEGEND

- Pavement
- Bridge
- Median / Grass Panel
- Existing ROW
- Proposed ROW
- Signal

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Figure 4.5-4
Alternative 5
Diamond Interchange

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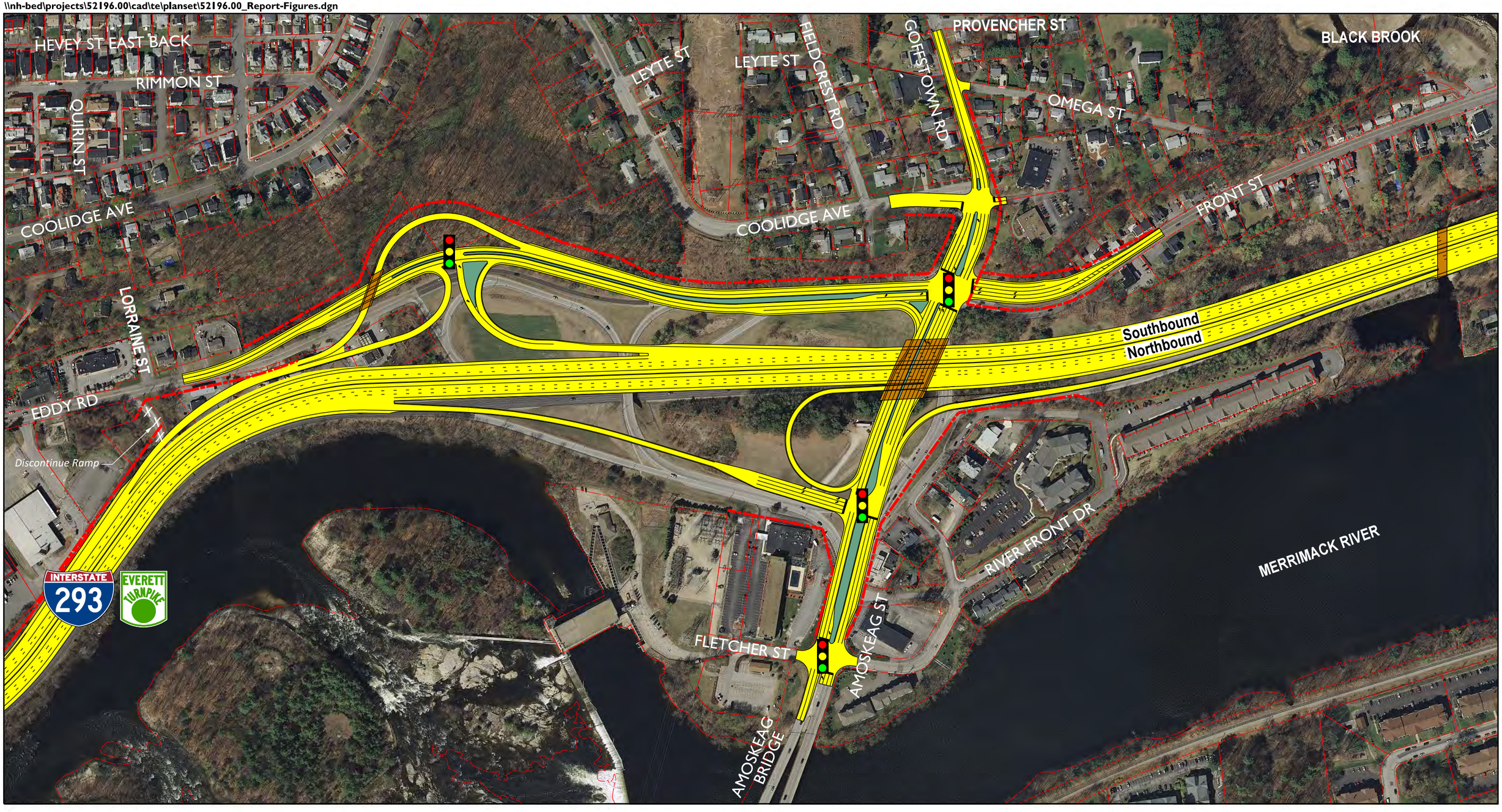

LEGEND

- Pavement
- Bridge
- Median / Grass Panel
- Existing ROW
- Proposed ROW
- Signal

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Figure 4.5-5
Alternative 5A
Off-Set Diamond Interchange

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south on Eddy Road will turn left to Eddy Road at a signalized intersection. For Eddy Road southbound traffic entering I-293, a fly-over ramp will allow motorists to access I-293 directly by bridging over Eddy Road without passing through the signalized intersection. The northbound traffic on Eddy Road will also have direct access to I-293 by way of a short ramp that merges with the fly-over ramp without passing through a signalized intersection.

Alternative 5A includes construction of 0.5 mile of Eddy Road, 0.2 mile of Goffstown Road and Coolidge Avenue, 0.2 mile of Amoskeag Street, 1.4 miles of interchange ramps, 0.8 mile of I-293, three (3) bridges (Goffstown Road/Amoskeag Street over I-293, the southbound on-ramp fly-over Eddy Road; and I-293 over Black Brook), 0.1 mile of retaining walls, and four signalized intersections.

Alternative 6

Alternative 6 **(Figure 4.5-6**) evaluates a Diverging Diamond Interchange (DDI), sometimes referred to as a Double Crossover Diamond. A DDI is a diamond interchange that more efficiently facilitates heavy left-turn movements. The ramp configuration is comparable to the traditional diamond, but the traffic on the roadway crossing over I-293 moves from the established right-side of the roadway and crosses over to the left-side of the road briefly between the signalized ramp intersections. Shifting the traffic from the right side to the left side eliminates any conflict with through traffic and allows all the left turning traffic to enter I-293 without the need to utilize a left-turn signal phase at the signalized ramp intersections. The principal benefits of a DDI are 1). The reduction in vehicle conflict points from thirty conflicts with a typical diamond interchange to 18 conflicts with a DDI and 2). Each of the two signalized ramp intersections for a DDI can be operated with a simple two-phase operation for improved efficiency.

Alternative 6 is similar to Alternative 5 and also has two basic design features. The first develops a new DDI connecting Eddy Road to the west and Amoskeag Street to the east with the northbound and the southbound ramps forming two separately controlled signalized intersections. The DDI interchange connector road will join Amoskeag Street at a T-type signalized intersection. The second element includes a new separate bridge structure over I-293 carrying two-way traffic and linking Goffstown Road and Amoskeag Street. The existing Front Street connection to Goffstown Road will be maintained with a T-type signalized intersection. The existing four-way signalized intersection connecting River Front Drive and Fletcher Street to Amoskeag Street will also be retained.

Alternative 6 includes construction of 0.5 mile of Eddy Road/Amoskeag Street connector, 0.25 mile of a new connector linking Eddy Road to Amoskeag Street, 0.2 mile of Goffstown Road and Coolidge Avenue, 0.2 mile of Amoskeag Street, 1.2 miles interchange ramps, 0.8 mile of I-293, three bridges (Eddy Road/Amoskeag Street DDI connector over I-293, Goffstown Road/Amoskeag Street over I-293, and I-293 over Black Brook), 0.3 mile of retaining walls, and five signalized intersections.

Alternative 7

Alternative 7 (**Figure 4.5-7**) evaluates a traditional diamond interchange with the use of roundabouts instead of signals at the intersections with the northbound and southbound ramps. Alternative 7 design features would include a new diamond interchange connecting Eddy Road to the west and Amoskeag Street to the east with the northbound and the southbound ramps. Because of the high volume of traffic, each of the ramp intersections with the Eddy Road/Amoskeag connector will be controlled with a two-lane roundabout.

The roundabout interchange connector road will join Amoskeag Street at a T-type signalized intersection. The design would also include a new separate bridge structure over I-293 carrying two-way traffic and linking Goffstown Road and Amoskeag Street. The existing Front Street connection to Goffstown Road will be maintained with a T-type signalized intersection. The existing four-way signalized intersection connecting River Front Drive and Fletcher Street to Amoskeag Street would also be retained.

Alternative 7 includes construction of 0.5 mile of Eddy Road/Amoskeag Street connector, 0.25 mile of a new connector linking Eddy Road to Amoskeag Street, 0.2 mile of Goffstown Road and Coolidge Avenue, 0.2 mile of Amoskeag Street, 1.2 miles of interchange ramps, 0.8 mile of I-293, three bridges (Eddy Road/Amoskeag Street roundabout interchange connector over I-293, Goffstown Road/Amoskeag Street over I-293, and I-293 over Black Brook), 0.2 mile of retaining walls, and three signalized intersections.

4.5.3 Exit 7 Interchange Alternatives

The primary deficiency for the Exit 7 Segment is that the existing interchange is a partial interchange, only supporting connectivity for motorists traveling to and from the south on I-293. There are no ramps to provide connectivity to the north. In addition to the interchange capacity deficiencies and other safety issues, the nearly 60-year old interchange has substandard merge, diverge and weave areas on I-293 that further exacerbate traffic operations. The existing ramp intersections with Front Street are both substandard and confusing to traffic entering and exiting. To address these issues, two options were evaluated for their feasibility and practicality that either reconstruct the existing partial interchange to a fully directional interchange or relocate Exit 7 and construct a new interchange further to the north.

Key components toward the development of these options include measures that will improve connectivity for northbound and southbound traffic and improve safety and mobility, while looking to minimize impacts to residences, businesses, and the environmental resources. Segment 7 includes five alternatives and will involve widening I-293 approximately 0.8 miles when reconstructing existing Exit 7 or 1.9 miles when relocating Exit 7 to the north.

Alternative 8 involves reconstructing existing Exit 7 to a fully directional interchange at its current location while Alternatives 9A and 9B will relocate the interchange and construct a new fully directional interchange just north of Manchester Community College. Alternatives 10A and 10B are variations of Alternatives 9A and 9B in that they involve not only a new Exit 7 interchange, but include extending the Dunbarton Road connector in Manchester further to the west across Black Brook to Goffstown Road.

For Exit 7 Alternatives 8, 9A, 9B, 10A and 10 B were considered feasible and described below.

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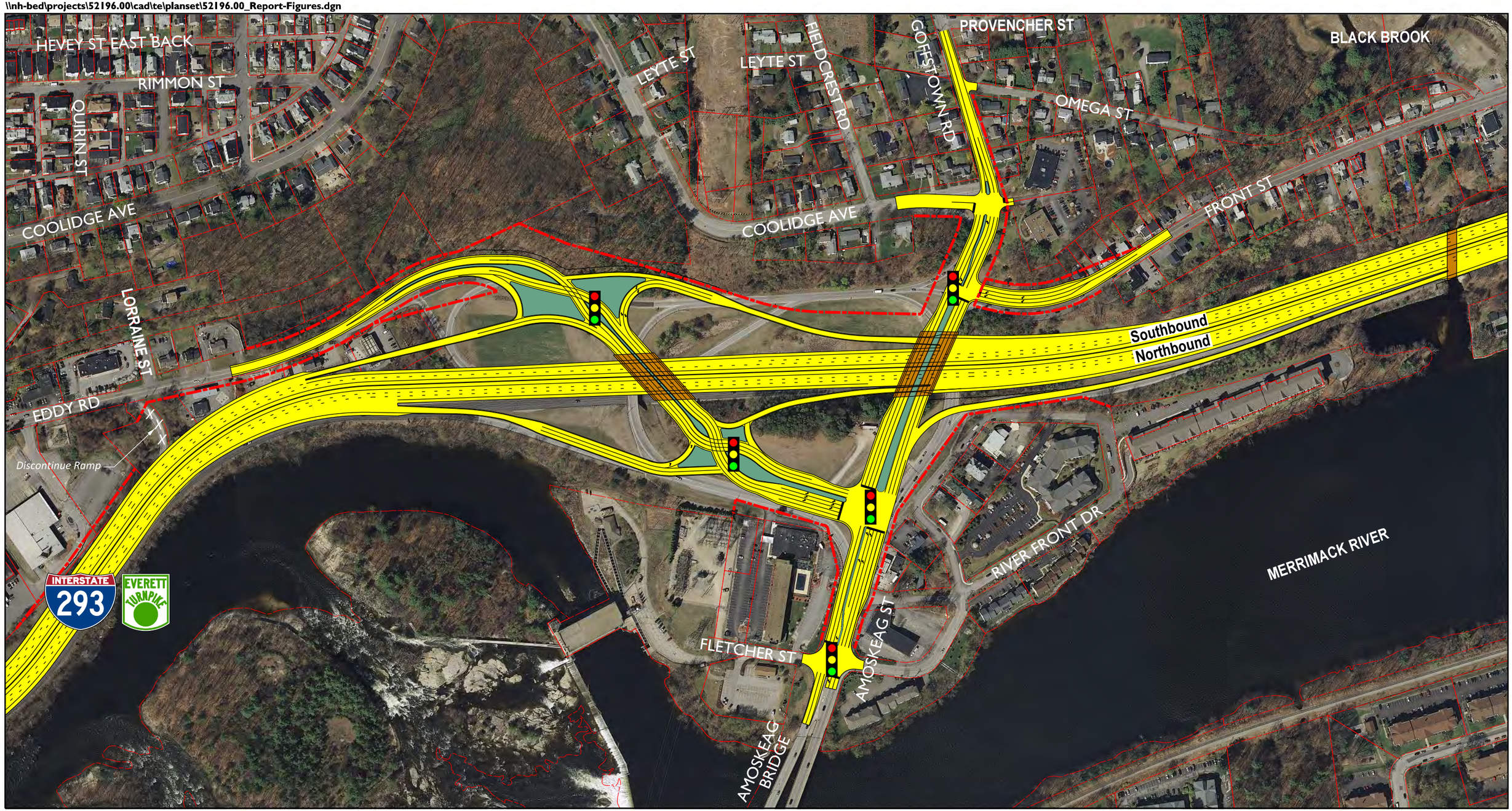

LEGEND

- Pavement
- Bridge
- Median / Grass Panel
- Existing ROW
- Proposed ROW
- Signal

0 300 600

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Figure 4.5-6
Alternative 6
Diverging Diamond Interchange (DDI)

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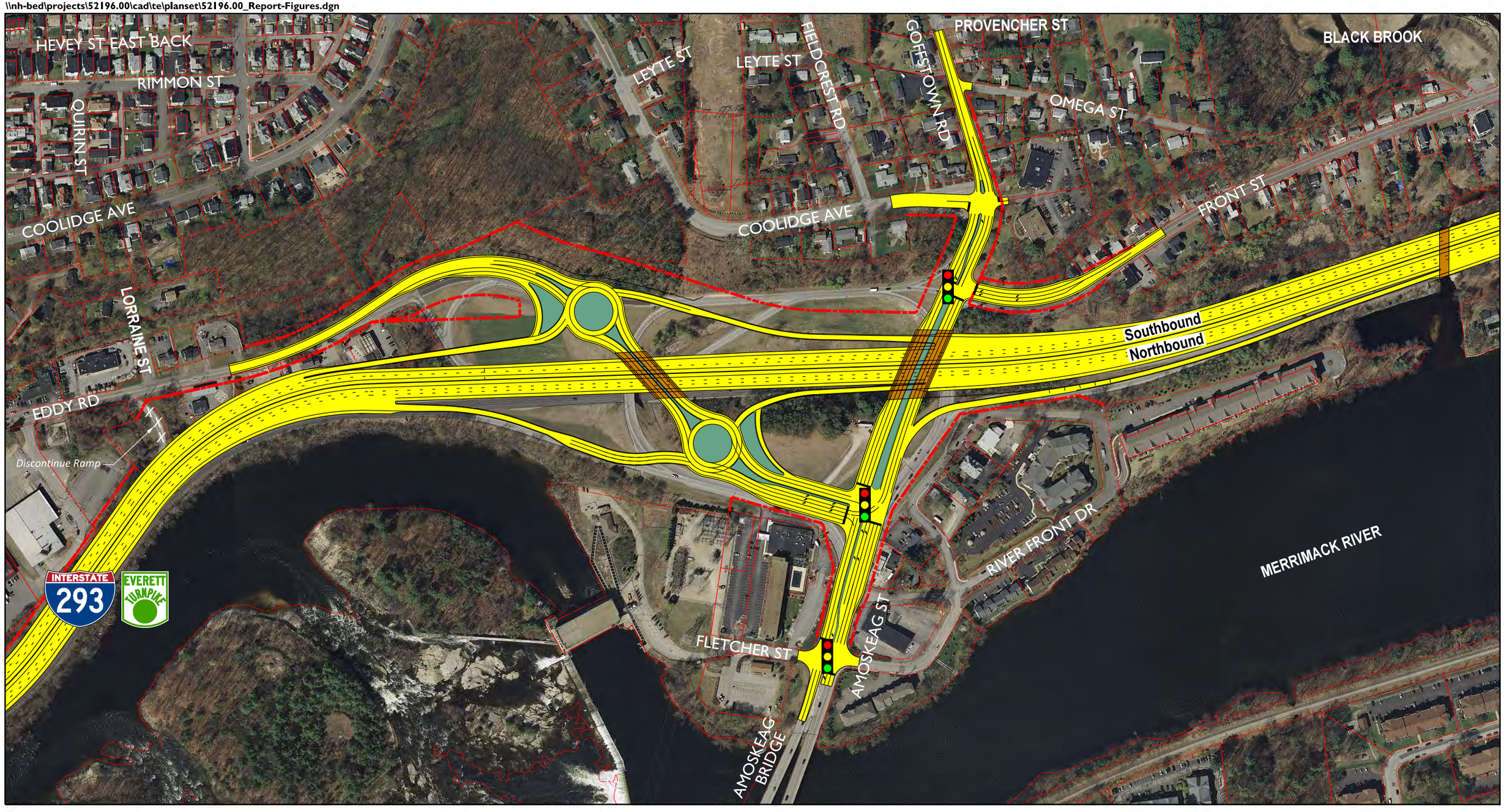

LEGEND

- Pavement
- Bridge
- Median / Grass Panel
- Existing ROW
- Proposed ROW
- Signal

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Figure 4.5-7
Alternative 7
Roundabout Diamond Interchange

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Alternative 8

Alternative 8 (**Figure 4.5-8**) evaluates the potential of constructing a new fully directional diamond interchange at the current Exit 7 location. The development of a new diamond interchange for at Exit 7 considered a constructible design layout that will minimize/eliminate impacts to:

- The Manchester Landfill area to the west.
- Any paved areas or buildings at the Manchester Community College.
- Existing wetland areas at Black Brook and Stark Lane.
- Impacts to Merrimack River, Black Brook, and the 100-year flood plain.
- Commercial and residential properties.

The interchange layout will widen Front Street to accommodate through/turning traffic at the signalized northbound and southbound ramp intersections with Front Street. Wider bridges will carry I-293 over Front Street, Stark Way and Black Brook. Retaining walls 10 to 25 feet high along the southbound off-ramp and six to 18 feet high along Black Brook will be constructed to minimize resource and property impacts. Alternative 8 includes construction of 0.4 mile of Front Street, 0.8 mile of interchange ramps, 1.3 miles of I-293, three bridges (I-293 over Front Street, I-293 over Stark Way, and I-293 over Black Brook), 0.7 mile of retaining walls, and two signalized intersections.

Alternatives 9A, 9B, 10A and 10B

Alternatives 9A and 9B (**Figure 4.5-9**) will relocate Exit 7 and construct a new fully directional interchange on I-293 just north of Manchester Community College and adjacent to the Manchester Landfill. Both alternatives avoid the Manchester Landfill by shifting the Interchange Connector Road alignment northerly while attempting to avoid the steep terrain and wetlands near the transmission line corridor. Both alternatives are similar with new connections to Front Street to the east and at Dunbarton Road to the west. The 1.0-mile long Interchange Connector Road passes under I-293. The northbound on and off-ramps and the southbound off-ramp will be in a diamond interchange configuration while the southbound on-ramp will be configured in a loop layout.

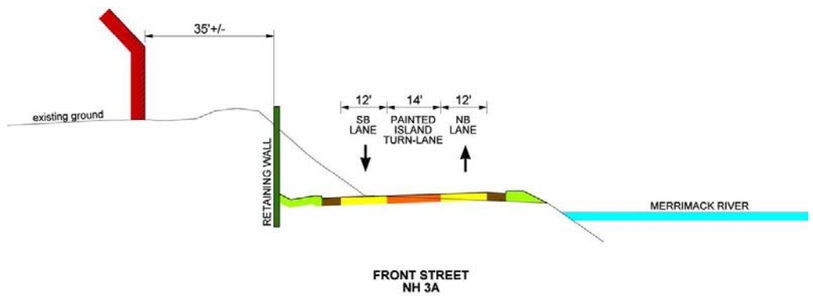
The primary difference between Alternative 9A and 9B is the location of the proposed Interchange Connector Road intersection with a widened and reconstructed Front Street. For Alternative 9A, the Interchange Connector Road intersects Front Street at the existing Country Club Drive intersection Alternative 9B, the Interchange Connector Road intersects Front Street approximately 800 feet further to the south of Country Club Drive. New driveway access to the Interchange Connector Road will be provided for Country Club Drive and for Manchester Community College.

The development of a relocated interchange for Exit 7 considers a constructible design layout that will minimize/eliminate impacts to:

- The Manchester landfill area to the south.
- Residential properties along Front Street, Delia Drive and Country Club Lane.
- Paved areas or buildings at the Community College.
- Existing wetland areas.
- The Merrimack River and the 100-year flood plain.
- Black Brook and the 100-year flood plain (Alt 10A and 10B).
- Residential properties along Dunbarton Road, Straw Road, Goffstown Road (Alt 10A and 10B).

Alternatives 10A and 10B (**Figure 4.5-10**) are similar to Alternatives 9A and 9B, respectively with the primary difference being variations of the Dunbarton Road connection. For Alternatives 9A and 9B the highway improvement proposed are essentially the same and include, the widening of 0.25 mile of Front Street to accommodate turning traffic at the new Interchange Connector Road, construction of 1.0 mile of Interchange Connector Road, construction of 800 feet of intersection approach connecting the proposed Interchange Connector Road with Dunbarton Road, and the construction of 500 to 700-foot long drives from the Interchange Connector Road into the Community College and to Country Club Drive, respectively. Both Alternatives also include building six to twenty foot high retaining walls along Front Street to minimize impacts to adjacent residential properties, the construction of 0.8 mile of interchange ramps, reconstructing 1.8 miles of I-293, a new bridge carrying I-293 over the Interchange Connector Road, 0.2 mile of retaining walls, and four signalized intersections. A cross-section of Front Street depicting the retaining wall is shown in **Exhibit 4.4-1**.

Exhibit 4.4-1 – Front Street Cross-Section
Near Connector Road Intersection



For Alternatives 10A and 10B, the 800-foot Dunbarton Road connection proposed for the 9A and 9B layout will be extended westerly as the Goffstown Connector Road bridging across Black Brook an additional 0.7 mile, linking the proposed Exit 7 Interchange Connector Road with the Goffstown Road/Straw Road intersection. The highway improvements proposed are similar to 9A and 9B with the difference being the 0.7-mile extension of the Dunbarton Connector includes a proposed Goffstown Connector Road to Goffstown Road/Straw Road intersection, the construction of a new bridge over Black Brook, and the 0.1-mile reconstruction of Straw Road. Note that the configuration and alignment of the Goffstown Connector Road will require more detailed evaluation under the National Environmental Policy Act (NEPA) phase of the project.

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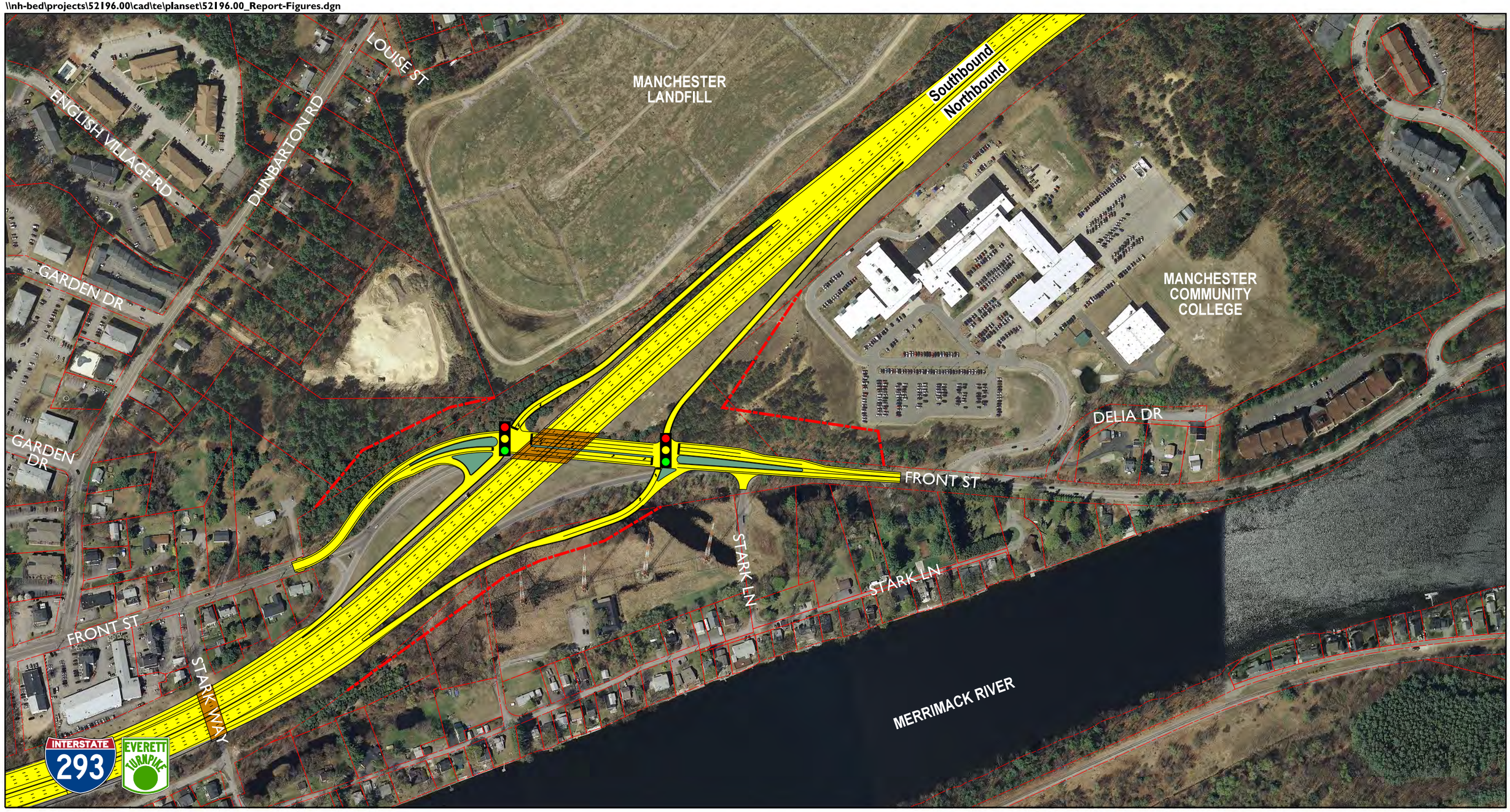

LEGEND

- Pavement
- Bridge
- Median / Grass Panel
- Existing ROW
- Proposed ROW
- Signal

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Figure 4.5-8
Alternative 8
Diamond Interchange (Current Location)

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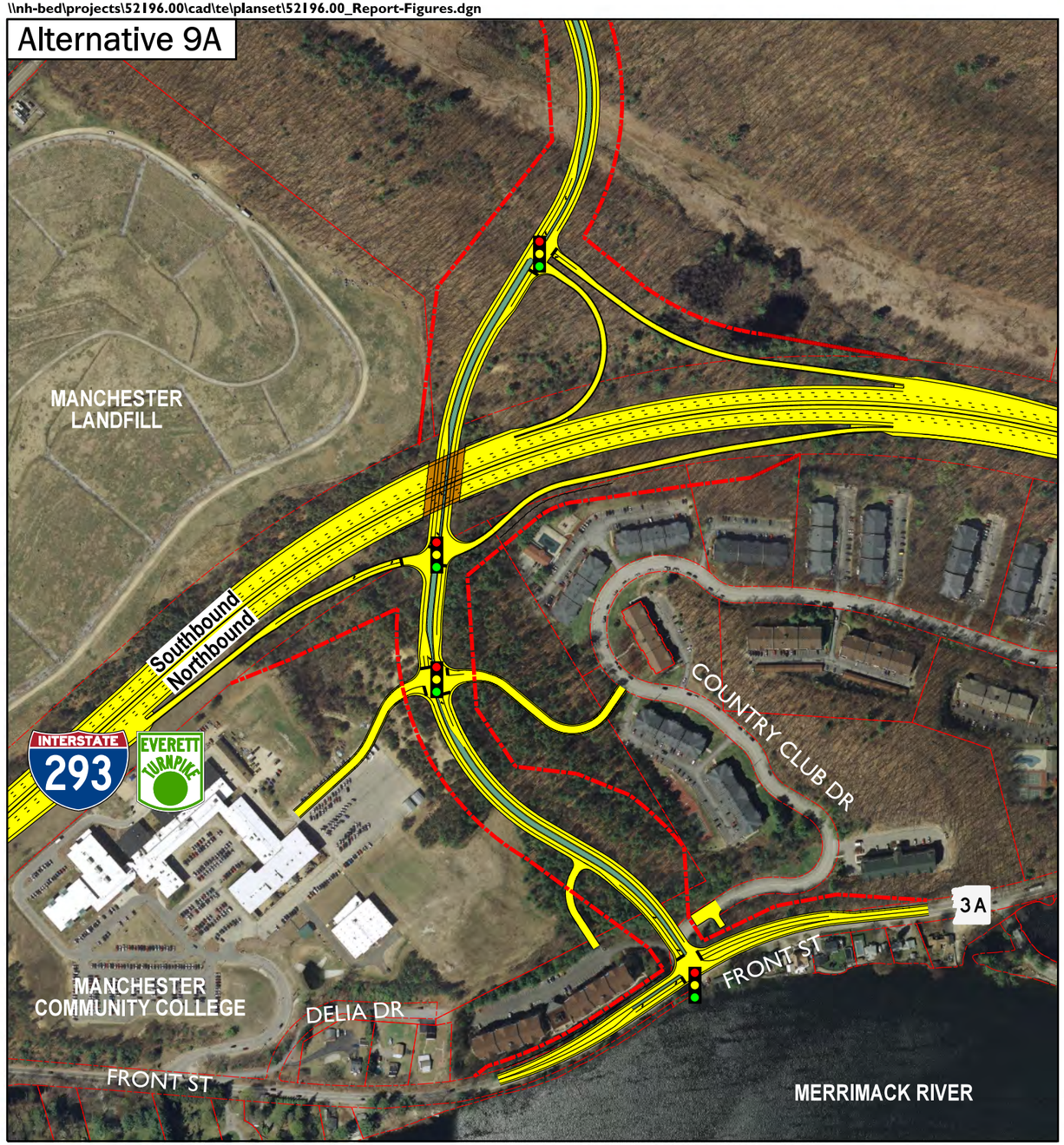
Alternative 9A



Alternative 9B

LEGEND

- Pavement
- Bridge
- Median / Grass Panel
- Existing ROW
- Proposed ROW
- Signal

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Figure 4.5-9
Alternative 9A & Alternative 9B
Exit 7 - Relocated Interchange

Manchester, NH

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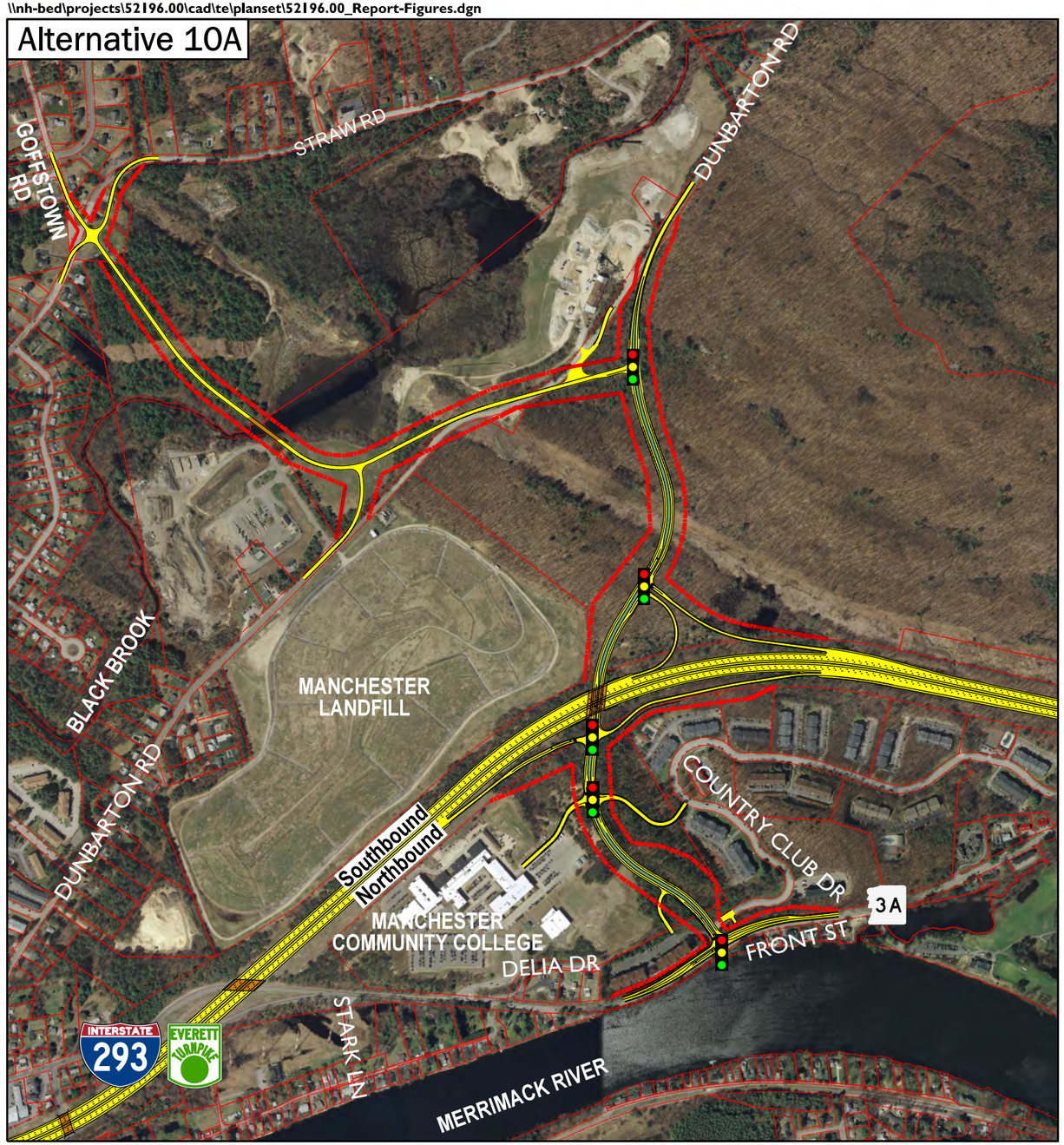
Alternative 10A



Alternative 10B

LEGEND

- Pavement
- Bridge
- Median / Grass Panel
- Existing ROW
- Proposed ROW
- Signal

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Figure 4.5-10
Alternative 10A & Alternative 10B
Exit 7 - Relocated Interchange (with connection to Goffstown Rd.)

Manchester, NH

New Hampshire DOT Department of Transportation

5 Evaluation of Alternatives

5.1 Introduction

When considered in the context of the existing transportation system and the environmental resources described in Chapter 2, the future travel demands described in Chapter 3, and the conceptual alternatives described in Chapter 4, this chapter provides a comparison of the relative benefits and impacts of each alternative. The chapter describes the methodologies and criteria used in conducting the evaluation, along with results of the evaluation.

5.2 Evaluation Criteria

This section describes the criteria used to evaluate the range of alternatives. The section includes a discussion on major components such as addressing the study purpose, meeting the needs of the communities, providing acceptable traffic operations, and other methods and metrics used to determine potential impacts.

5.2.1 Addressing the Study Purpose

As described in Chapter 1, the purpose of this Study is to consider transportation system modifications aimed at addressing ***capacity*** and ***safety*** related deficiencies along a 3-mile segment of I-293 at interchanges Exits 6 and 7. Consideration is given to relocating and/or reconfiguring Exit 7 into a full directional interchange. The evaluation of alternatives considers how well each alternative meets this purpose.

5.2.2 Meeting Community Needs

Input received through the public outreach effort, including the Technical Advisory Committee, is clear that an important consideration of the surrounding communities is how the upgrade of the corridor may support the economic well-being of the region. In particular, officials from the City of Manchester and the Town of Goffstown have expressed a strong desire for the relocation of the Exit 7 interchange to the north. Doing so will support the City of Manchester's Hackett Hill Master Plan and may provide much needed connectivity to the Town of Goffstown's industrial zoned land. Therefore, the evaluation of the alternatives will consider the benefit this connectivity may have on the economic well-being of the surrounding communities.

5.2.3 Traffic Operational Criteria

As previously discussed in Section 2.3.6, level of service (LOS) is a term used to describe the operational conditions of roadway facilities. Six (6) levels of service are defined that range in letter designation from LOS A to LOS F, with LOS A representing the best operating condition and LOS F representing the worst. In the design of new roadway facilities, the NHDOT generally considers LOS C as desirable and LOS D as minimally acceptable. The NHDOT under certain circumstances may accept LOS E operation. LOS E may encourage multi-modal use and reduce the use of single-occupant vehicles, particularly during the peak hours of the day.

5.2.4 Resource Evaluation Methods

Understanding potential impacts on environmental and social resources is another important element of the Study. To review these issues, an impact analysis of each alternative was conducted.

As described in Chapter 2, available GIS data for the study area were obtained from various state agencies, NHGRANIT, and the municipalities. Existing environmental information was verified and updated in the field based on a reconnaissance-level effort. Information pertaining to ROW and property in the study area was obtained by 2012 GIS parcel mapping, including assessment records provided by the City of Manchester.

Potential impacts were then calculated using a GIS overlay analysis, in which the footprint of each roadway option was overlaid onto the various environmental resources. To evaluate many of the environmental resources (wetland, floodplain, hazardous material, farmland, rare species, ROW, parks, cultural), the project footprint consisted of the preliminary slope limits (area of new fill) engineered for each alternative. For other resources (aquifer and water quality), the amount of new pavement associated with each alternative was used for the project footprint. **Table 5.2-1** summarizes the metrics used to evaluate these resources.

Impacts presented in this study must be interpreted cautiously. First, only direct impacts were considered. However, certain resources (i.e., historic buildings and historic districts) can be affected indirectly. Second, all identified impacts are preliminary estimates because they are based on preliminary rough grading without site-specific survey contours or detailed engineering. Third, resource mapping relies primarily on landscape-level environmental data rather than detailed site-specific studies that would be required during a formal NEPA or permit evaluation. Fourth, the ROW displacement estimates do not quantify any corresponding loss of tax base associated with the acquisition, as it too early in the design phase to quantify this information. The impacts, however, are still useful and appropriate for comparing the relative impacts of each alternative.

Table 5.2-1 Environmental Evaluation Metrics

Resource/Impact	Metric
Wetlands	Acres of Dredge/Fill Number of Stream Crossings
Water Quality	Acres of New Pavement
Floodplains	Acres of New Fill
Aquifer	Acres of New Pavement
Farmland	Acres of Disturbance
Rare, Threatened, Endangered Species/Habitat	# of Federally Listed Populations # of Populations Potentially Impacted
Parkland & Recreation	# of Sites Potentially Impacted
ROW Displacement	# of Parcels Affected #Buildings Impacted by Land use Type Acres of Acquisition
Historic/Archeological Resources	# of Known Archeological Sites # of Historic Above-ground Structures Directly Impacted
Hazardous Waste	# of Potential Sites Impacted
Construction Cost	2013 Dollars

5.3 Alternatives Evaluation

This section summarizes the results of the alternatives evaluation, which include: the No Build alternative, three I-293 mainline alternatives (Alternatives 1, 2, and 3), five Exit 6 alternatives (Alternatives 4, 5, 5A, 6, and 7), and five Exit 7 alternatives (Alternatives 8, 9A, 9B, 10A, and 10B). The results of the evaluation are summarized in **Table 5.3-1**. The table summarizes the impacts and preliminary estimated costs of each alternative. In addition, it summarizes how well each alternative meets the study purpose of addressing the capacity and safety needs of the corridor and how well each meets the needs of the communities, which in this case focus on the potential for supporting economic development. The table uses the colors of green, yellow and red as an indication of the alternative either substantially meeting, moderately meeting, or failing to meet the objectives.

5.3.1 No Build

The No Build alternative reflects the perpetuation of the existing transportation infrastructure within the study area. Therefore, the No Build alternative does not consider any physical alteration to the existing transportation system. However, the alternative does include the same level of traffic growth out to the future design year of 2035 as each of the Build alternatives. The No Build serves as a benchmark to compare the benefits and impacts of the Build alternatives.

The No Build alternative will fail to address the capacity and safety deficiencies identified in the study purpose. Additionally, the No Build alternative will fail to meet the surrounding community's desire to support the economic well-being of the area.

5.3.2 I-293 Mainline Alternatives 1, 2, and 3

Capacity and Safety

Alternative 1, which maintains the existing two travel lanes per direction along the mainline while upgrading the interchanges, will fail to meet the capacity purpose as the segment between Exits 5 and 6 is projected to operate at LOS E while the segment between Exits 6 and 7 is projected to operate at LOS F. Despite the poor level of service that will result from not providing additional travel lanes, upgrading the configurations of the interchanges suggests that the alternative will moderately meet the purpose of enhancing safety.

Alternatives 2 and 3, expand the mainline to three travel lanes per direction, will substantially meet the capacity purpose as all mainline segments will operate at LOS C or better. The additional capacity, improved alignment, and upgraded interchanges will suggest that both alternatives will substantially meet the purpose of enhancing safety.

Table 5.3-2 summarizes the levels of service for the I-293 segments under a widening scenario (Alternatives 2 or 3) in combination with the various Exit 6 and Exit 7 interchange alternatives.

Table 5.3-1

I-293 Exits 6 and 7 Transportation Planning Study Evaluation Matrix

Study purpose is to consider transportation system modifications aimed at addresing **capacity** and **safety** related deficiencies along the mainline and at the interchanges (Exits 6 and 7) for a 3 mile segment of I-293 including consideration of relocating and reconfiguring Exit 7 into a fully directional interchange. The evaluation is conceptual and should not be interpreted as a conclusive study of impacts.

		No Build	I-293 Mainline			Exit 6 Interchange					Exit 7 Interchange				
			Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 5A	Alt 6	Alt 7	Alt 8	Alt 9A	Alt 9B	Alt. 10A	Alt 10B
Purpose			Maintain 4-lanes with Interchange Alternative	6-lanes with Interchange Alternative (easterly alignment)	6-lanes with Interchange Alternative (westerly alignment)	Single Point Urban Interchange	Standard Diamond Interchange	Off-Set Diamond Interchange	Diverging Diamond Interchange	Diamond Interchange with Roundabouts	Tight Diamond Interchange at Existing Location	Relocated Interchange with access to Front St and Dunbarton Rd	Relocated Interchange with access to Front St and Dunbarton Rd	Relocated Interchange w/ access to Front St and Goffstown Rd	Relocated Interchange w/ access to Front St and Goffstown Rd
Addresses capacity deficiencies along I-293						N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Addresses safety deficiencies along I-293						N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Adresses capacity deficiencies at interchanges			See interchange alternatives	See interchange alternatives	See interchange alternatives										
Addresses safety deficiencies at interchanges			See interchange alternatives	See interchange alternatives	See interchange alternatives										
Community Needs (Economic Development)															
Supports Hackett Hill Master Plan Connectivity			N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A					
Supports Goffstown/I-293 Connectivity			N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A					
Impacts	**Metric**														
Wetlands	Acres of Impact	0		0.1	0.1	3.4	2.9	3.3	2.9	2.9	2.1	1.6	1.7	1.8	1.9
	Number of Stream Crossings	0		0	0	2	3	3	3	3	4	6	6	7	7
Water Quality	Acres of New Pavement	0		4.9	4.7	11.49	10.7	11.8	9.9	9.7	11.8	19.2	19.2	21.8	21.8
Floodway	Acres of New Fill	0		0	0	0	0	0	0	0	0	0	0	0	0
Floodplain	Acres of New Fill	0		2.8	1.9	2.0	1.8	1.6	1.7	1.8	2.1	0.7	0.4	1.0	0.7
Aquifer	Acres of New Pavement	0		4.9 (U)	4.7 (U)	14.6 (U)	13.9 (U)	15.5 (U)	13.6 (U)	13.4 (U)	12.3 (U)	17 (0.4 - Till, 16.6 - U)	16.9 (0.4 - Till, 16.5 - U)	20 (0.4 - Till, 19.6 - U)	20.1 (0.4 - Till, 19.7 - U)
Farmland	Acres of Disturbance	0		0	0	0	0	0	0	0	4.7	22.3	19.9	22.3	19.9
Rare, Threatened, Endangered Species/Habitat	# of Federally Listed Populations Impacted	0		0	0	0	0	0	0	0	0	0	0	0	0
	# Populations Potentially Impacted	0		4 state listed "T" or "E"	4 state listed "T" or "E"	4 state listed "T" or "E"	4 state listed "T" or "E"	4 state listed "T" or "E"	4 state listed "T" or "E"	4 state listed "T" or "E"	8 (4 state listed "T" or "E", 3 state listed "SC", 1 NHB tracked, not yet added	6 state listed "T" or "E"	6 state listed "T" or "E"	7 state listed "T" or "E"	7 state listed "T" or "E"
Highway Noise	# of Sensitive Receptors	N/A		3	3	78	77	81	78	77	25	16	19	38	41
Public Parks & Recreation	# of Sites Impacted	0		0	0	0	0	0	0	0	0	0	0	0	0
Right-of-Way	# of Parcels Affected	0		8	8	21	21	24	22	21	6	8	10	16	18
	Buildings Impacts by Landuse Type	0		2 Commercial	2 Commerical	7 (2 Single Fam. Res., 1 Multi-Fam. Res., 4 Com.)	9 (3 Single Fam. Res., 2 Multi-Fam. Res., 4 Com.)	11(4 Single Fam. Res.,3 Multi-Fam. Res., 4 Com.)	9 (3 Single Fam. Res., 2 Multi-Fam. Res., 4 Com.)	9 (3 Single Fam. Res., 2 Multi-Fam. Res., 4 Com.)	0	0	1 Single Fam. Res.	2 (1 Single Fam. Res., 1 Multi-Fam. Res.)	4 (2 Single Fam. Res., 1 Multi-Fam. Res, 1 Com.)
	Acres of Acquisition	0		3.6	4.2	1.2	4	5.5	4.6	4	3.6	31.8	31.4	45.2	44.8
Historic/Archaeological Resources	# of Known Historic Properties Directly Impacted	0		Amoskeag Federal House, Amoskeag Millyard Historic District	Amoskeag Federal House, Amoskeag Millyard Historic District	Amoskeag Federal House, Amoskeag Millyard Historic District	Amoskeag Federal House, Amoskeag Millyard Historic District	Amoskeag Federal House, Amoskeag Millyard Historic District	Amoskeag Federal House, Amoskeag Millyard Historic District	Amoskeag Federal House, Amoskeag Millyard Historic District	0	0	0	0	0
	# of Known Archaeological Sites Impacted	0		1	1	2	2	2	2	2	0	0	0	0	0
Hazardous Waste	# of Potential Sites Impacted	0		3	4	7	6	7	6	6	3	4	4	4	4
Construction Cost	2013 Dollars			$18 - $20 M	$8 - $9 M	$54 - $60 M	$38 - $42 M	$37 - $41 M	$41 - $45 M	$34 - $37 M	$33 - $36 M	$36- $40 M	$37 - $41 M	$42 - $47 M	$43 - $48 M

LEGEND

Substantially Meets Objective

Moderately Meets Objective

Minimally or Fails to Meet Objective

Notes:
(U) = Stratified-drift Undifferentiated
(T) = Threatened, (E) - Endangered, (SC) - Species of Concern

N/A = Not Applicable

Table 5.3-2 Freeway Capacity Analysis Summary

I-293 (FEET) Freeway Segment	Peak Period	Alternative LOS* 4&8	4/5/6/7&9	4&10
I-93 to Exit 7 SB	AM	B	B	B
	PM	B	B	B
Exit 7 to I-93 NB	AM	A	A	A
	PM	C	C	C
Exit 7 to Exit 6 SB	AM	NA	C	C
	PM	NA	B	B
Exit 6 to Exit 7 NB	AM	NA	B	A
	PM	NA	C	C
Exit 6 to Exit 5 SB	AM	C	C	C
	PM	C	C	C
Exit 5 to Exit 6 NB	AM	B	B	B
	PM	C	C	C

* Freeway Level of Service.

NA - Not Applicable (see weave operations on Figures 5.3-1 and 5.3-2).

Community Needs (Economic Development)

Although any upgrade of the I-293 mainline will support the economic development needs of the surrounding communities, the focus of the economic development needs relates mostly to the Exit 7 alternatives as these alternatives have the potential to most closely support the City of Manchester's Hackett Hill Master Plan and the Town of Goffstown's need for improved connectivity. For this reason, the I-293 mainline alternatives are considered not applicable under the community needs consideration.

Environmental Impacts

Alternatives 2 and 3 will impact an estimated 0.1 acres of Wetland 2, located just south of the Eddy Road southbound on-ramp. It should be noted that top-of bank delineation for the Merrimack River was not performed for this Study. A formal top-of-bank delineation may lead to additional wetland impacts to the Merrimack River under Alternative 3, where the alignment is shifted towards the river.

The primary measure of water quality used in the Study is the area of new impervious surfaces associated with the construction of each alternative measured as the number of acres of new pavement. Alternative 2 has slightly more new impervious surfaces totaling an estimated 4.9 acres in comparison to Alternative 3, which has an estimated 4.7 acres of new impervious surfaces. All Alternative 3 impervious surfaces will be located within a stratified-drift undifferentiated aquifer. Alternative 2, which involves widening the mainline towards the Merrimack River, will also have a greater potential impact on the riparian buffer zone between the highway and the river. It is important to note that this assessment does not account for the stormwater treatment measures that will mitigate and reduce the potential for water quality impacts. The location of these measures will be identified in the next phase of the project.

Both alternatives will impact the FEMA mapped 100-year floodplain with Alternative 2 resulting in a greater impact on these resources in comparison to Alternative 3. Areas of possible encroachment and impact are along the Merrimack River from south of the Eddy Road on-ramp to just north of the Exit 5 (Granite Street) northbound on-ramp. Neither alternative will impact the Regulatory Floodway as currently mapped by FEMA. The conceptual engineering completed as part of this Study allows for neither calculation of the volume of floodplain fill nor a hydraulic analysis of potential effects on the Merrimack River, which will be completed during the NEPA phase.

Alternatives 2 and 3 may potentially impact four state listed threatened/endangered species associated with the Merrimack River. No federally listed species are located within the study area. The data provided by the NHNHB for the impact analysis does not list the actual species name, only the Federal/State listing status.

Properties with potential hazardous waste sites exist at the former millyard complex located at 194/195 McGregor Street, former millyard at 345 McGregor Street, the Eddy Road PSNH Substation, and a gasoline station (Mobil 15021) on Eddy Road. These properties may be impacted. A notable concern is present at 194/195 McGregor Street, where a plume of chlorinated solvents in the groundwater exists and a Groundwater Management Permit (GMP) has been assigned. Both Alternatives 2 and 3 will require ROW at 194/195 McGregor Street, adjacent to I-293, which will likely warrant further investigation during final design to minimize health and safety risks. Both alternatives require ROW acquisition from the Mobil Station on Eddy Road.

ROW Impacts

Alternatives 2 and 3 may affect eight private parcels and two commercial buildings. The footprint of Alternative 3 will have a slightly larger potential impact on existing commercial properties associated with widening towards the west.

Cultural Resources

NHDHR and cultural resources staff from NHDOT noted that the Amoskeag Falls area is one of the most important archaeological areas in the state, with known deposits occurring several feet below ground. Preliminary information provided by NHDR indicates that one known archaeological site may be affected by both Alternative 2 and 3.

In terms of historic above-ground structures, both Alternative 2 and 3 will impact ROW associated with the National Register-listed Amoskeag Millyard Historic District. Alternative 3 will require more land acquisition due to the westerly alignment associated with this alternative. Both alternatives will also impact the c.1898 Valve House located immediately adjacent to the existing I-293 southbound travel lane. Due to the small footprint of the Valve House, it is anticipated that the Valve House could be relocated within the historic district to preserve the building.

Alternative 3 may also limit the existing commercial use of the former American Cotton Duck and Stark Mills Cotton Storehouse buildings. Specifically, Alternative 3 will require acquiring the parking/loading dock space at the rear of the building (side adjacent to I-293). Additionally, both Alternative 2 and 3 will require ROW acquisition adjacent to the former Mill #12 Annex, Cloth Room, for the purposes of matching into the alignment at Exit 5. It should be noted that the Mill #12 recently received a community grant to make site plan improvements. Future roadway design in this area will attempt to minimize any impacts associated with the site plan improvements to Mill #12.

The Amoskeag Federal House, located at 225 Eddy Road outside of the Amoskeag Historic District, would be impacted by Alternatives 2 and 3. This building has been previously relocated twice, once in the 1950s and again in 1984. A National Register nomination was completed for the house in 1974, but the building was never listed. However, the house is identified as a Local Historic Site.

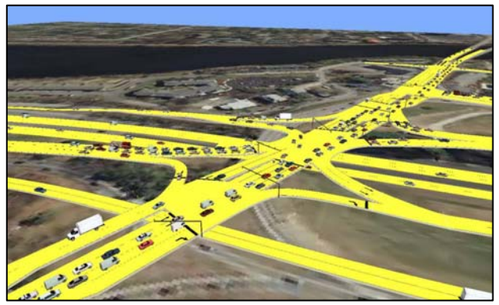
Construction Cost Estimate

The results of a programing construction cost estimate (2013 Dollars) shows an estimated construction cost of $18 to $20 million for Alternative 2 and an estimated construction cost of $8 to $9 million for Alternative 3. Note that the programming construction cost estimate does not include costs related to utility construction or relocation, right-of-way acquisition or relocation, mitigation, or preliminary and final engineering fees.

5.3.3 Exit 6 Interchange Alternatives 4, 5, 5A, 6, and 7

Capacity and Safety

Alternative 4 (SPUI) will substantially meet both the capacity and safety purpose. Each of the signalized intersections will operate at LOS C or better, while all of the ramp movements will similarly operate at LOS C or better. This alternative will also distribute traffic well as all traffic entering and exiting I-293 is accommodated at the SPUI while the Goffstown Road/Eddy Road/Front Street intersection is reconfigured so that Eddy Road and Front Street connect to Amoskeag Street by a separate bridge over I-293 rather than passing through the SPUI. By separating this intersecting traffic, the conflicts and congestion adjacent to the SPUI interchange are eliminated allowing, safer and more efficient traffic flow at the SPUI.



Alternatives 5, 5A, and 6 moderately meet the capacity purpose while substantially meeting the safety purpose. Each of the alternatives has at least one signalized intersection that will operate at LOS D. However, of greater concern is the queuing that occurs between the signalized intersections of the northbound ramps and the Amoskeag Street intersection under alternatives 5 and 6. The proximity of these two intersections combined with the high volume of traffic shows the potential of traffic queuing back from one intersection into the other. Alternative 5A has potential congestion issues at the Goffstown Road/Front Street intersection.

Alternative 7 (Diamond Interchange with Roundabouts) will substantially meet the safety purpose as properly designed roundabouts have been shown to enhance safety. However, Alternative 7 will fail to meet the capacity purpose. The 2-lane roundabouts will operate at LOS F. Also the proximity of the signalized Amoskeag Street intersection with the roundabout at the northbound ramps will be potentially problematic.

Levels of service for the signalized intersections and ramp junctions associated with the alternatives for Exit 6 are shown in **Figure 5.3-1.**

Community Needs (Economic Development)

As was the case for the upgrade of the I-293 mainline, any upgrade of Exit 6 may also support the economic development needs of the surrounding communities. However, the focus of the economic develop need relates primarily to the Exit 7 alternatives as these alternatives have the potential to support the City of Manchester's Hackett Hill Master Plan and the Town of Goffstown's need for improved connectivity. For this reason, the Exit 6 alternatives are considered not applicable under the community needs consideration.

Environmental Impacts

Nine wetlands (Wetlands 2-10), in addition to Black Brook and the Merrimack River, will be impacted by each alternative at Exit 6. Alternatives 4 and 5A have slightly larger impacts than Alternatives 5, 6, and 7. Wetlands 5, 6, and 7 will be filled in their entirety under each alternative evaluated. Nearly half to up to three quarters of Wetland 8 may be impacted as well by the various alternatives. A small amount of fill slope will impact the Merrimack River south of the existing Exit 6 northbound off-ramp. Black Brook will be impacted by widening of the existing bridge over Black Brook.

From a water quality perspective, Alternative 7 will create the least amount of new impervious area at an estimated 9.7 acres compared to the largest amount of new impervious of 11.8 acres generated by Alternative 5A. Alternatives 4, 5 and 6 will result in an estimated 11.5, 10.7 and 9.9 acres of new impervious area, respectively.

All of the alternatives will impact a portion of the Zone AE floodplain associated with the Merrimack River, and Zone A floodplain associated with Black Brook. Potential floodplain impacts range from 1.6 acres (Alternative 7) to 2.0 acres (Alternative 4), with Alternatives 5, 5A, and 6 impacting 1.8, 1.7, and 1.8 acres respectively.

Aquifer impacts for each of the five alternatives are similar, but because Alternative 5A (Offset Diamond Interchange) requires more infrastructure than the other alternatives, a larger amount of aquifer will be impacted. Alternative 7 (Diamond Interchange with Roundabouts) will impact the least amount of aquifer.

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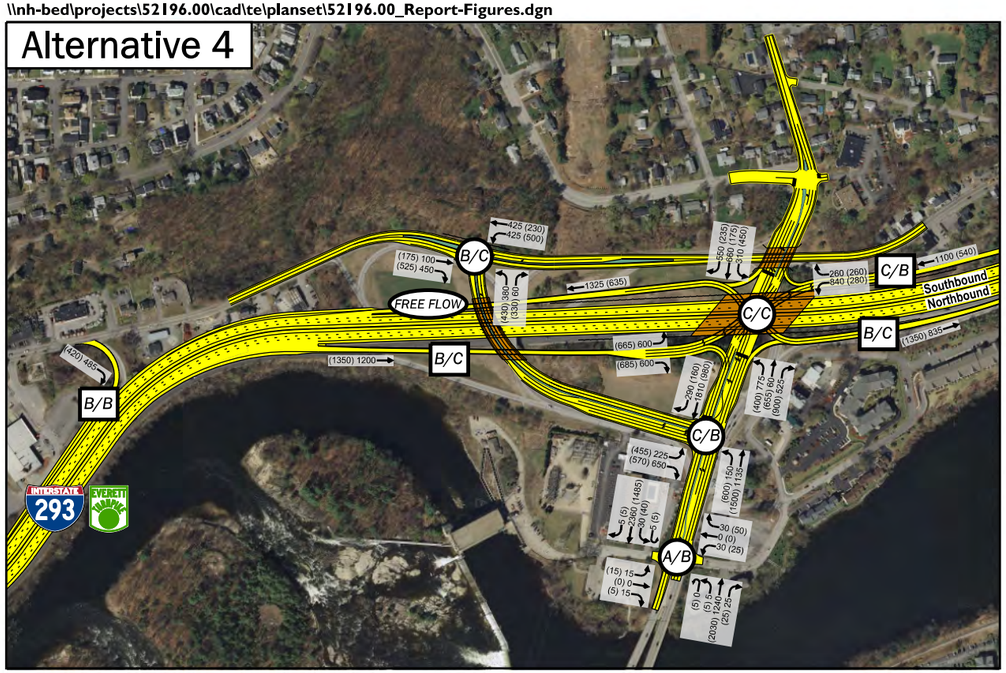

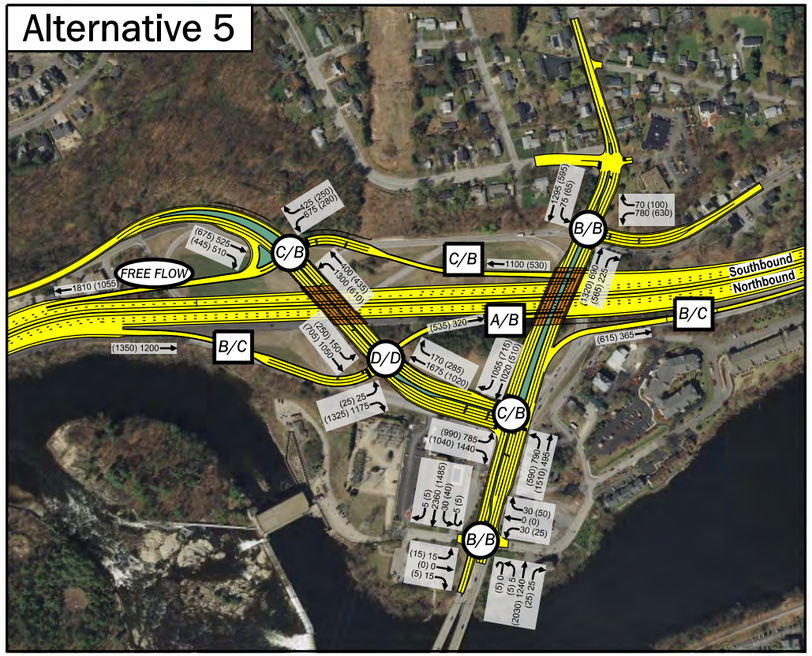

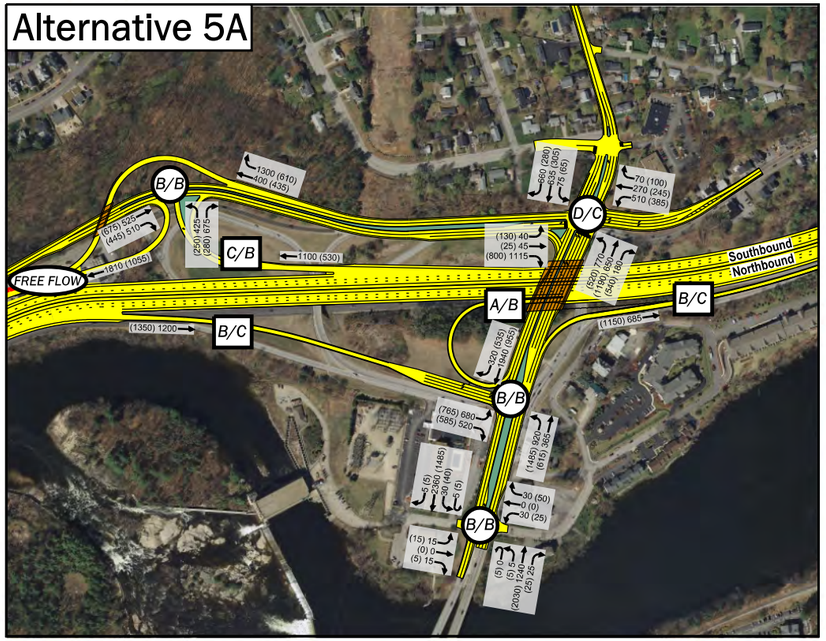

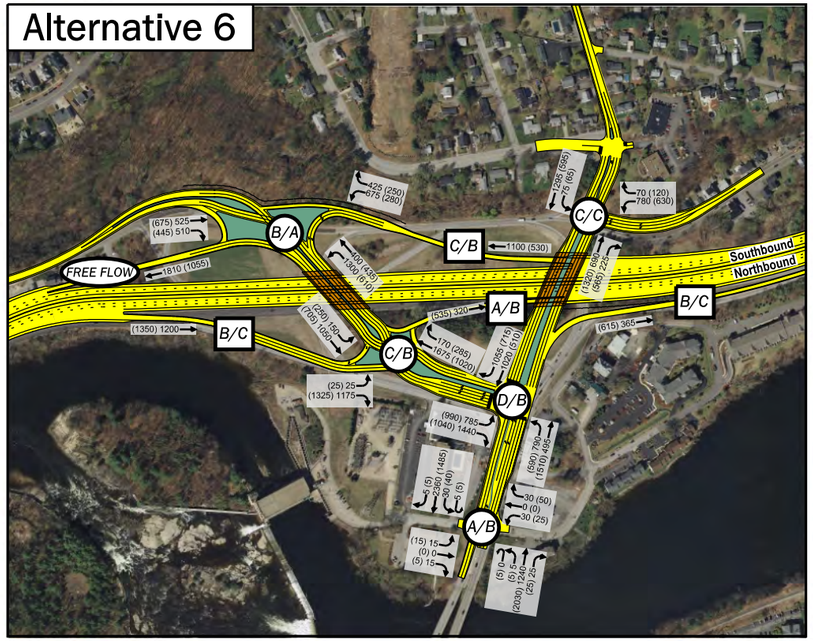

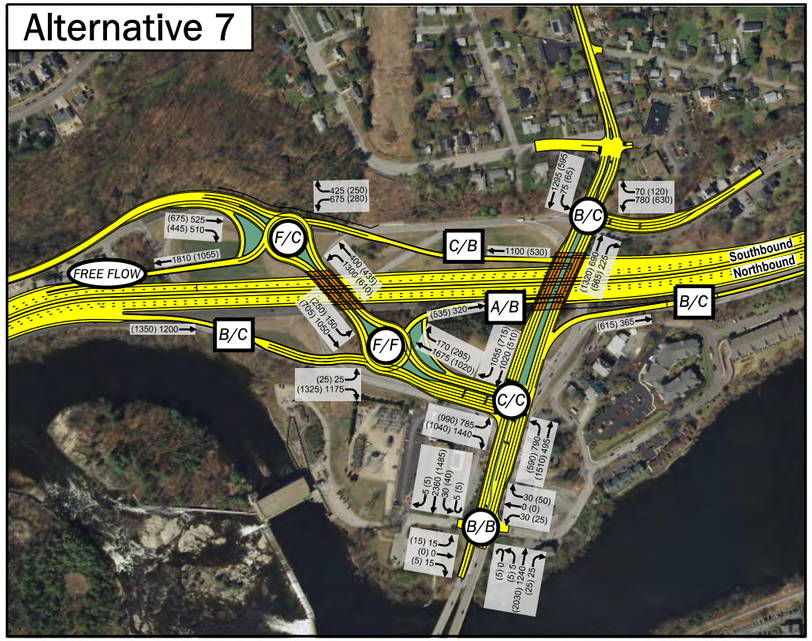

LEGEND

- B/B - Intersection Level of Service AM / PM
- B/B - Ramp Merge/Diverge Level of Service AM / PM
- ←XXXX (XXXX) - AM (PM) Peak Hour Volumes
- Pavement
- Bridge
- Median / Grass Panel

NOT TO SCALE

VHB *Vanasse Hangen Brustlin, Inc.*

Manchester 16099
FEET/I-293, Exit 6-7 Planning Study

Figure 5.3-1
Exit 6 Alternatives Level of Service

Manchester, NH

New Hampshire DOT Department of Transportation

Each of the five Exit 6 interchange alternatives will potentially impact four state listed or endangered species as identified by NHNHB. These species are associated with habitat found along the banks of the Merrimack River.

Given the urbanized landscape surrounding Exit 6, a large number of known properties with hazardous material concerns exist in the study area. Each of the five alternatives requires acquisition of land between Eddy Road and I-293, between the Exit 6 southbound off-ramp and the Eddy Road on-ramp. Two gasoline stations (Mobil Station 15021 located at 210 Eddy Road and Shell Station 100012 located at 245 Eddy Road) are located in this acquisition area. More serious concerns are associated with Shell Station due to a prior gasoline release at the property prompting the implementation of a Groundwater Management Zone (GMZ). Each alternative will also have slope impacts on the Amoskeag Sunoco gasoline station located at 49 Amoskeag Street. Additional slope impacts may occur on several other properties with hazardous material concerns by each alternative, but it is expected that additional research will determine that most of them pose no substantial risk.

ROW Impacts

Expected impacts to private property are similar across all five alternatives, ranging from 21 to 24 parcels potentially impacted. Similar to other resource impacts, Alternative 5A, with the larger project footprint, will potentially have the largest impact on private property, totaling 24 parcels and 11 buildings. Alternatives 4, 5, and 7 will impact the fewest parcels (21); however, Alternative 4 will require substantially less. Alternative 6 will impact 22 parcels.

Cultural Resources

Similar to the Mainline Alternatives, Exit 6 is sensitive for archaeological resources given the proximity to the Merrimack River. Based on preliminary mapping from NHDHR, it anticipated that two known archaeological sites may be impacted by the footprint of each alternative.

The Amoskeag Federal House will be impacted by proposed Exit 6 southbound improvements under each alternative. As discussed previously, the House has been relocated twice and is not integral to its current location on Front Street. A small amount of ROW in the northern section of the National Register-listed Amoskeag Millyard Historic District will also be impacted. However, no structures within the historic district will be impacted. Although no other documented above-ground historic resources are anticipated to be directly impacted, all of the alternatives require realigning a portion of Front Street north of Goffstown Road. In consultation with NHDHR and the preliminary field-reconnaissance effort, it is anticipated that once surveyed, at least one local historic district and several historic properties may be identified in this area along Front Street.

Construction Cost Estimate

The results of a programming construction cost estimate (2013 Dollars) shows an estimated construction cost of $54 to $60 million for Alternative 4, $38 to $42 million for Alternative 5, $37 to $41 million for Alternative 5A, $41 to $45 million for Alternative 6, and $34 to $37 million for Alternative 7. Note that the programming construction cost estimate does not include costs related to utility construction or relocation, right-of-way acquisition or relocation, mitigation, or preliminary and final engineering fees.

5.3.4 Exit 7 Interchange Alternatives 8, 9A, 9B, 10A, and 10B

Capacity and Safety

Alternative 8, which involves reconfiguring Exit 7 at its current Front Street location, will moderately meet both the capacity and safety purposes. Although the two signalized intersections at the northbound and southbound ramps will operate at LOS C, the existing capacity and safety related deficiencies are related to the proximity of the interchange with the Exit 6 interchange. The Exit 6 northbound on-ramp and the Exit 7 northbound off-ramp will be separated by approximately 1,400 feet. The proximity of the interchanges results in the need to provide an additional weaving lane (a fourth lane) in each direction on I-293 for the short distance between the ramps. This additional widening will result in additional property impacts. The northbound weaving movement will operate at LOS D.

Alternatives 9A, 9B, 10A, and 10B all will substantially meet both the capacity and safety purpose. The ramp movements will all operate at LOS C or better. The signalized intersections at the interchange and at Front Street will operate at LOS C or better for Alternative 9A and 9B and at LOS D or better for Alternatives 10A and 10B. Relocating Exit 7 to the north will also benefit operations at Exit 6 as some motorists who currently travel to/from the west into Goffstown and to/from the north on I-293 will divert to Exit 7.

Levels of service for the signalized intersections and ramp junctions associated with the alternatives for Exit 7 are shown in **Figure 5.3-2.**

Community Needs (Economic Development)

Alternative 8 fails to meet both Manchester's need for improved connectivity to the Hackett Hill area and Goffstown's need for improved connectivity to I-293. To meet these needs will necessitate the relocation of the interchange to a location north of the Manchester Community College.

Alternatives 9A and 9B, which relocate the interchange to the north, both substantially meet the objective of supporting connectivity to Hackett Hill, but fail to meet Goffstown's need for improved connectivity. The reason for this is that Alternatives 9A and 9B extend westerly only to Dunbarton Road and do not extend across Black Brook to Goffstown Road.

Alternatives 10A and 10B, which involve both relocating the interchange to the north and extending the westerly connection across Black Brook to Goffstown Road, will substantially meet the objective of supporting connectivity to Hackett Hill and will substantially meet the objective of improving connectivity between Goffstown and I-293. This improved access is expected to enhance economic opportunities for the Town of Goffstown.

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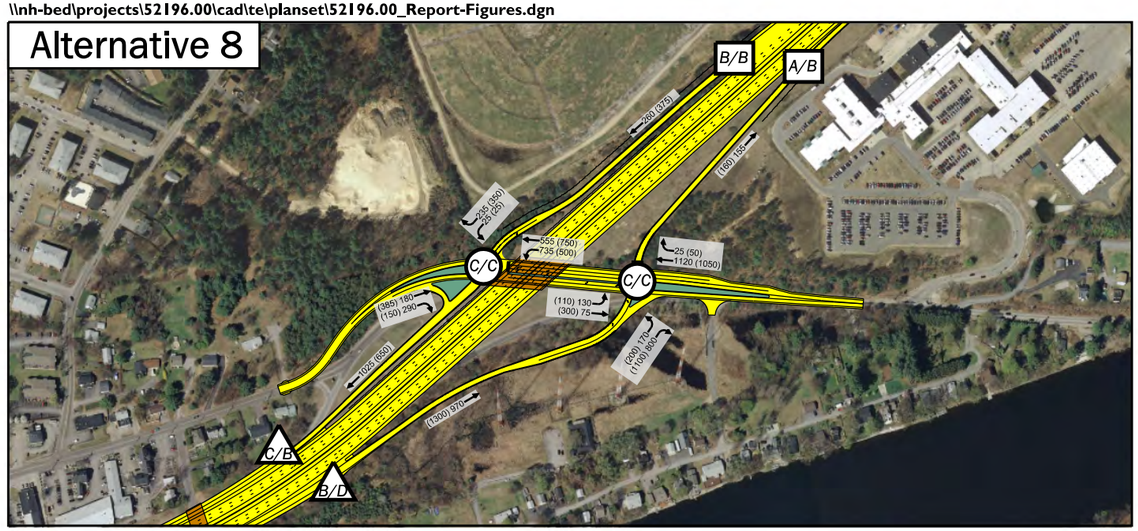

LEGEND

- B/B - Intersection Level of Service AM / PM
- B/B - Ramp Merge/Diverge Level of Service AM / PM
- B/B - Weave Level of Service AM / PM
- * - Signal Not Warranted
- ←XXXX (XXXX) - AM (PM) Peak Hour Volumes
- Pavement
- Bridge
- Median / Grass Panel

NOT TO SCALE

VHB Vanasse Hangen Brustlin, Inc.

Manchester 16099
FEET/I-293, Exit 6-7 Planning Study

Figure 5.3-2
Exit 7 Alternatives Level of Service

Manchester, NH

New Hampshire DOT Department of Transportation

Environmental Impacts

Reconfiguring Exit 7 at its current location to a tight diamond interchange (Alternative 8) will result in greater wetlands impacts in comparison to Alternatives 9A, 9B, 10A and 10B, which relocate Exit 7 further to the north. The majority of the wetland impacts associated with Alternative 8 will be caused by the proposed northbound off-ramp, impacting the western boundary of Wetland 1.

Relocating Exit 7 north of Manchester Community College and constructing the Dunbarton Connector Road (Alternatives 9A and 9B) will result in fewer wetland impacts than other alternatives. Alternatives 9A and 9B impact nine wetlands (Wetlands 19, 20, 21, 27, 29, 31, 32, 33, and 37). Several of these wetlands (27, 28, 31, and 37) are noted as potential vernal pools during the field-reconnaissance. Many of the wetlands in this area are hydrologically connected by intermittent streams.

Intermittent streams are jurisdictional areas and will need to be delineated in future phases of the Study.

Alternatives 10A and 10B are identical to Alternatives 9A and 9B except for the Goffstown Connector Road. The Goffstown Connector Road will add a wetland impact associated with crossing Black Brook. Impacts to Black Brook have been minimized in the design by almost entirely spanning Black Brook and its associated wetlands.

Alternative 8 will produce the least amount of new impervious area at an estimated 11.8 acres, whereas Alternatives 9A and 9B will result in an estimated 19.2 acres and Alternatives 10A and 10B would result in 21.8 acres of new impervious area. Much of the additional impervious area associated with Alternatives 9 (A&B) and 10 (A&B) is located in the Black Brook watershed due to the proposed Dunbarton Road and Goffstown Connector Roads to the west of the existing Exit 7 interchange.

All five Exit 7 alternatives will impact FEMA 100-year floodplain associated with the Merrimack River, Black Brook, and Milestone Brook. Alternative 8 will impact a larger area in comparison to the other four alternatives. Floodplain impacts for Alternative 8, 9A and 9B are associated with the Merrimack River and Milestone Brook. Alternative 9B would impact the least amount of floodplain. The Goffstown Connector Road associated with Alternative 10A and 10B, will increase impacts. As discussed in Section 2, no hydraulic analysis has been completed for either Black Brook or Milestone Brook. The hydraulic analysis will need to be completed in future phases of the Study.

Similar to the Mainline and Exit 6 alternatives, the Exit 7 alternatives occur in an area mapped as an aquifer. Alternative 8 has the smallest project footprint and will therefore have less impact on the aquifer.

Farmland soils underlie portions of the Exit 7 interchange improvement areas. Specifically, Alternatives 9A and 10A, will impact prime farmland soil and farmland soil of local importance. Alternative 8 will impact the least area of farmland soil, all of which is classified as farmland soil of local importance. Alternatives 10A and 10B have similar farmland soil impacts as Alternatives 9A and 9B, but impact slightly less area. As discussed in Section 2, the farmland soils primarily occur in forested areas, with no active farms in the study area.

The surrounding landscape at Exit 7 is not as developed as areas to the south and includes a large forested tract of land associated with the Hackett Hill area. All five alternatives may impact identified habitat of rare, threatened, or endangered species associated with the Merrimack River, Black Brook and Milestone Brook. In terms of state-listed species, Alternatives 9 (A&B) and 10 (A&B) potentially impact six and seven state-listed species respectively. Alternative 8 may impact four state-listed species, three species of statewide concern, and one exemplary natural community. Due to proximity of the Hackett Hill area and the Manchester Cedar Swamp, NHNHB expressed concern for the potential for Atlantic White Cedar habitat in the wetlands west of I-293. These concerns will need to be addressed in future phase of the Study when a formal wetland delineation is completed.

The Manchester Municipal Landfill is the primary hazardous waste concern in the area. Groundwater resources in this area have been impacted by landfill leachate, which is in direct contact with the groundwater. Although none of the alternatives will directly impact the landfill, all the footprints will occur in the established Groundwater Management Zone (GMZ). Other known properties with hazardous waste concerns exist in the area, but are limited to above-ground storage tanks. Future research may determine that most of them pose no substantial risk. Additional research of these sites is necessary to confirm this preliminary expectation.

ROW Impacts

Relocating Exit 7 will require a substantial amount of new ROW, approximately 31 acres for Alternatives 9A and 9B, and approximately 45 acres for Alternatives 10A and 10B. Alternative 9B, 10A, and 10B may impact one, two, and three buildings, respectively. The building impact associated with 9B will occur to a single family residence located on Delia Drive. Buildings impacts associated with Alternatives 10A and 10B include the building on Delia Drive and one single family residence and one multi-family residence impact in the vicinity of the intersection Goffstown Road/Straw Road.

Cultural Resources

No known archaeological sites or above-ground historic structures will be impacted by any of the alternatives. However, NHDHR has stated that the Black Brook area has the potential for archaeological sensitivity. Further study will need to occur during the NEPA phase.

Construction Cost Estimate

The results of a programming construction cost estimate (2013 Dollars) shows an estimated construction cost of $33 to $36 million for Alternative 8, $36 to $40 million for Alternative 9A, $37 to $41 million for Alternative 9B, $42 to $47 million for Alternative 10A, and $43 to $48 million for Alternative 10B. Note that the programming construction cost estimate does not include costs related to utility construction or relocation, right-of-way acquisition or relocation, mitigation, or preliminary and final engineering fees.

6 Conclusions

The purpose of this Transportation Planning Study is to evaluate potential broad, transportation system changes and establish a range of practicable alternatives aimed at addressing capacity and safety related deficiencies along I-293 and the Exit 6 and 7 interchanges. The study also considers relocating and reconfiguring Exit 7 into a full directional interchange.

The study (Part A) is the first part of a three part process. The study will be followed by Preliminary Engineering and Environmental Documentation (Part B) and Final Design Plans (Part C) and ultimate construction. This study establishes a range of practicable alternatives for further development and more detailed evaluation under Part B. The following key findings and issues emerged during the study.

No Build

The No Build alternative will not meet the study purpose. Capacity analyses performed for the existing I-293 freeway segments and ramps under the 2035 No Build alternative show substantial degradation in traffic operations. Many of the freeway segments and ramp junctions are expected to degrade to LOS E or F. All but two of the nine signalized intersections are expected to operate at a LOS D or worse.

Transportation Demand Management

Transportation Demand Management (TDM), encompassing a wide range of strategies designed to change personal travel behavior, can result is a reduction in demand for automobile use and in the need to construct additional roadway capacity. TDM actions alone will not meet the study purpose. However, TDM actions need not be an either/or alternative but could be implemented in conjunction with a Build alternative. There is a wide-range of TDM strategies and actions that have the potential to reduce vehicular travel demand. These actions will be further developed and evaluated in more detail under Part B.

Transportation System Management

Transportation System Management (TSM) strategies are generally low cost, easy to implement actions aimed at optimizing the performance of the existing transportation system. Some examples of TSM actions include traffic signal coordination, access management, and incident management. Based on feedback from the public NHDOT forces cut back growth along the east side of I-293, south of the Exit 6 northbound off-ramp. This low cost and easy to implement action had an immediate effect of improving driver sight lines as motorists approach the interchange. In addition, the NHDOT is evaluating opportunities to install dynamic message boards along I-293 aimed at alerting southbound motorists of peak period congestion at the Exit 6 ramps. Other actions being considered include increasing the storage capacity of the Exit 6 northbound off-ramp by widening the ramp to provide two-lanes, with possible traffic signal enhancements at Amoskeag Street. These actions will be further developed under Part B.

I-293 Mainline

Meeting the study purpose will necessitate the widening and reconstructing of the I-293 mainline from its current four-lane divided highway configuration to a modern six-lane divided highway for most of the study corridor. However, the projected travel demand for the segment through and north of Exit 7 suggests that an upgraded four-lane divided highway section could be retained through this area. Regardless of the number of lanes that may be initially constructed, consideration should be given to constructing the Exit 7 interchange to accommodate a future six-lane divided highway.

Potential Impacts to the Merrimack River

The Merrimack River, which flows along the easterly edge of the study area directly adjacent to I-293 and Front Street, is the most prominent environmental resource occurring within the study area and is a regionally important water resource. Additionally, two perennial tributaries, Black Brook and Milestone Brook, drain from the west with their watersheds primarily located in the communities of Manchester, Dunbarton and Goffstown. However, the Merrimack River is known to have water quality impairments and its existing water quality is not sufficient to fully support all designated uses. The primary water quality concern relates to elevated levels of *E. coli* bacteria. The Merrimack River is also considered to be marginally impaired relative to supporting aquatic life due to previously detected elevated levels of aluminum, low pH and low dissolved oxygen saturation levels.

A primary factor influencing water quality is the amount of impervious surface in a watershed; larger percentages are associated with decreased water quality. Increased runoff, if not properly managed, could have a variety of impacts on the Merrimack. These potential impacts include increased chances of flooding, erosion of streambanks and drainage ways, warming of stream waters, and decreased groundwater base flow due to less infiltration.

Thus, because all of the study alternatives that propose to expand the pavement surface will result in increased imperviousness, careful study and management of the potential impact on the Merrimack River and its tributaries will be a critical issue during subsequent project phases. A formal top-of-bank delineation for the Merrimack River, Black Brook, or Milestone Brook, may also lead to additional impacts. A top-of-bank delineation will be necessary in next phase of the project.

Mainline Segment - Alternatives 2&3 – A Tradeoff of Impacts to the Merrimack River or the Historic Millyard District

The 0.8-mile mainline segment, which begins just north of Exit 5, is constrained with the Amoskeag Millyard Historic District on the west and the Merrimack River on the east. Developing a workable alternative in this section will involve a tradeoff between impacts to the Merrimack River and the Millyard; minimizing impacts to one resource will involve increased impacts to the other. Both alternatives will impact the floodplain of the river, with Alternative 2 resulting in the greater impact compared to Alternative 3. However, Alternative 3 will require greater impacts to the Millyard than Alternative 2. Balancing these impacts and choosing a preferred alternative will be a key issue during the NEPA phase. Substantial regulatory protection is in place for both floodplain and river bank impacts (e.g., NH RSA 482-A relative to dredge and fill in wetlands, the Clean Water Act Section 404 and Executive Order 10988), as well as impacts to historic resources (e.g., Section 106 of the National Historic Preservation Act and Section 4(f) of the USDOT Act, which requires demonstration that no prudent or feasible alternative exists to the "use" of historic property).

Exit 6 Alternatives

Of the five alternative configurations evaluated at Exit 6, the SPUI will meet the study purpose, provide acceptable operating conditions, and will distribute traffic flow well. The Front Street/Eddy Road connection to Amoskeag Street will be provided by a bridge separated from the ramp movements that will be accommodated at the SPUI. Each of the diamond interchange configurations, with the exception of the Diamond Interchange with Roundabouts, will also meet the study purpose and provide acceptable operating conditions. However, these configurations will not distribute traffic flow as well as the SPUI. The proximity of the traffic signal controlled northbound ramps and the traffic signal controlled Amoskeag Street intersection show potential queuing problems under the Standard Diamond Interchange Alternative and the Diverging Diamond Interchange Alternative. The Diamond Interchange with Roundabouts Alternative does not operate well (Level of Service F) and will not meet the study purpose and should be eliminated from further consideration.

Exit 7 Alternatives

Reconfiguring Exit 7 to provide fully directional connectivity to I-293 at its current Front Street location will moderately meet the capacity and safety study purpose. However, the limited spacing between the interchange and Exit 6 is not ideal and would necessitate an additional weaving lane (a fourth lane) in each direction on I-293 between the interchanges. Reconstructing the interchange at its existing location will fail to meet the City of Manchester's desire to support connectivity to the Hackett Hill area and the Town of Goffstown's desire to support connectivity between I-293 and the town's industrial zoned land.

Each of the alternatives that involve relocating the Exit 7 interchange to the north will operate well and meet both the capacity and safety study purposes. The relocated interchange alternatives that provide a westerly connection to Dunbarton Road will meet the City of Manchester's desire to support connectivity to the Hackett Hill area. The alternatives that extend westerly to Goffstown Road crossing Black Brook will meet the Town of Goffstown's desire to support connectivity between I-293 and the town's industrial zoned land.

Crossing of Black Brook

During the course of the study, members of the public and Goffstown town officials expressed a strong desire to create a new direct connection between I-293 and Goffstown. In response to these public comments, Alternatives 10A and 10B were developed, both of which would construct a Goffstown Connector Road. This extension will require construction of a new bridge over Black Brook. While impacts have been minimized as a result of the careful alignment of this possible new roadway, the creation of a new crossing of this perennial tributary to the Merrimack River stands out as an important potential impact which will need further study during the next project phase.

Construction Costs

For the purpose of preparing a programing construction cost estimate (2013 Dollars), the I-293 corridor was divided into three separate roadway segments that include a Mainline Segment, an Exit 6 Segment, and an Exit 7 Segment. The Mainline segment includes the southernmost 0.8-mile section of the I-293 study area. The Exit 6 Segment includes the Exit 6 interchange and adjacent 0.8-mile section of I-293. The Exit 7 Segment includes the current Exit 7 interchange and a 1.9-mile section of I-293 north of Exit 6.

Note that the programming construction cost estimate does not include costs related to utility construction or relocation, right-of-way acquisition or relocation, mitigation, or preliminary and final engineering fees. The programing construction cost estimates for each alternative is summarized in Table 6.1-1.

Table 6.1-1 Construction Cost Estimate

Segment	Construction Cost
I-293 Mainline Segment	
Alternative 2	$18 to $20 million
Alternative 3	$8 to $9 million
Exit 6 Segment	
Alternative 4	$54 to $60 million
Alternative 5	$38 to $42 million
Alternative 5A	$37 to $41 million
Alternative 6	$41 to $45 million
Alternative 7	$34 to $37 million
Exit 7 Segment	
Alternative 8	$33 to $36 million
Alternative 9A	$36 to $40 million
Alternative 9B	$37 to $41 million
Alternative 10A	$42 to $47 million
Alternative 10B	$43 to $48 million

Benefits of Enhanced Regional Highway Access

In addition to the immediate and direct benefits associated with highway improvements (safety, increased capacity, improved level of service), there is the potential for indirect and induced economic benefits within a broader regional context.

Regardless of the selected alternative, improvements to Exit 6 will allow for improved connectivity between downtown Manchester to points north and south. Downtown Manchester serves as a regional employment and financial services hub within the State of New Hampshire. Due to the availability of existing office and light industrial/research & development (R&D) space, it has the capacity to increase the workforce. Easier access to and from the downtown area may accelerate existing economic development trends, leading to higher employment within the region.

Similarly, the relocation of Exit 7 will enhance accessibility to existing and potential job generation areas. For example, the Hackett Hill Master Plan calls for a total build-out of over a million square feet of office and R&D space. The various Exit 7 alternatives may accelerate the development of new facilities and create jobs. In addition, Alternatives 10A and 10B include improved access to Goffstown Road linking undeveloped industrial zoned land in the Town of Goffstown with I-293. This improved access may accelerate development of this property and increase the tax base for both communities.

Next Steps

The evaluation presented in this planning study phase identifies key issues on a conceptual basis, and should not be interpreted as a conclusive study of impacts. More formal analysis of impacts will need to occur during the next preliminary design and environmental analysis phase with the more detailed evaluation of the alternatives under the National Environmental Policy Act (NEPA). NEPA is a comprehensive federal law that applies to all projects that may receive federal funds for any portion of the financing or licensing for the project. The main provision of NEPA requires an Environmental Impact Statement (EIS) be written for all "major federal actions" which may have a "significant impact" on the environment. However, NEPA permits an Environmental Assessment (EA) to be prepared for an action where the significance of the social, economic, and environmental impacts are not clearly established. The NEPA study under an EA will examine the project alternatives and impacts in greater detail with additional in-depth public involvement.

In addition to the federal requirements under NEPA, the NHDOT will need to prepare and submit an Interchange Modification Report (IMR) to the Federal Highway Administration (FHWA) under the next phase of the project study. The IMR is required because the project considers the reconfiguration and potential relocation of interstate system interchanges along the interstate system. This action serves as a formal request through FHWA to modify Exit 6 and Exit 7, regardless of the funding source of project. At a minimum, the interchange modification request will evaluate and document eight FHWA policy requirements. The IMR for the improvements along I-293 with Exit 6 and 7 must demonstrate that:

- *The existing system cannot accommodate the design-year traffic demands.*
- *All reasonable alternatives have been considered.*
- *The proposed change does not have a significant adverse impact on the safety and operation of the Interstate facility or on the local street network based on both the current and the planned future traffic projections.*
- *The proposed access connects to a public road only and will provide for all traffic movements.*
- *The proposal is consistent with local and regional land use and transportation plans.*
- *The proposal is consistent with any long-range system or network plan.*
- *When a new or revised access point is due to a new, expanded, or substantial change in current or planned future development or land use, requests must demonstrate appropriate coordination has occurred between the development and any proposed transportation system improvements.*
- *The proposal will be included as an alternative in the required environmental evaluation, review and processing.*

The FHWA approval of the interchange modifications and/or relocation constitutes a federal action, and as such, requires the NEPA process be followed. For this project, the preparation of the IMR and the NEPA documentation can be conducted concurrently through the next project development phase.

During the next project phase a review of funding sources will be necessary. Funding through FHWA, New Hampshire Turnpike Capital Program and local funds are potential sources to finance this project. I-293 is eligible for FHWA funding given that it is a "free section of the Turnpike" where motorists can access/egress the highway without paying a toll. Federal funds, if available, may also be used to support the infrastructure improvements along the access roads to the interchanges. Funding for right-of-way and/or construction within the Turnpike Capital Program would require specific legislative authority to the NHDOT and would likely be contingent on review of toll revenues to pay the expanded bonding authority. Other funding sources through local municipal contributions and/or public/private partnerships may be necessary for any desired system upgrades to the local roadway system.