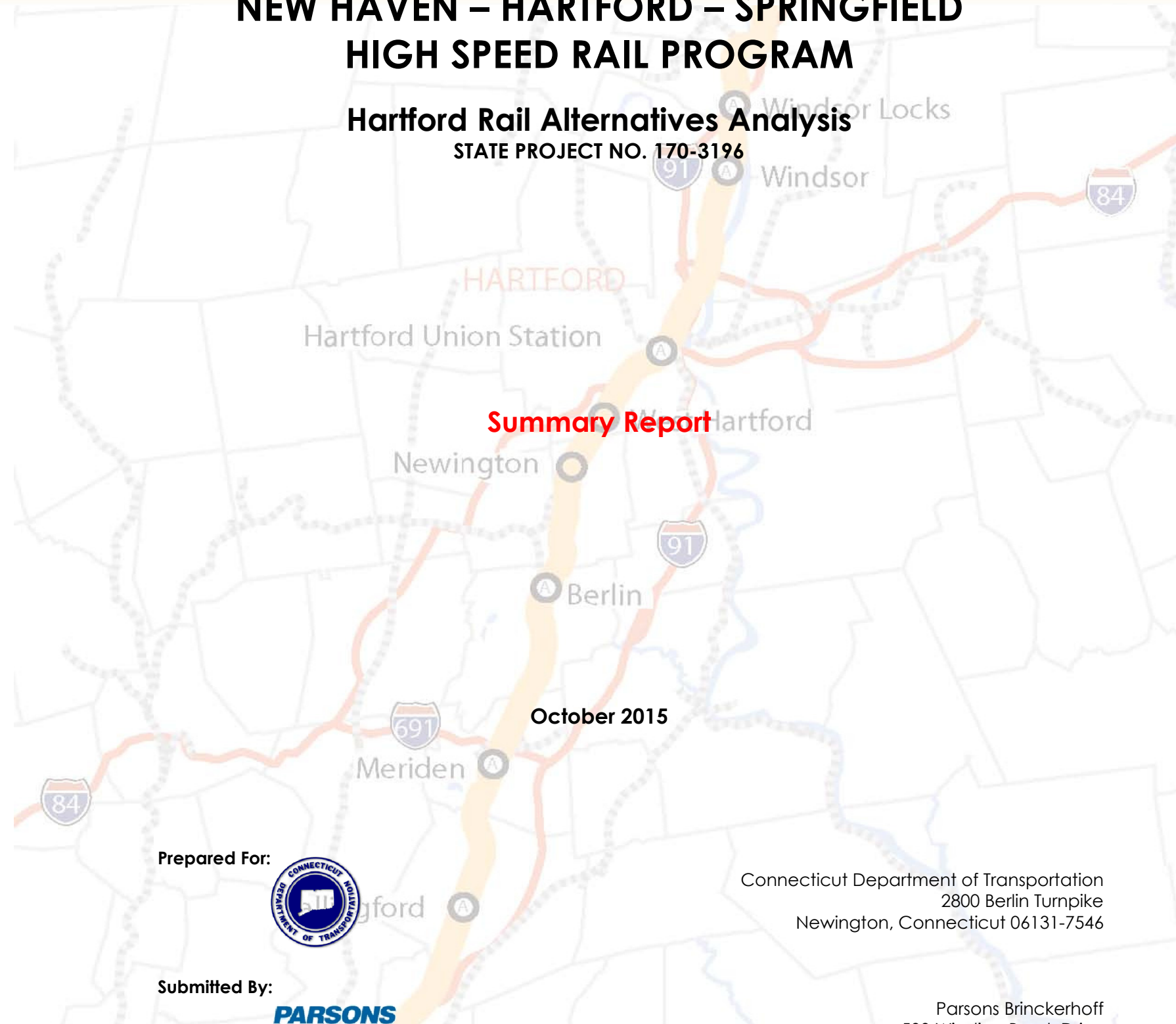


# NEW HAVEN – HARTFORD – SPRINGFIELD HIGH SPEED RAIL PROGRAM

## Hartford Rail Alternatives Analysis

STATE PROJECT NO. 170-3196



**Summary Report**

October 2015

Prepared For:



Connecticut Department of Transportation  
2800 Berlin Turnpike  
Newington, Connecticut 06131-7546

Submitted By:

**PARSONS  
BRINCKERHOFF**

Parsons Brinckerhoff  
500 Winding Brook Drive  
Glastonbury, Connecticut 06033

TABLE OF CONTENTS

1 Introduction ..... 2

1.1 What Is this Study About?.....2

1.2 Why Is this Project Needed? .....3

1.3 How Does this Study Integrate with the I-84 Hartford Project?.....3

2 What Options Were Considered? ..... 4

2.1 How Were the Options Defined? .....4

2.2 Overview of the Alternatives .....5

2.3 Adaptive Reuse Opportunity for Rail Viaduct .....20

3 What Was the Study Process? ..... 21

3.1 How Were the Alternatives Evaluated?.....21

3.2 What Are the Key Design Guidelines? .....21

3.3 What Were the Evaluation Focus Areas?.....22

3.4 How To Determine the Best Fit with the Stated Goals? .....22

4 What Did the Analysis Conclude? ..... 24

4.1 What Are the Primary Conclusions Drawn from this Analysis? .....24

4.2 What Are the Key Observations for Each Focus Area? .....25

4.3 Why Is Coordination Between Hartford Rail and the I-84 Hartford Project Important?.....27

4.4 How Can the Hartford Rail Project Advance with the I-84 Hartford Project? .....27

5 How Do the Estimated Costs Compare for Each Alternative? ..... 28

5.1 What Were the Assumptions? .....28

5.2 What Is the Estimated Capital Cost Range for Each Alternative? .....28

5.3 How Could this Project Potentially be Funded? .....29

6 What Are the Next Steps? ..... 30

7 Where Is Additional Information Available? ..... 30

1 INTRODUCTION

1.1 What Is this Study About?

The Connecticut Department of Transportation (CTDOT) is conducting an Alternatives Analysis (AA) for the future of the aging Hartford rail viaduct. The viaduct is an elevated track structure adjacent to Hartford’s historic Union Station that serves both Amtrak intercity passenger trains and freight trains. This AA will develop and evaluate options to maintain, reconstruct, or relocate the rail corridor in this area (track and station), and will help guide the local decision-making process toward selection of a locally preferred alternative to address the stated need.

The Hartford rail viaduct is a critical link in the regional passenger and freight rail system, and in particular for the New Haven-Hartford-Springfield (NHHS) Rail Program, which will expand intercity passenger rail service on the 62-mile corridor between New Haven, Connecticut and Springfield, Massachusetts. To accommodate additional passenger train service in the NHHS Corridor, infrastructure improvements are planned, including restoration of nearly 40 miles of double track, adding several passing sidings, upgrading bridges and culverts, and improving safety at grade crossings. A platform upgrade is also planned at Hartford Union Station to construct a new high-level platform on top of a portion of the existing low-level platform. However, the planned NHHS improvements at Hartford Union Station do not include upgrade or replacement of the aging Hartford rail viaduct, given the potential magnitude of the effort and necessity of reviewing options and developing solutions in concert with I-84 in the same corridor.

This AA is being completed concurrently and in close collaboration with the I-84 Hartford Project, a CTDOT project to address structural and operational deficiencies within the I-84 highway corridor approximately between Flatbush Avenue and the I-91 interchange in Hartford. Options which will be considered for that planning effort include replacing the existing I-84 viaduct or reconfiguring the highway and its interchanges within the corridor. It is critical that the development and evaluation of rail corridor alternatives be conducted in close coordination with the analysis of highway alternatives, and vice versa, as the alignments of these two modes cross each other several times and each impacts the other. Said another way, it is critical to the best outcome for both modes, for the City of Hartford, and for the surrounding region that the planning for these two projects be fully integrated and that the project area be considered as a single transportation corridor.

Such an approach is also consistent with Governor Malloy’s “Let’s Go CT” statewide transportation plan. The plan calls for “a best-in-class transportation system for the long term to be realized through a combination of ambitious statewide, corridor, and local projects across all transportation modes.”<sup>1</sup>

The study area for the AA, as shown in Figure 1, is focused on the rail corridor approximately between Albany Avenue / Main Street on the east and Park Street on the west, just west of downtown Hartford and adjacent to I-84.

<sup>1</sup> [http://www.governor.ct.gov/malloy/lib/malloy/2015.02.18\\_CTDOT\\_30\\_YR\\_Vision.pdf](http://www.governor.ct.gov/malloy/lib/malloy/2015.02.18_CTDOT_30_YR_Vision.pdf)

Figure 1: Study Area Map



1.2 Why Is this Project Needed?

The purpose of this project is to address the ongoing **serviceability** of the aging rail viaduct infrastructure, increase regional rail **mobility**, improve local **connectivity**, and create a gateway that spurs **economic development**. These are wide-ranging themes that go beyond simply building a piece of transportation infrastructure to also address large community goals.

Serviceability

The rail viaduct was constructed in 1911 and continues to serve Amtrak’s intercity passenger and freight trains. Originally serving four tracks, today the structure supports service on only one track. The rail viaduct infrastructure is nearing the end of its useful service life and requires frequent and costly repairs to maintain its operations. As time goes on, serviceability will become even more expensive. Thus, it is essential that the need for significant on-going maintenance be addressed.

Mobility

The corridor through Hartford consists of a single track, which limits the number of trains that can reliably operate on the corridor. There is a need to add an additional track to keep pace with future plans for increased passenger and freight service along the corridor. The long-term vision of the NHHS Rail Program includes up to 25 daily roundtrip trains (19 more than today), with connections to Boston and Montreal and 30-minute, bi-directional, peak hour service. Hartford’s Union Station is expected to be the second busiest station on the NHHS rail corridor behind New Haven Union Station.

Connectivity

Downtown Hartford and the Asylum Hill neighborhood were separated when the rail viaduct and later I-84 were constructed. Reconnecting these two areas would help restore the community cohesion that was previously impacted by the construction of these facilities. This project seeks to address this need by exploring opportunities to potentially relocate a portion of the viaduct and the station. This, along with potential improvements to I-84, could diminish the visual and physical barriers that these two facilities impose and re-stitch the community fabric.

Multi-modal connections are a critical feature of Union Station, including connections to rail, local and regional bus, bus rapid transit, bicycle, and pedestrian modes. This project should maintain and strengthen these connections where feasible, and facilitate the accommodation of new initiatives, such as CTfastrak and NHHS rail service. The growing concentration of transportation services in and around Union Station will increase the area’s role as an activity hub, helping to further remove psychological barriers between downtown Hartford and Asylum Hill.

Economic Development

Economic development is a stated goal of the City of Hartford and the Capitol Region Council of Governments (CRCOG) as demonstrated in a number of recent planning studies: *One City, One Plan*; *Downtown Hartford Circulation Study*; *Downtown West*; *iQuilt*; *Making It Happen*; and *I-84 Viaduct Study*, among others. New development and redevelopment are needed to continue providing opportunities and a high quality of life to those living in the City of Hartford and the surrounding area. This project seeks to address this need by exploring the potential role of an infrastructure project to attract investment in the areas immediately adjacent to the existing Union Station or any new station being considered as part of the rail viaduct project.

1.3 How Does this Study Integrate with the I-84 Hartford Project?

The alternatives for the Hartford Rail Alternatives Analysis must be closely coordinated with the I-84 Hartford Project, which is the parallel planning program to rebuild and possibly realign I-84 through the city of Hartford. Currently, the rail line crosses I-84 at two locations in close proximity to the existing station. Thus, any realignment of either the rail line or the highway necessarily impacts the other, and coordination and integration of the two projects is essential. Additionally, impacts on the CTfastrak alignment must also be considered.

As technical work has been advancing on both the highway and rail projects, it has become increasingly apparent that neither the highway nor the rail program can be “solved” without the other. These two projects require a single and integrated approach that yields the best possible results for these two high-priority and visionary projects.

However, one of the many challenges to meeting this goal is that the rail and highway projects are at different stages of development and are proceeding on different overall timetables. The I-84 Hartford (highway) project is entering the detailed environmental review process, but final project definition decisions are still months away. It is impossible for this rail AA to develop a rail “answer” without a highway “answer”, and the reverse is also true for the highway study. Therefore, the approach taken for the rail AA is to present a range of rail options that reflects the spectrum of possible highway solutions. What is important to note, however, is that both the NHHS Rail Program and the I-84 Hartford Project are key transportation initiatives for the State of Connecticut and both are consistent with the state’s vision for the future of transportation in Connecticut.

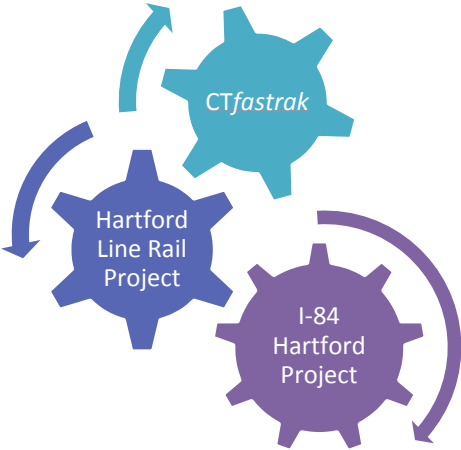
Based on the initial development of possible highway options by the I-84 Hartford Project, the rail options to maintain, reconstruct, or relocate the right-of-way were initially evaluated under two possible I-84 conceptual scenarios:

- 1. Assuming I-84 remains in place in the study area (generally maintaining its current horizontal and vertical alignments); and
- 2. Assuming I-84 is realigned horizontally and lowered vertically to be generally at or below ground level (in an open cut) in the study area.

As the initial I-84 program scenarios have been considered and further developed by the I-84 Hartford Project since the initial definition of rail alternatives, a third potential scenario has emerged:

- 3. Assuming at least a portion of I-84 through the study area is reconstructed in a tunnel section.

Based on these principles, a series of rail alternatives were defined for evaluation. Continuing coordination between the I-84 and rail line design options has informed the design refinements to ensure that at a conceptual level, the alternative designs for the rail and highway elements are compatible with each other.



*The approach taken for the rail AA is to present a range of rail options that reflects the spectrum of possible highway solutions.*

2 WHAT OPTIONS WERE CONSIDERED?

2.1 How Were the Options Defined?

A series of rail alternatives was defined based on options to “maintain”, “reconstruct”, or “relocate” the Hartford rail viaduct and associated infrastructure. The maintenance option preserves the existing structure and continues to use the current station location; the reconstruction option rebuilds and expands the current infrastructure generally in its current location, and relocation options result in a new alignment and a new Hartford station location.

The rail options developed and analyzed during this study should be treated not as a complete assessment of all available design options, but rather as a representative sample of the spectrum of options that could be implemented. The conclusions of this analysis provide a starting point for more detailed design development that addresses the relationships between all transportation infrastructure in the study corridor. Table 1 highlights some of the key physical characteristics of the design options.

**Maintain** – Preserve the existing rail viaduct.

**Reconstruct** – Rebuild and expand current infrastructure.

**Relocate** – Develop new rail alignment and new station location.

		Table 1: Characteristics and Attributes of Alternatives						
		A	B	C	D	E	F1	F2
Key Characteristics	Future Alignment of Rail Infrastructure							
	Maintenance of Existing Rail Infrastructure	✓						
	Reconstruction of Rail Infrastructure		✓					
	Rail Relocation South of I-84			✓		✓		
	Rail Relocation North of I-84				✓		✓	✓
Vertical Alignment of Future I-84	I-84 remains in place (elevated)	✓	✓	✓	✓			
	I-84 rebuilt at or below ground level (open cut)					✓	✓	✓
	I-84 rebuilt at least partially in a tunnel			✓			✓	✓
Physical Attributes	Track and Rail Operations							
	Number of tracks	1	2	2	2	2	2	2
	Gauntlet track for oversize freight trains		✓	✓	✓	✓	✓	✓
	Rail service maintained during construction	✓	✓	✓	✓		✓	✓
	Future connection to Griffin Line not precluded			✓	✓	✓	✓	✓
	Station Infrastructure							
	Renovation to current station building	✓	✓					
	New station building location			✓	✓	✓	✓	✓
	Platform location relative to ground	Above	Above	Above	Below	Below	Below	Below
	Longer platform than existing		✓	✓	✓	✓	✓	✓

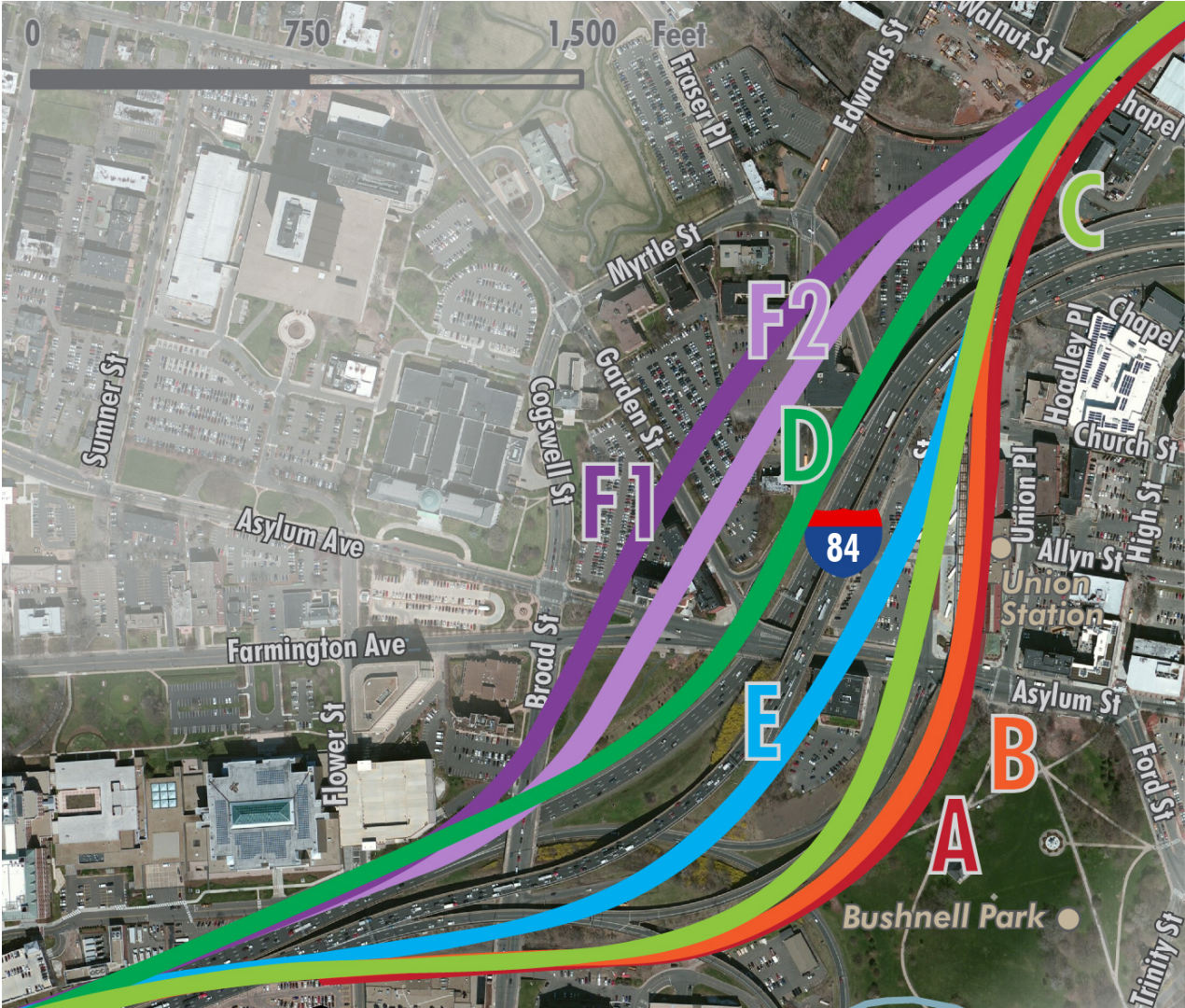
For the scenario in which I-84 is rebuilt at or below ground level in an open cut, maintenance and reconstruction options for rail are not viable due to the resulting vertical conflict between the rail line and the highway with both being at the same elevation where they cross each other. To avoid this vertical conflict, three rail relocation options associated with I-84 rebuilt at or below ground level (in an open cut) are identified. In Alternative E, the rail line

crosses under a ground-level I-84 to create a new alignment south of the highway, whereas Alternatives F1 and F2 create a new rail alignment on the north side of I-84 to avoid any crossings of the highway.

The I-84 Hartford Project is also considering a scenario in which a portion of the highway alignment is in a tunnel. For the scenario of I-84 in a tunnel, the logical horizontal alignment and vertical profiles for the rail line generally are consistent with that of Alternative C for a relocation option south of I-84, and generally are consistent with that of Alternative F for a relocation option north of I-84. For the I-84 tunnel scenario, the benefits, impacts, and constraints are very similar to Alternative C for a relocation option south of I-84, and very similar to Alternative F for a relocation option north of I-84. Therefore, for purposes of this analysis, separate alternatives specific to the I-84 tunnel scenario were not defined.

The rail alternatives developed through this study were intended to address both passenger and freight needs in the corridor. A full description of existing conditions related to both passenger and freight elements is provided in the *Existing Conditions Report* (March 2014).

Figure 2: Alignments Defined for Detailed Evaluation



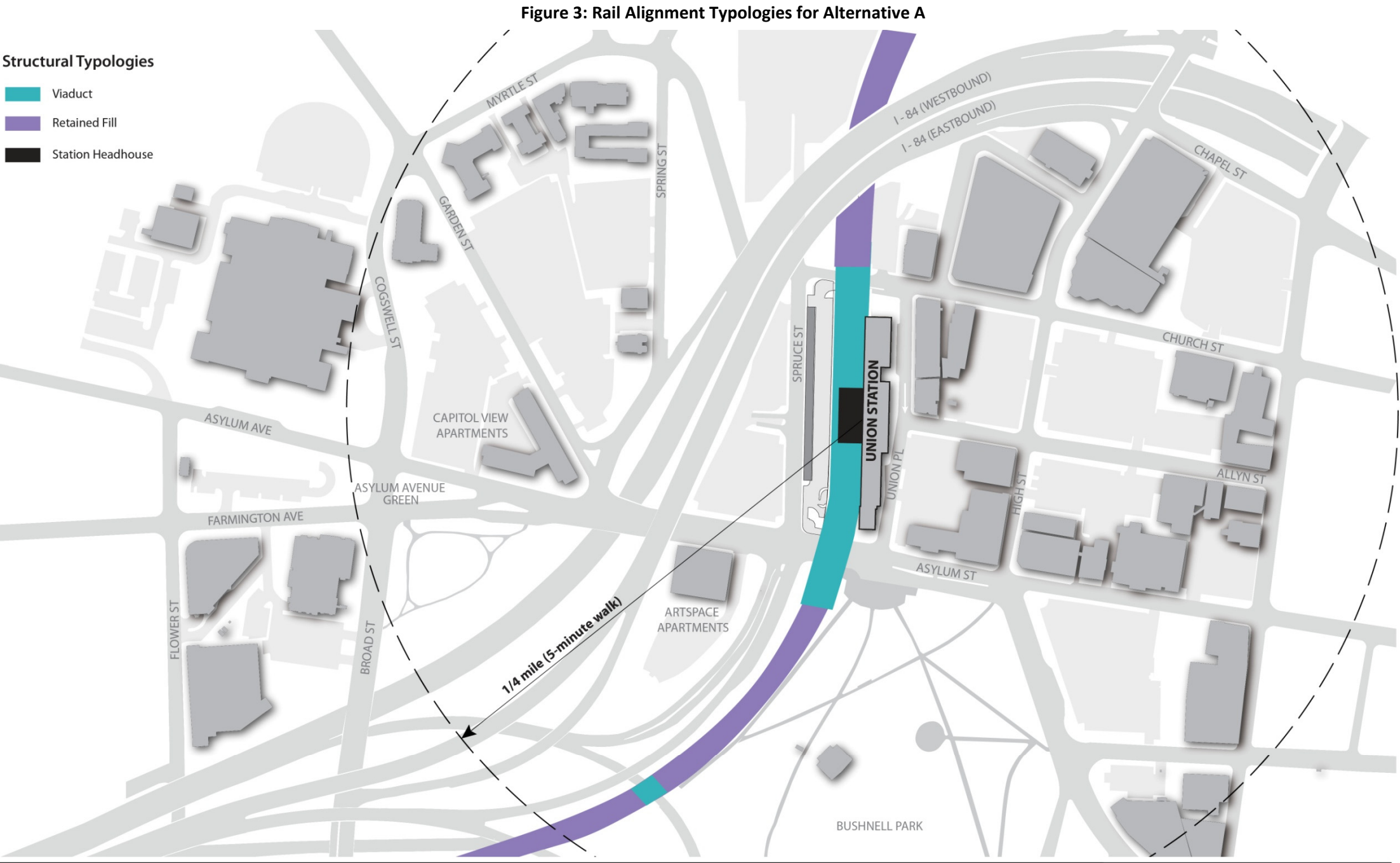
2.2 Overview of the Alternatives

Alternative A - Maintenance

- Intended to bring infrastructure to a state of good repair to remain safe and fully functional for the next 25 years.
- Improves serviceability of existing infrastructure, but does not add new capacity (i.e. maintenance of the one existing serviceable track only).
- Consists of a series of individual projects related to the viaduct itself, as well as other affected bridges / structures within the study area. Also includes projects related to station building maintenance, which are also directly impacted by structural needs (in the case of the Transportation Center and the platform).
- It is assumed for purposes of this analysis that the platform upgrades planned for the initiation of NHHS service will be in place.

I-84 Assumption

Alternative A assumes that I-84 will remain in its current location (same horizontal alignment and vertical profile). If I-84 were to be rebuilt at or below ground level in an open cut, this option for rail would not be viable due to the resulting vertical conflict between the rail line and the highway with both being at the same elevation where they cross each other.



Alternative A (Maintenance)

Hartford Rail AA, Hartford, CT

Alternative B – Reconstruction

- Consists of a series of projects to fully reconstruct the Hartford rail viaduct and other associated facilities as needed based on condition and ability to support additional capacity.
- Creates new track capacity (provision for two through tracks and gauntlet tracks in the station area, which would allow oversize freight trains the extra clearance they require by moving the train farther away from the platform edge).
- Assumes that the existing track and platform will be reconstructed largely in place with a similar vertical profile as current, although some minor alignment modifications are included to address several design goals (e.g. second track, slightly longer platform, increased roadway clearance).
- Crosses underneath I-84 at same location as current.
- Modest track curvature at the platform enables alignments to avoid impacts at Bushnell Park.
- Assumes that the Transportation Center building will be reconstructed generally in the same location, but could be expanded to support additional passenger activity.

**I-84 Assumption**  
Alternative B assumes that I-84 will remain in its current location (same horizontal alignment and vertical profile). If I-84 were to be rebuilt at or below ground level in an open cut, this option for rail would not be viable due to the resulting vertical conflict between the rail line and the highway with both being at the same elevation where they cross each other.

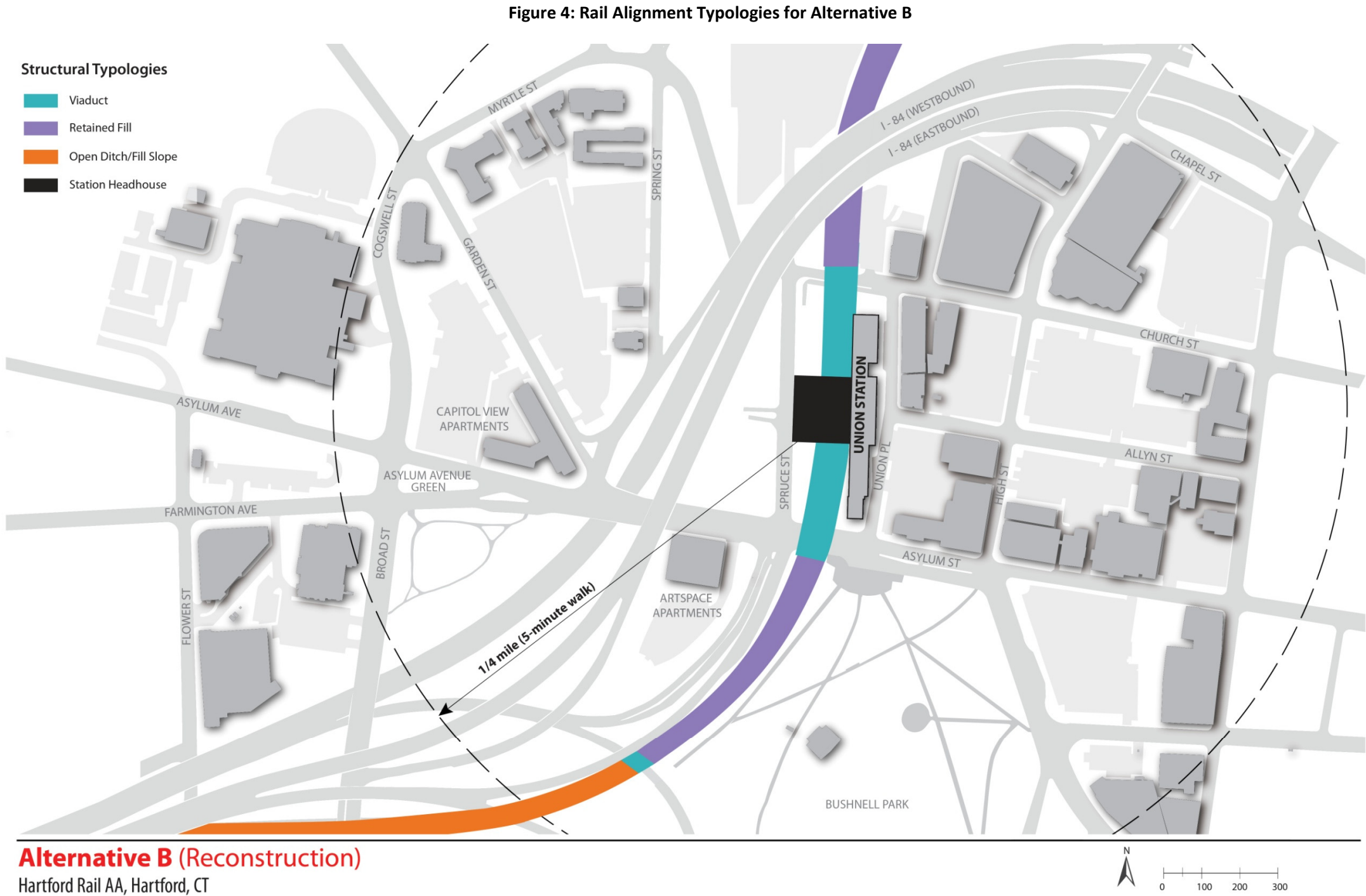
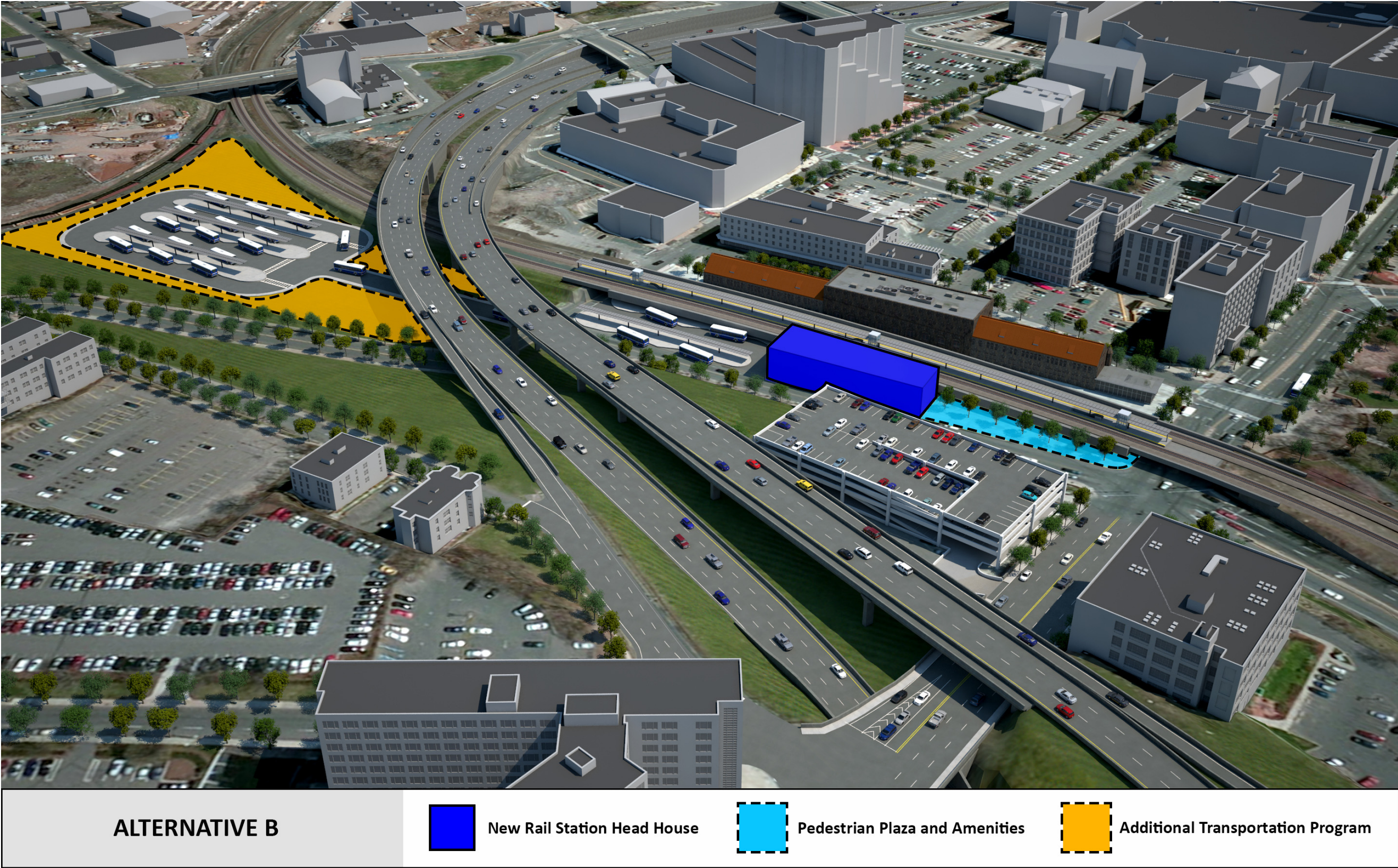
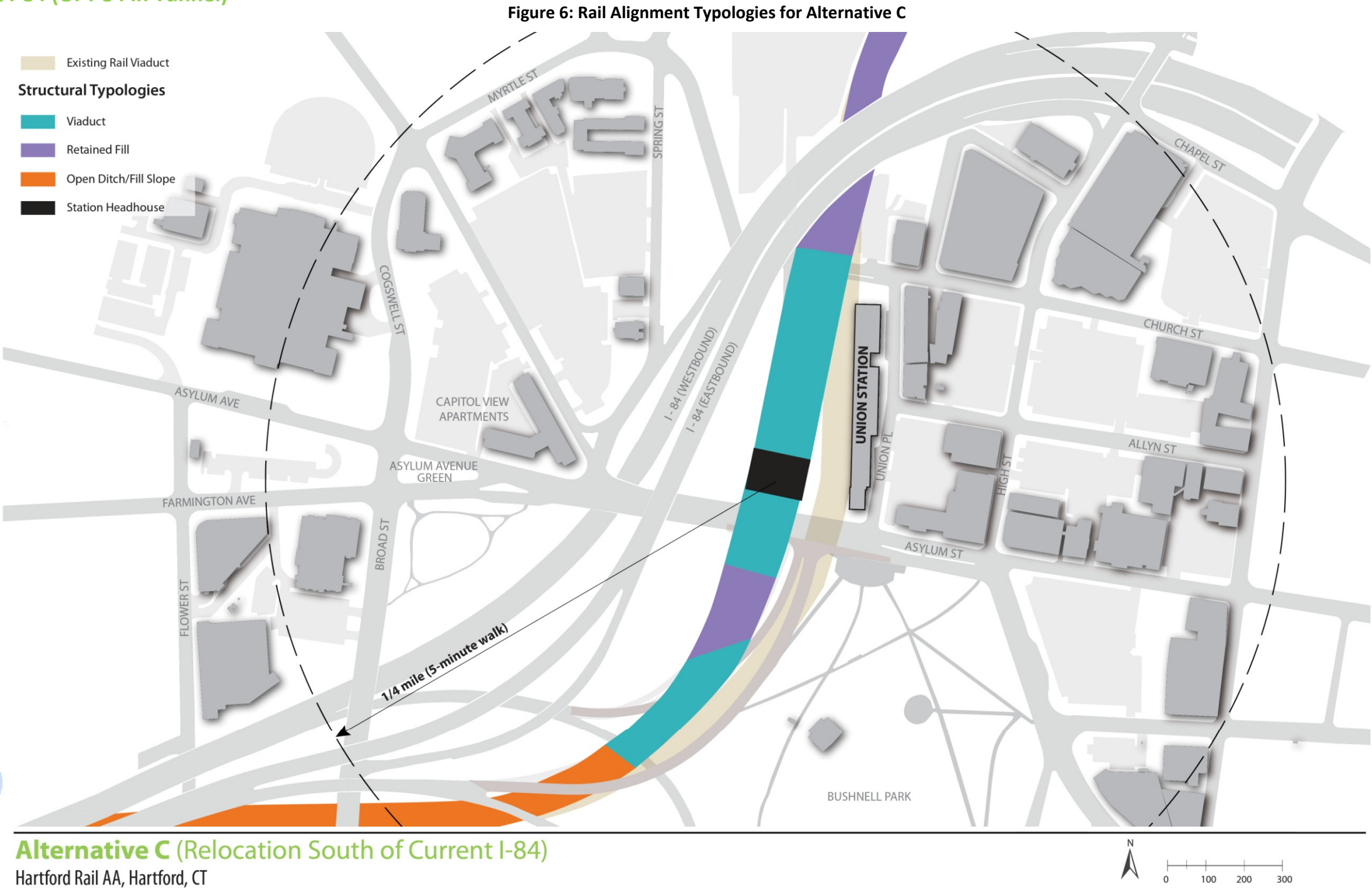


Figure 5: Perspective View of Program Elements for Alternative B



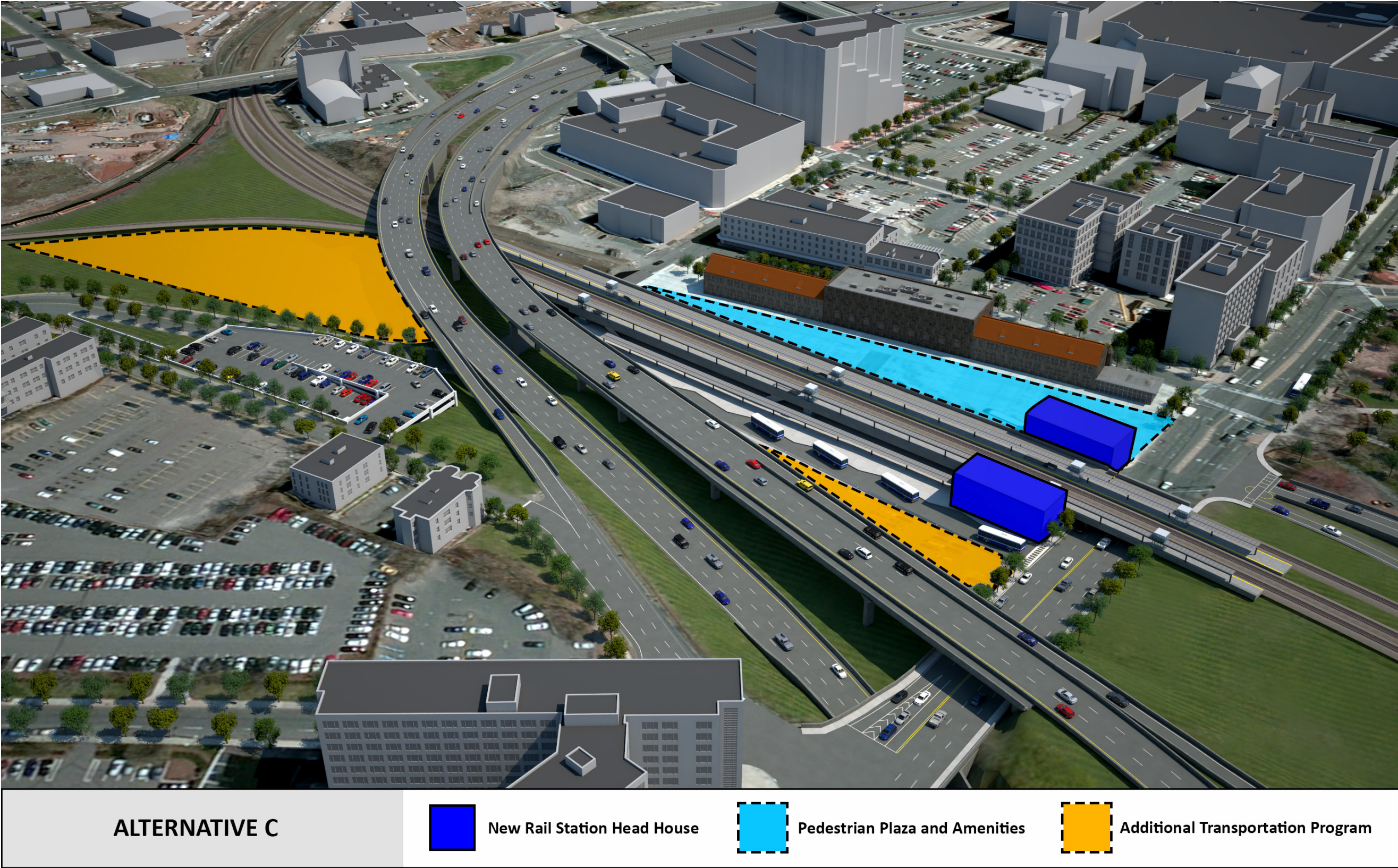
Alternative C - Relocation South of Current I-84 (Or I-84 in Tunnel)

- Relocates track south of I-84 in close proximity to existing alignment.
- Creates new track capacity (provisions for two through tracks; gauntlet or by-pass track in the station area); does not preclude capability for track connection to Griffin Line.
- Generally maintains existing profile.
- Provides new elevated platform generally above Spruce Street; constructs new station services building adjacent to platform.
- Modest improvements to existing track curvature approaching the station from the west.
- Platform length of 1050' is significantly longer than the existing platform; skewing the alignment with slight curvature at the station enables a longer platform while avoiding impacts to Bushnell Park.
- Constructs new bridges as needed to support realignment.
- Expands and relocates ancillary facilities such as parking lot and bus staging area.
- Crosses underneath I-84 at same location as current.



**I-84 Assumption**  
Alternative C assumes that I-84 will remain in its current location (same horizontal alignment and vertical profile).

Figure 7: Perspective View of Program Elements for Alternative C



Alternative D – Relocation North of Current I-84

- Relocates track north of I-84 (on opposite side of the highway from the current station), with much of the alignment through the study area below grade in an open cut.
- Creates new track capacity (provisions for two through tracks, gauntlet or by-pass track in the station area); does not preclude capability for future track connection to Griffin Line.
- Significant improvements to track geometry results in 2-3 minutes of travel time savings.
- Provides new below-grade platform (in an open cut) from Asylum Ave. continuing northeast beyond Myrtle St.
- Modest track curvature at the platform enables a length of 1050' (significantly longer than existing).
- Constructs new bridges / tunnels as needed to support realignment.
- Constructs new station services building at ground level adjacent to the platform.
- Expands and relocates ancillary facilities such as parking lot and bus staging area.

**I-84 Assumption**  
Alternative D assumes that I-84 will remain in its current location (same horizontal alignment and vertical profile).

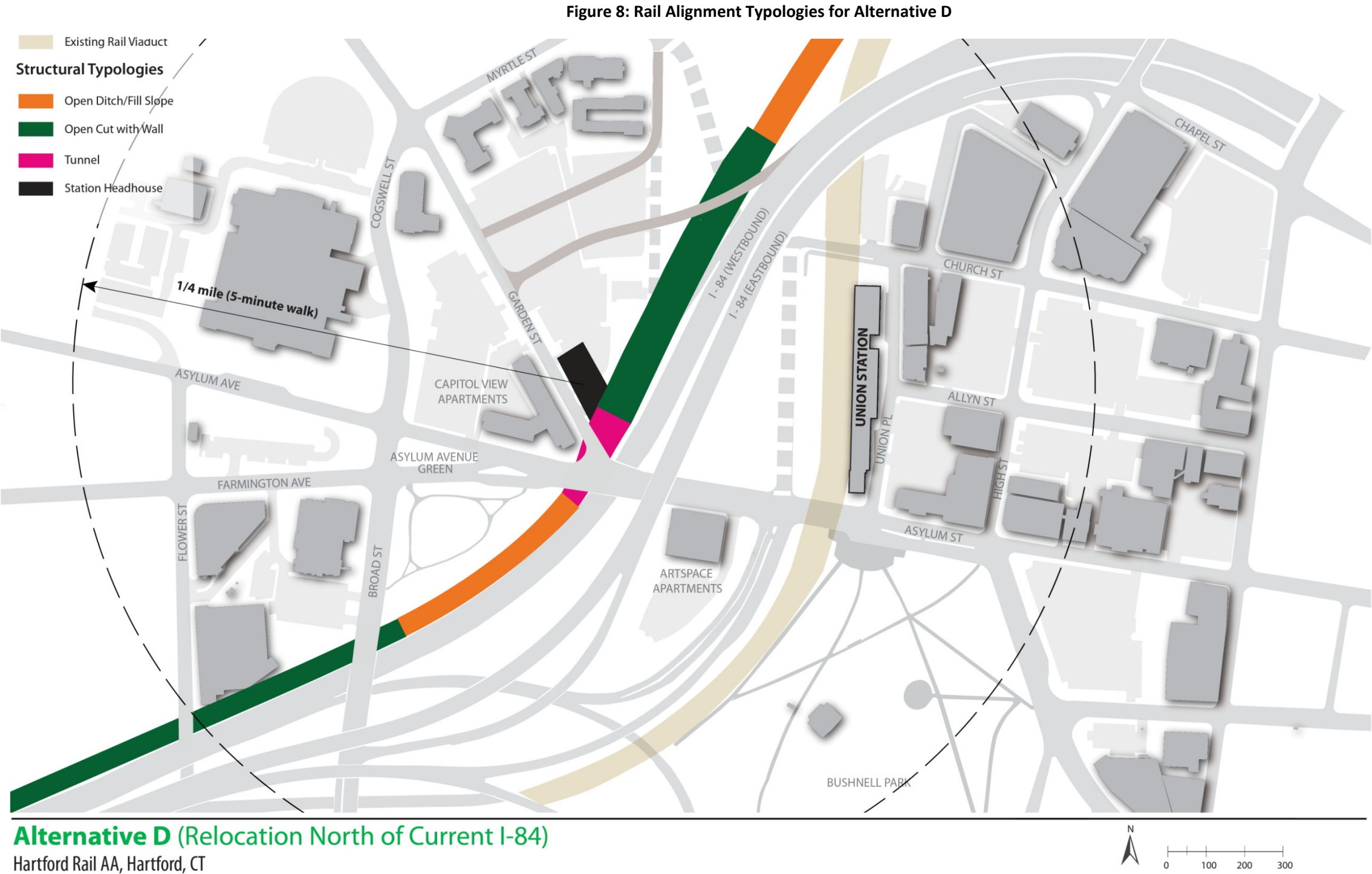
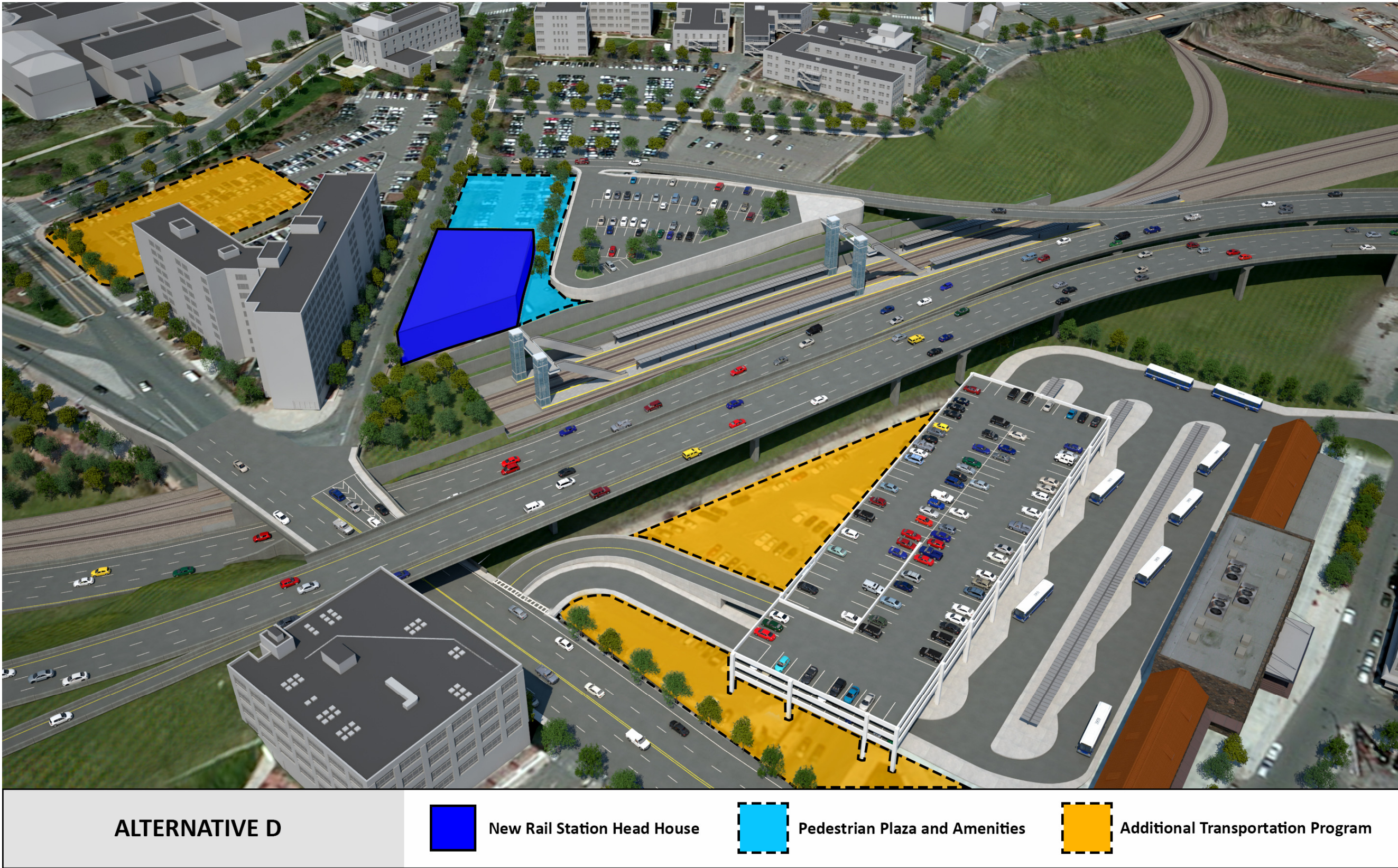


Figure 9: Perspective View of Program Elements for Alternative D



Alternative E- Relocation South of Potential At-Grade I-84

- Relocates track south of I-84 mostly in a tunnel section.
- Creates new track capacity (provisions for two through tracks, gauntlet or by-pass track in the station area); does not preclude capability for future track connection to Griffin Line (though the connection would occur in a tunnel).
- Provides new platform generally along Spruce Street below-grade in a tunnel with an open-cut section along a portion of the platform itself; constructs new station services building at ground level above the platform.
- Modest track curvature at the platform enables a length of 1050' (significantly longer than existing).
- Modest improvements to track curvature approaching the station from the west.
- Crosses underneath I-84 at same locations as current, but would be below-grade rather than on the surface.
- Constructs new bridges and/or tunnels as needed to support realignment.
- Expands and relocates ancillary facilities such as parking lot and bus staging area.

I-84 Assumption

Alternative E assumes that I-84 will be reconstructed primarily at-grade slightly to the north of the current highway alignment. Alternative E crosses the rail line under a ground-level I-84 to create a new rail alignment south of the highway.

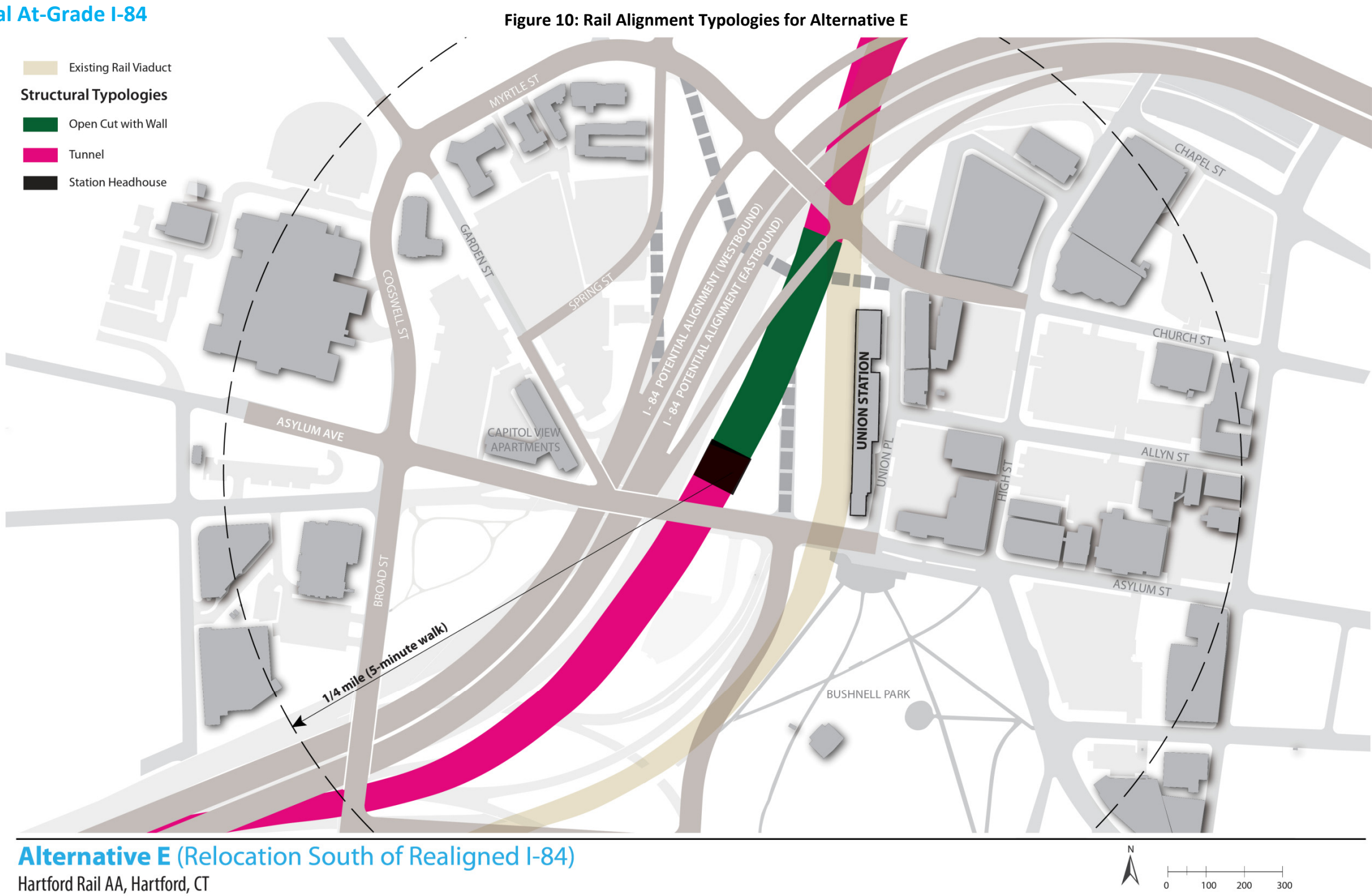
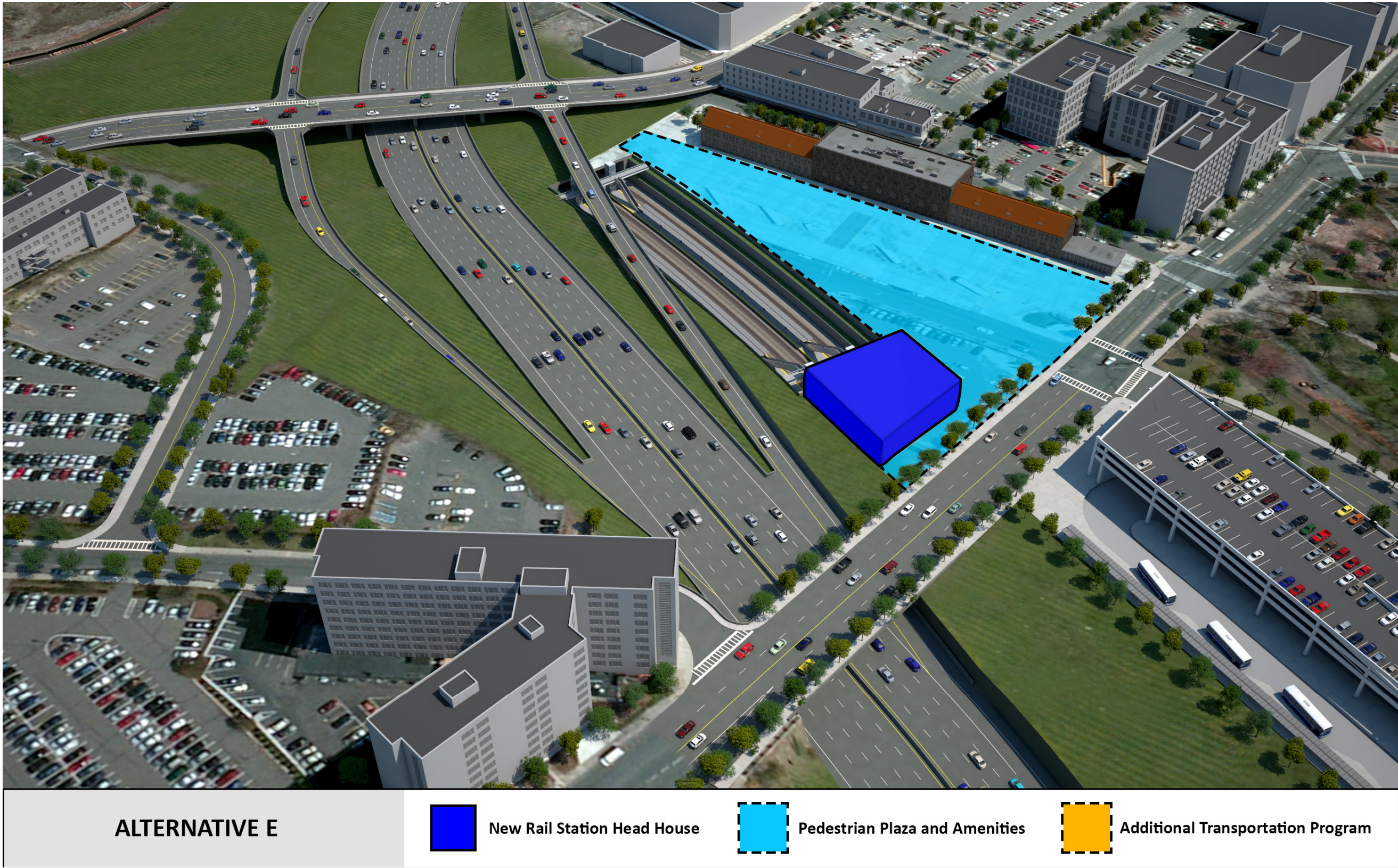


Figure 11: Perspective View of Program Elements for Alternative E



Alternative F1 – Relocation North of Potential At-Grade I-84 (Or I-84 in Tunnel)

- Relocates track north of I-84 (on opposite side of the highway from the current station), with much of the alignment through the study area in an open cut. The alignment would be farther to the north than the Alternative D alignment.
- Creates new track capacity (provisions for two through tracks, gauntlet or by-pass track in the station area); does not preclude capability for future track connection to Griffin Line.
- Significant improvements to track geometry results in 2-3 minutes of travel time savings.
- Constructs new bridges / tunnels as needed to support realignment.
- Provides new below-grade platform between Asylum Avenue and Myrtle Street with a portion of the platform in a tunnel and a portion in an open cut section; constructs new station services building at ground level.
- Modest track curvature at the platform enables a length of 1050' (significantly longer than existing).
- Expands and relocates ancillary facilities such as parking lot and bus staging area.

I-84 Assumption

Alternative F1 assumes that I-84 will be reconstructed primarily at-grade slightly to the north of the current highway alignment. Alternative F1 creates a new rail alignment on the north side of I-84 to avoid any crossings of the highway.

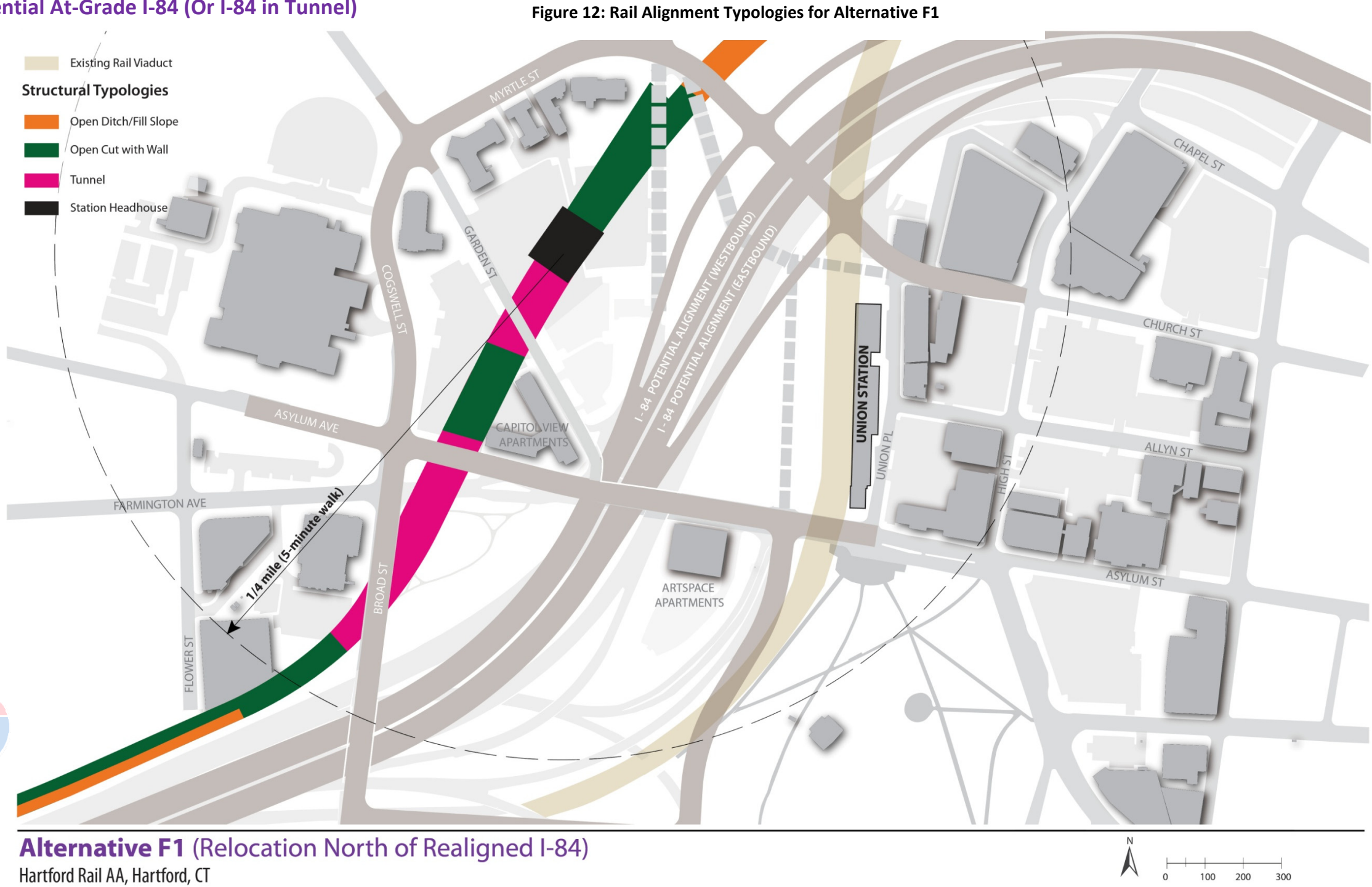


Figure 13: Perspective View of Program Elements for Alternative F1



Figure 14: Detailed Station Area Plan for Alternative F1



Alternative F2 – Relocation North of Potential At-Grade I-84 (Or I-84 in Tunnel)

- Relocates track north of I-84 (on opposite side of the highway from the current station), with much of the alignment through the study area in an open cut. The alignment would be farther to the north than the “Alternative D” alignment.
- Creates new track capacity (provisions for two through tracks, gauntlet or by-pass tracks in the station area); does not preclude capability for future track connection to Griffin Line.
- Significant improvements to track geometry results in 2-3 minutes of travel time savings.
- Constructs new bridges / tunnels as needed to support realignment.
- Provides new below-grade platform between Asylum Avenue and Myrtle Street primarily in an open cut section; constructs new station services building at ground level.
- Modest track curvature at the platform enables a length of 1050’ (significantly longer than existing).
- Expands and relocates ancillary facilities such as parking lot and bus staging area.

I-84 Assumption

Alternative F2 assumes that I-84 will be reconstructed primarily at-grade slightly to the north of the current highway alignment (and slightly farther north than the alignment assumed for Alternative F1 to achieve a higher highway design speed). Alternative F2 creates a new rail alignment on the north side of I-84 to avoid any crossings of the highway.

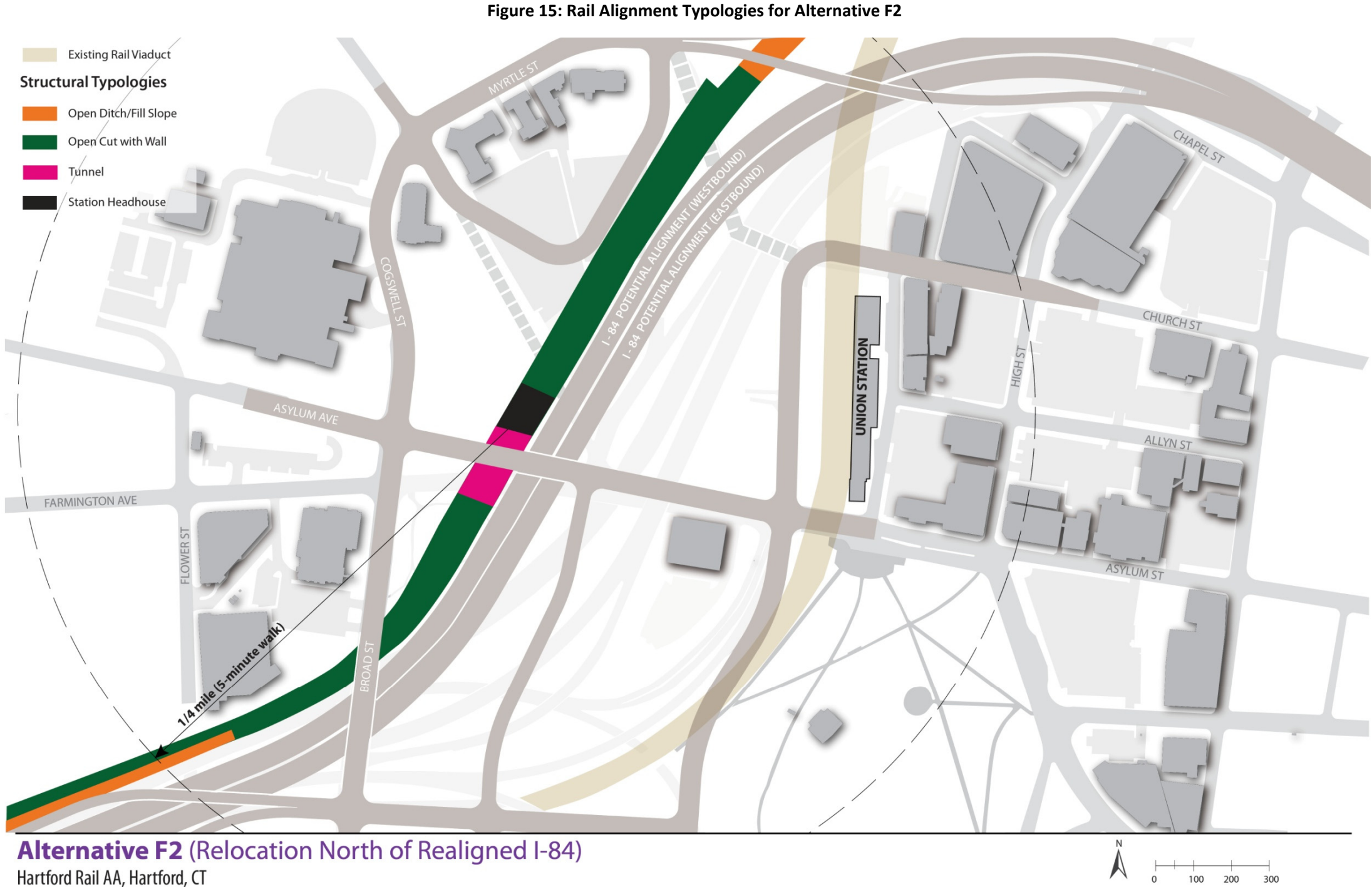


Figure 16: Perspective View of Program Elements for Alternative F2



Figure 17: Detailed Station Area Plan for Alternative F2



2.3 Adaptive Reuse Opportunity for Rail Viaduct

For options that involve a significant relocation of the rail corridor (Alternatives D, E, F1, and F2), the possibility exists to repurpose the current rail viaduct structure. This study included a brief analysis to review the potential for establishing a linear park on the elevated viaduct after the rail function would be relocated. This concept is not reflected in the representative station area plans for each of the rail design alternatives, but could be adapted into the station area plans for compatible options (i.e. Alternatives D, E, F1, and F2).

In concept, the potential linear park would be built atop the Amtrak elevated rail viaduct connecting Capitol Avenue to Main Street. Repurposing the rail viaduct would create a series of small and large open spaces connected by a network of multi-use paths. The project is envisioned as three “rooms” with the following programs and structures:

1. Bushnell Terrace

- Views of historic Bushnell Park, the State House and the downtown Hartford skyline;
- Connect to iQuilt Greenwalk, accessing key public buildings and the Connecticut River waterfront in Downtown Hartford;
- Large, low-rise terrace steps can used for theatre performance, eating lunch, waiting, children’s play area, or sunbathing, among other activities;
- Small kiosks can be built into the terrace infrastructure, providing a venue for small scale, locally owned businesses, such as food vendors;
- In the case that I-84 is relocated, the Bushnell Terrace will help attract future development, such as bike shops, restaurants or offices between Asylum and Broad Streets.

2. Union Station Market Place

- Renovation and repurposing of historic Union Station to accommodate a wide range of temporary or permanent uses such as a food market, library, bookstore, event space rental or seasonal festivals;
- Ground level plazas along Union Place and at the Union Station Bus Terminal with interior and exterior spaces;
- Platform level includes 7,000 square feet of semi-outdoor space for temporary or permanent use, while third floor can be used for tenant or management offices.

3. Downtown North Connection

- Link to Downtown North Development (dono) including the new ballpark on Trumbull Street, and new mixed use development;
- Prioritize use lighting, art and industrial design features to create comfortable and safe open space at the I-84 underpass;
- Pedestrian connection between the frontier of future development in Hartford (Downtown North) and the iQuilt Greenwalk and Hartford riverfront.

This concept encourages myriad economic and social opportunities, placing Hartford alongside several other cities that have repurposed non-operational rail infrastructure into vibrant public space including New York City’s High Line Park and The 606 in Chicago. Similar to the benefits achieved in New York City and Chicago, an elevated linear park in Hartford would spark economic investment interests, creating a new destination in downtown Hartford. The project would connect two existing development efforts in Hartford, the iQuilt Greenwalk and the DN/DW Plan for the City of Hartford (2013), creating a more livable and walkable downtown Hartford.

If the concept of an elevated linear park is embraced, it should be further developed as a part of the more detailed study of compatible rail alignment options.

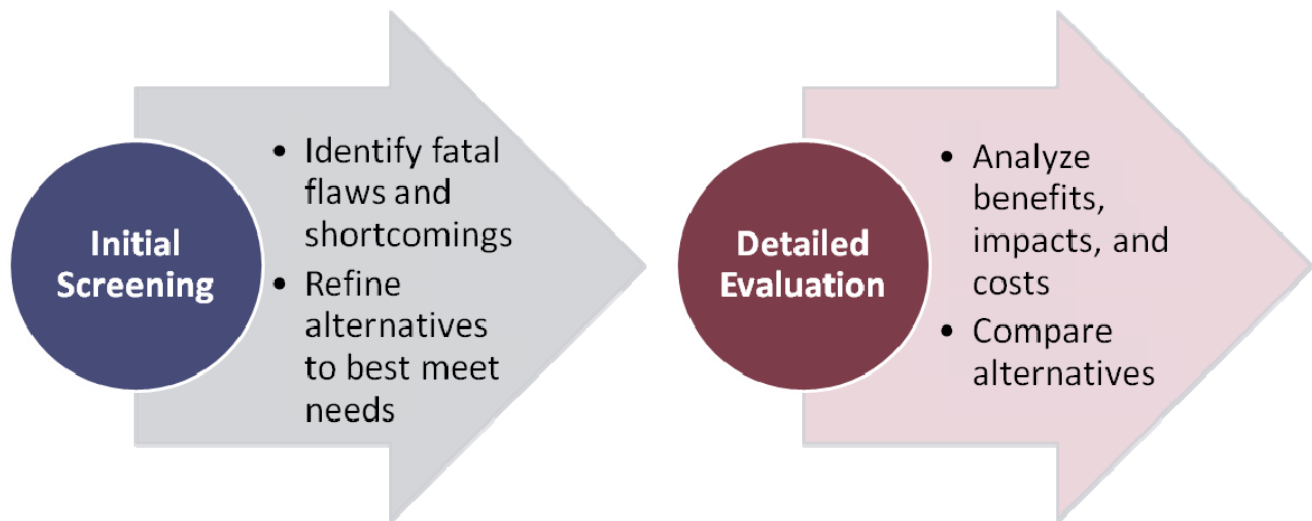


3 WHAT WAS THE STUDY PROCESS?

3.1 How Were the Alternatives Evaluated?

A two-phased process was used to assess options to maintain, reconstruct, or relocate the rail corridor in the vicinity of Hartford Union Station. An “initial screening” analysis qualitatively examined six primary rail alternatives (Alternatives A, B, C, D, E and F) to identify potential fatal flaws and other, less severe shortcomings. Each of the alternatives was then refined to best fit with the design guidelines presented in the *Description of Infrastructure Needs Memorandum* (April 2014). The intent of the initial screening, as described in the *Initial Screening Report* (September 2014), was not to eliminate alternatives, but rather be responsive to as many project needs as possible for all three types of options. Given that it may not be feasible to meet every need, the unachievable needs for each alternative were noted for comparison.

The refined alternatives then underwent a more rigorous analysis in a “detailed evaluation” phase comparing the relative strengths, weaknesses, benefits, costs, and impacts of each alternative. This phase featured a greater level of detail and more focused quantitative data, and was intended to enable a selection between the maintenance, reconstruction, and relocation alternatives. As the “detailed evaluation” process subsequently occurred, several additional refinements to the alternatives were made. These modifications are noted in *Detailed Evaluation of Alternatives Report* (May 2015) as part of the evaluation findings for each specific option. Most notably, Alternative F was subdivided into two sub-options – Alternatives F1 and F2. These sub-options are distinguished by their rail alignments and station locations north of I-84.



3.2 What Are the Key Design Guidelines?

The specific design guidelines are based on existing NHHS program design criteria, applicable industry and operator standards, conversations with key stakeholders such as Amtrak and Greater Hartford Transit District (owners of Union Station), and recommendations from previous related planning studies.

In addition to guidelines for specific elements, an overall design goal is stated for each major infrastructure feature. These goals are linked to the project needs as described in the *Project Overview and Summary of Need* (March 2014). This step helps to ensure that the specific design guidelines address the overall project needs as previously defined.

For this potential project, design guidelines differ for the maintenance option and the reconstruction and relocation options. The maintenance option is intended to serve as a baseline option focused solely on bringing the current infrastructure to a state of good repair. No capacity expansions or significant operational enhancements will be included in the baseline “maintenance” scenario. However, the reconstruction and relocation options will provide opportunities to increase capacity and enhance operations, and the design guidelines reflect these goals.

Table 2 describes the primary working assumptions and parameters are based on the targets defined in the *Description of Infrastructure Needs* report.

Table 2: Rail Alignment Assumptions and Targets		
Category	Assumptions and Physical Parameters	Preferred / Target Number
Rail Alignment		
Track geometry	<ul style="list-style-type: none"><li>No curvature at platform desired, but up to 1°40’ acceptable to meet ADA.</li><li>Maximum 2.5% grade; maximum desirable grade of 1.5%. Within station limits, maximum grade of 0.1%. Vertical curves shall be avoided within station limits.</li><li>Minimum 15’ between track centerlines wherever feasible. Track centers between a main track and an industrial side track shall be 17’ or greater wherever feasible.</li></ul>	2 tracks to meet the needs of the 2030 Service Development Plan (3rd track for freight by-pass or siding)
Clearance	<ul style="list-style-type: none"><li>Refer to Amtrak Standard track plan AM70003A.</li><li>Minimum 22’6” vertical clearance required by CT law (current NHHS clearance is 18’6”).</li></ul>	
Freight accommodation at station	<ul style="list-style-type: none"><li>Use of gauntlet track (rather than fold-up platform edge) is preferred; consider freight by-pass track as option.</li></ul>	
Structural design	<ul style="list-style-type: none"><li>All new or replacement structures shall be designed for AREMA Cooper E80 plus 50% impact and/or minimum of 286k freight with other live loads and loading group combinations applied as specified in Chapter 8 and 15 of AREMA.</li></ul>	100-year design life
Passenger Station		
Platform length	<ul style="list-style-type: none"><li>Sufficient length for 12-car trains.</li></ul>	1050’ minimum
Station footprint	<ul style="list-style-type: none"><li>Provide for a significant station with a station building and waiting room, ticket office, and checked baggage service. Additional features and amenities should include restrooms and commercial space for restaurant / food service and/or other use.</li><li>A larger station footprint may be necessary for any underground platform options that are developed. Use NFPA 130 to inform underground access design.</li></ul>	
Expansion capability	<ul style="list-style-type: none"><li>Provide space to expand from a two-track to three-track layout in the future with additional platform space as necessary.</li><li>Platform length extensions beyond the minimum of 1050’ are not anticipated.</li></ul>	

Table 2: Rail Alignment Assumptions and Targets (continued)		
Category	Assumptions and Physical Parameters	Preferred / Target Number
Multimodal Transportation Program		
General Assumptions	<ul style="list-style-type: none"><li>The programmatic parcel boundaries are set to offset 10 feet from edge of streets and existing buildings and 20 feet from edge of highway structure and rail structure;</li><li>Areas of severe vertical grade change are excluded from the parcel analyzed;</li><li>The station head houses are assumed to be the same throughout the alternatives and meet design requirements.</li></ul>	
Parking	<ul style="list-style-type: none"><li>Approximately 60-65 feet per parking bay;</li><li>City standard parking stall;</li><li>Parking structures assumed to have three levels unless otherwise stated in the narrative;</li><li>Parking structure is able to structurally support other usage on top.</li></ul>	250 spaces
Intercity bus and local bus	<ul style="list-style-type: none"><li>Bus length varies from 40 - 45 feet, depending on city or intercity;</li><li>Sawtooth bus bays provided, unless otherwise stated;</li><li>Center low-level platform with shelters;</li><li>60-foot outer turning radius;</li><li>For parallel on-street parallel bus bays, each bay is 80 feet long, unless nose-to-tail berthing is possible.</li></ul>	15 bays (intercity bus) 20 bays (local bus)
Pick-up/Drop-off and Taxi	<ul style="list-style-type: none"><li>Each space takes up 22 feet long curb space.</li></ul>	15-20 taxi spaces in close proximity to station; 25 pick-up / drop-off parking spaces
Transit Plaza	<ul style="list-style-type: none"><li>Square footage includes amenities and retail space on the plaza, as well as the building footprint of the station head house.</li></ul>	
Transit-oriented development (TOD)	<ul style="list-style-type: none"><li>TOD potential is calculated as gross lot area only, and does not incorporate assumptions regarding land use, site configuration, building placement, internal street network, landscaping, or other site features.</li></ul>	
Pedestrian and bicycle connectivity	<ul style="list-style-type: none"><li>Sidewalks connect to all surrounding areas.</li><li>Bike lanes or other bike facilities considered as part of new / improved street connections.</li><li>Off-street pedestrian / bikeway facilities considered for compatible design options.</li></ul>	

3.3 What Were the Evaluation Focus Areas?

As stated earlier, the rail AA is a critical link in the New Haven-Hartford-Springfield Rail program. Both the NHHS Rail Program and the I-84 Hartford Project are key transportation initiatives and are strategic components of the vision for the future of transportation in Connecticut. The purpose of this project is to address the ongoing **serviceability** of the aging rail viaduct infrastructure, increase regional rail **mobility**, improve local **connectivity**, and spur **economic development**. The evaluation criteria, which are tied to each of these themes, define the areas of focus for the screening of alternatives.

Table 3 illustrates project goals, criteria, and the focus areas for the detailed evaluation phase. During the initial screening phase, the criteria were analyzed broadly. During the detailed evaluation stage, the same general criteria

were used, but the analysis was more rigorous and targeted. Using the established criteria provides an objective and thorough means of considering the rail alignment alternatives and various station location options.

Table 3: Evaluation Criteria		
Connection to Statement of Need	Criterion	Detailed Evaluation Focus Area
Address serviceability of viaduct	<ul style="list-style-type: none"><li>Minimize construction impacts</li><li>Minimize potential environmental impacts</li><li>Assure that life cycle costs are commensurate with benefits</li></ul>	<ul style="list-style-type: none"><li>Constructability and phasing</li><li>Environmental considerations</li><li>Conceptual cost estimates</li></ul>
Increase rail mobility	<ul style="list-style-type: none"><li>Accommodate future passenger and freight rail operations</li><li>Meet the design and engineering constraints</li></ul>	<ul style="list-style-type: none"><li>Rail and transit operations</li></ul>
Improve local connectivity	<ul style="list-style-type: none"><li>Fit in corridor in coordination with potential reconstructed I-84 alignment</li><li>Increase station’s role as an activity and multimodal hub</li><li>Accommodate traffic flow and parking needs and foster improved pedestrian and bicycle connections</li><li>Support other planning efforts</li></ul>	<ul style="list-style-type: none"><li>Traffic and parking</li><li>Multimodal transportation program analysis (station area plans)</li></ul>
Spur economic development	<ul style="list-style-type: none"><li>Improve and revitalize the station area and surrounding neighborhoods</li><li>Create opportunities for transit-oriented development</li></ul>	<ul style="list-style-type: none"><li>Urban design (station area plans)</li><li>Transit-oriented development analysis (station area plans)</li></ul>

3.4 How To Determine the Best Fit with the Stated Goals?

The “detailed evaluation focus areas” identified in Table 3 provide the framework for the assessment of each alternative. The following paragraphs describe the evaluation methodology used for each of the focus areas.

Constructability and Phasing

For each alternative, conceptual track plans and profiles were developed. Based on minimum roadway and rail vertical clearances, geographic limits were established for the following types of track sections:

- Open ditch/fill slope sections;
  - Open cut with walls;
  - Cut-and-cover tunnels;
- Station platforms; and
  - Rail bridges.

These sections were depicted on the conceptual track plans and profiles. Over the course of the study, the limits of each type of section were refined, as well as the proposed station locations. Based on the conceptual plans/profiles and the details developed for each structure, constructability and phasing challenges were identified for each alternative.

Environmental Considerations

A screening-level evaluation of potential impacts was conducted for the following:

- Community disruption (including neighborhoods, access, environmental justice, and community cohesion);
- Ecologically Sensitive Areas (including biota of conservation concern and their habitats, wetlands, water resources, farmland soils and parklands/Section 4(f));

- Flooding;
- Hazardous materials;
- Historic resources;
- Air quality;
- Noise and vibration;
- Visual and aesthetics; and
- Construction phase.

These resource areas were evaluated in terms of their general impact potential by each of the proposed rail alternatives. Since this is a preliminary environmental screening effort, no in-depth quantitative analyses (i.e., acres of wetlands impacted, acres or square feet of property impacts, etc.) were conducted. More detailed analyses and further field verification of these resources will be carried out during future phases of this project.

**Rail and Transit Operations**

The rail operations assessment focused on the capacity of the NHHS corridor through Hartford, as well as travel time impacts from track geometry changes. As a secondary criterion, it also evaluated the ability to not preclude a future track connection to the Griffin Line, which is a freight line extending north from Union Station into Bloomfield.

From an operational perspective, the 2030 Service Development Plan states that two tracks provide sufficient capacity to meet the service needs that are anticipated through 2030. However, recognizing that the rail and highway investments to be made in the study corridor will have a service life far beyond 2030, it is appropriate to not preclude the opportunity for additional operational capacity in the future. The conceptual design options for track relocation included the identification of space requirements for a third track through the station area. This additional track could have various functions such as a by-pass, provide additional freight capacity or even provide a connection to the Griffin Line if such a connection were to be desired in the future. As the development of corridor design options moves forward in concert with the I-84 Hartford Project, consideration should be given to the ability to reserve space for additional track capacity to serve future growth. Such design considerations must be made in the context of striking the best balance of meeting the current and future needs of all transportation in the corridor.

The bus transit assessment focused on the future routing and ease of passenger transfer between rail and bus for each alternative. For each rail alternative, the discussion examines the three primary bus services (intercity, local, CTfastrak) individually, and it describes the relative ease of access to the rail station (based on anticipated roadway level-of-service conditions), directness of routing to/from the station, likely bus stop/station locations, and associated accommodations for local taxi and kiss-and-ride activities. In some alternatives, potential roadway improvements are recommended for improved bus operations.

**Traffic and Parking**

The traffic, pedestrian, parking, and bus operations analysis focused on impacts primarily in the vicinity of the station. This evaluation provides a relative high-level comparison of impacts among the seven alternatives.

The methodology used to assess traffic operations for each of the rail alternatives is based on the general type and level of roadway improvements that theoretically would be needed to accommodate future changes in traffic volumes at an acceptable level of service (LOS). For each rail alternative, roadway traffic volumes were redistributed to a modified street network developed for that alternative. The traffic analysis also qualitatively addresses the ability of each rail alternative to better accommodate pedestrians.

It is assumed that a portion of the rail and transit customers will continue to park at or near the Hartford rail station. Currently, there are 190 parking spaces in the primary lot on Spruce Street. One of the criteria that identified as part of the study was a requirement for future alternatives to provide at least 250 parking spaces at or near the rail

station. The parking assessment focuses on the ability of each alternative to accommodate the projected 250-space demand for future NHHS riders and the approximate location of this parking supply in proximity to the rail station.

**Station Area Planning Analysis**

A station area planning analysis was conducted to evaluate each rail alternative’s capacity to create and support a well-functioning multimodal station. The *Refined Definition of Alternatives* report laid out how different transportation programs and private development configurations might work together under each rail alignment alternative. The *Refined Definition of Alternatives* document presented diagrams of multimodal transportation program configurations and diagrams of urban design and TOD assessment, including various physical configurations and land use assumptions. The analysis presented in the *Detailed Evaluation of Alternatives* report takes another step forward to evaluate potential programmatic quantities (such as numbers of parking spaces, bus bays, and taxi spaces, and square feet of transit oriented development) that are achievable under those land use assumptions.

The analysis includes an evaluation of the following:

- How the station area (defined as the land area within a quarter-mile radius of any potential future rail station) could potentially organize around the primary transportation infrastructure elements (rail, I-84 mainline and interchanges, and new local street connections);
- What the station area could yield in terms of transit-oriented development; and
- Consistency with local city planning and urban design goals and objectives.

The station area planning analysis results for each alternative are organized into three components: multimodal transportation program; transit-oriented development (TOD) capacity; and urban design assessment.

The station area planning analysis for each alternative follows the basic three-part structure outlined above. However, the station area planning analysis for Alternatives F1 and F2 included an additional layer of site analysis to investigate in detail how the station area’s transportation functions, potential joint development, transit-oriented development, and adjacent redevelopment could be configured horizontally and vertically. To illustrate the potential, an illustrative site plan and series of cross-sections are presented to convey site layout and circulation, building configuration and massing, as well as land use considerations that would work together to achieve longstanding urban design and city planning objectives.

**Conceptual Cost Estimate**

Conceptual capital costs for each alternative were determined using a variety of source data. Please note that this is a conceptual planning-level cost estimate that should be used only for the purposes of comparing alternatives against each other. It should not be used for estimating the full construction cost of any alternative. At this stage, several items are difficult to quantify and have not been included in the estimates:

- Railroad Force Account Work
- Property acquisition costs
- Environmental costs
- Staging/phasing/maintenance and protection of traffic premium
- Utility work/ relocations
- Cost to temporarily relocate stations services under the existing Union Station rail viaduct

To account for the significant uncertainty that remains at this conceptual level of planning, calculated cost estimates (including contingencies) are presented as a range of potential costs.

4 WHAT DID THE ANALYSIS CONCLUDE?

Any transportation improvement project must balance many needs and many potential impacts to attempt to arrive at the best possible and practical solution and one which can be embraced by transportation agencies, regulatory agencies, communities, and the public. There is no magic formula for doing so. However, a qualitative and quantitative review of each of the evaluation criteria and each of the impact areas is a helpful tool in getting to the right decisions. Ideally, one or several alternatives will emerge which meet the purpose and need for the project, provide the desire benefits, and have impacts that are either acceptable or able to be mitigated.

In this corridor, the added challenge is that there are major improvement programs for two transportation modes in the corridor, both of which are important initiatives for the State of Connecticut.

Based on the results of this evaluation, and setting the stage for further coordination with the I-84 Hartford Project, the focus moving forward should be on options that relocate the rail alignment north of I-84.

4.1 What Are the Primary Conclusions Drawn from this Analysis?

Table 4: Primary Benefits and Costs of Each Alternative							
Alternative	Benefits (Opportunities)			Costs (Impacts)			Conclusions
	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH	
A							Alternative A does not achieve the project goals to increase mobility, improve connectivity, or spur economic development. Although the financial cost is comparatively low, completing the work at the station while maintaining active rail operations would be extremely challenging.
B							Alternative B introduces operational benefits from the provision of two tracks, as well as additional parking capacity. However, it does little to enhance urban design, and although this option is relatively inexpensive, it potentially impacts Bushnell Park.
C							Alternative C offers modest additional benefits as compared to Alternative B, primarily because of the much easier station construction. However, the capital cost is higher than that of Alternative B, and the potential impact to Bushnell Park is a significant concern.
D							Alternative D offers the most benefits to the multimodal transportation program and TOD capacity when compared to Alternatives A-C (i.e. those that assume I-84 remains in its current location). The capital cost is projected to be less than that of Alternative C, and the potential adverse environmental impacts are not as severe.
E							Alternative E provides significant urban design benefits, but the cost is much higher than that of any other option. In addition, Alternative E is impossible to construct while maintaining continuous and active rail service.
F1							Alternative F1 generates the most vehicular connectivity-related benefits, and also fares well in enhancing urban design. The capital costs, while higher than most options, are half of that of Alternative E. However, there are notable potential property impacts.
F2							Alternative F2 offers significant benefits like Alternative F1, but is distinguished through the development of an optimal station area plan enhancing urban design and local connectivity. The capital cost is lower than that of Alternative F1 and is in the middle of all options. There are slightly more potential property impacts, but constructability fares better than Alternative F1.

- Alternatives **A** and **B** are relatively inexpensive from a capital cost perspective, but the construction impacts of maintaining service during station renovation are severe. From a constructability perspective, these alternatives would be more attractive with a full shutdown of rail services during the construction period.
- Very few benefits can be gained by moving the rail alignment closer to I-84 while remaining on the south side of the highway (Alternative **C**). This option would be somewhat more attractive with a modified track alignment to minimize impacts to Bushnell Park, but such a change would force the existing tight curvature in the station area to remain.
- Of the options that assume I-84 remains in its current location, Alternative **D** offers notable benefits with relatively modest potential adverse impacts. The capital costs compare favorably to reconstruction in place.
- Alternative **E** is effectively fatally flawed if active rail service must be maintained during construction. Even if service could be shut down for an extended period during construction, the cost is much higher than that of other options.
- Alternatives **F1** and **F2** have very similar overall characteristics. Alternative **F1** does better in improving vehicular connectivity, whereas **F2** offers better urban design features and pedestrian improvements. Alternative **F1** is slightly more difficult to construct, whereas Alternative **F2** has slightly more potential adverse environmental impacts. Alternative **F2** requires less tunneling, contributing to its lower capital cost than Alternative **F1**.

- When viewed holistically in their current configurations, only Alternatives **D**, **F1**, and **F2** have perceived benefits greater than the costs. All of these are the options in which the rail line would be moved north of I-84, resulting in benefits such as 2-3 minutes of travel time savings and decreased track maintenance. However, all of these options have strong interactions with the I-84 mainline and interchanges, requiring a fully-integrated design effort for the highway and rail components of the overall corridor program.

4.2 What Are the Key Observations for Each Focus Area?

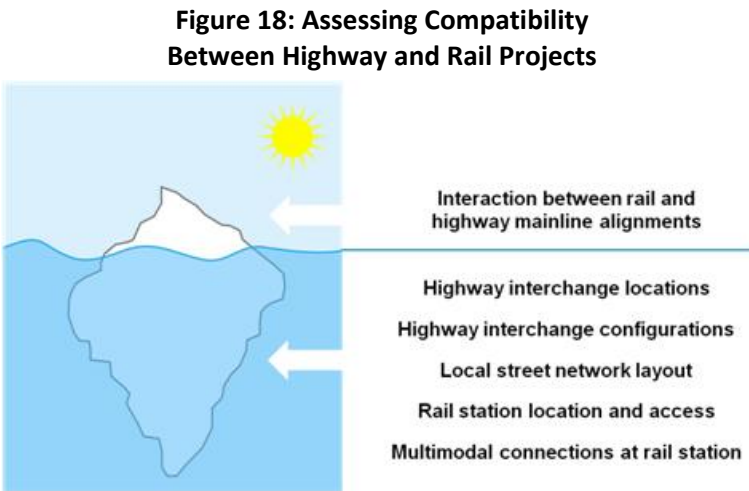
Table 5: Key Observations for Evaluation Focus Areas			
Overall Goal (from Statement of Need)	Focus Area	Relative Assessment of Alternatives	Key Observations
Address serviceability	Constructability and phasing (station)	<div><div>Most Difficult to Construct</div><div>A B F1 F2 D E C</div><div>Easiest to Construct</div></div>	From a station perspective, Alternatives A and B are much more difficult to construct than the alternatives that include a new station at a new location. Extremely challenging phasing and constructability issues must be addressed with regard to maintaining rail operations while performing extensive maintenance (Alternative A) or reconstruction (Alternative B).
	Constructability and phasing (track / structures)	<div><div>Most Difficult to Construct</div><div>E C F1 F2 D B A</div><div>Easiest to Construct</div></div>	Due to the extensive work involved, none of the alternatives are particularly easy to construct from a structural perspective. Alternatives A and B are difficult to construct while maintaining active rail service, and the other options will require modifications to I-84 and/or surrounding street infrastructure, requiring a complex construction sequencing plan. Alternative E is impossible to construct while maintaining active rail service.
	Environmental considerations	<div><div>Most Potential Adverse Impacts</div><div>C B F2 F1 D E A</div><div>Least Potential Adverse Impacts</div></div>	Alternative A has the fewest potential adverse environmental impacts because the alignment does not change under this option. At the other end of the spectrum, Alternatives C and B potentially impact Bushnell Park which is a significant historical and community resource. Options F1 and F2 have a high number of potential property impacts.
Increase rail mobility	Rail and transit operations	<div><div>Least Efficient Operations</div><div>E C B F1 D F2</div><div>Most Efficient Operations</div></div>	Alternative A limits future rail operational flexibility with only one track; all other alternatives provide the necessary two tracks to meet the needs of the 2030 Service Development Plan. Alternatives D, F1, and F2 provide improved track geometry, enabling travel time and track maintenance benefits. Alternative A also maintains current intercity bus limitations (i.e. no double-decker bus access, back-out spaces only), whereas other options improve upon this access. However, all options present operational limitations.
Improve local connectivity	Traffic and parking (traffic operations)	<div><div>Most Adverse Impacts</div><div>D C A B F2 E F1</div><div>Least Adverse Impacts</div></div>	Traffic operations are highly dependent on future decisions to be made regarding I-84 connections and the surrounding surface street network, but Alternative D rates the most poorly due to the required disconnection of Church Street and Myrtle Street. Alternatives E, F1, and F2 fare better due to potential ramp and street network changes, but these potential network changes are subject to further study through the I-84 Hartford Project.
	Traffic and parking (on-street pedestrian operations)	<div><div>Most Adverse Impacts</div><div>A B D C F2 E F1</div><div>Least Adverse Impacts</div></div>	Pedestrian operations are determined largely by the conditions on Asylum Street and the connections between various transit modes. Alternatives A-D have little positive impact on pedestrian operations on Asylum Street, whereas Alternatives E, F1, and F2 propose improvements. However, the distance between parking and the rail station as well as between rail and bus modes increases under several alternatives, including F1 and F2.
	Traffic and parking (parking capacity)	<div><div>Most Adverse Impacts</div><div>A C D E B F2 F1</div><div>Least Adverse Impacts</div></div>	Alternative A does not improve upon the existing rail station parking capacity. All of the other alternatives offer the ability to provide more parking capacity, but for some options access between the parking and the station is less direct than desirable. Alternative F1 offers the ability to meet parking demand next to the station, with the most direct access to/from I-84 ramps.

Overall Goal (from Statement of Need)	Focus Area	Relative Assessment of Alternatives	Key Observations
	Multimodal transportation program (station area planning)	<div><div>Desired Elements Unachievable</div><div><div>A</div><div>B</div><div>C</div><div>D</div><div>F1</div><div>F2</div><div>E</div></div><div>Desired Elements Achievable</div></div>	The desired multimodal transportation program can be achieved with varying levels of success across the alternatives. Alternatives A, B, and C do not meet the stated local bus need, but this particular component may be less critical than other elements. Relocating the rail component of the station to the north side of I-84 (Alternative D) offers more flexibility, but the most opportunity is provided through an integrated relocation of I-84 (Alternatives E, F1, and F2).
Spur economic development	Urban design (station area planning)	<div><div>Least Favorable Urban Design Concept</div><div><div>A</div><div>B</div><div>DC</div><div>E</div><div>F1</div><div>F2</div></div><div>Most Favorable Urban Design Concept</div></div>	Alternatives A (maintenance) and B (reconstruction) do little to create a higher-quality urban environment. Alternatives C and D are slightly better, but are greatly constrained by the presence of the existing I-84 viaduct. Alternatives E, F1, and F2 clearly present the most opportunity, but they rely on an integrated approach with a relocated I-84.
	Transit-oriented development capacity (station area planning)	<div><div>Least TOD Capacity</div><div><div>A</div><div>C</div><div>B</div><div>DE</div><div>F1</div><div>F2</div></div><div>Most TOD Capacity</div></div>	Similar to the urban design impacts noted above, Alternatives A (maintenance) and B (reconstruction) do little to create more TOD capacity. Alternative C actually fares slightly worse than Alternative B, because no developable space would remain between the relocated station and the I-84 viaduct. Alternatives E, F1, and F2 present the most opportunity, but they rely on an integrated approach with a relocated I-84.

4.3 Why Is Coordination Between Hartford Rail and the I-84 Hartford Project Important?

One of the primary conclusions from the analysis of rail alternatives is that all of the rail options – whether maintenance, reconstruction, or relocation –require close coordination with the I-84 Hartford project. The proximity of the two facilities is such that any improvements made to the rail line will have some physical interaction with I-84, regardless of whether I-84 remains in its current location or is shifted to a different vertical profile (such as an at-grade alignment). Throughout the AA study process, continuing coordination between the I-84 and rail line design options has informed the design adjustments to ensure that at a conceptual level, the alternative designs for the rail and highway elements are compatible with each other for the purpose of assessing impacts.

Clearly, some of the I-84 design options have a bigger impact on rail alternatives than others, and some I-84 design options render certain rail alternatives difficult if not impossible to implement. For example, reconstructing the existing rail alignment in place would be impossible with a ground level I-84, because the rail alignment would be at the same elevation as I-84 where they cross. The interaction between the mainline alignments is certainly the starting point for assessing overall compatibility; however, this design element is only the “tip of the iceberg”, as illustrated in Figure 18. Many other design attributes also must be considered to define the highway and rail elements in such a way that compatibility can be fully assessed.



Constructability and phasing is one of the biggest challenges for the rail alternatives. All of the rail reconstruction and relocation alternatives (Alternatives B, C, D, E, F1, and F2 as identified in the *Detailed Evaluation of Alternatives Report*) have I-84-related constructability and phasing challenges associated with them, with many of the issues related to I-84 ramps and structures. Maintaining traffic during construction (for both rail and highway elements) is a major concern, because there is very limited space for temporary lanes in the corridor without impacting the rail corridor. Additionally, many highway and rail options have significant impacts on the local street network.

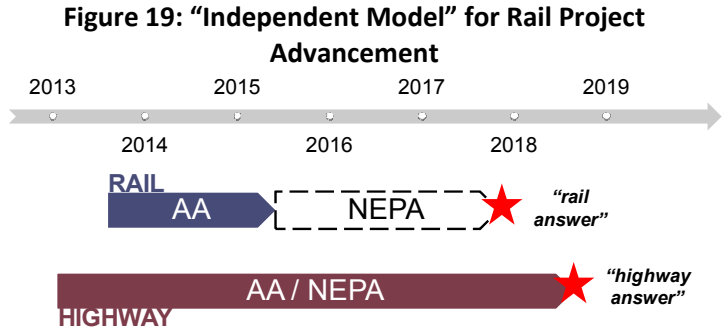
Based on this assessment, none of the rail reconstruction or relocation options can be constructed in such a way to be fully completed and “out of the way” of the highway project without causing significant impacts to the highway as well as the local street network during the course of construction. Likewise, highway options, and associated local street changes, are unlikely to be constructable without significant impacts on the rail corridor. The projects must be coordinated in such a way to advance together while seeking to minimize the impacts on both facilities during construction.

4.4 How Can the Hartford Rail Project Advance with the I-84 Hartford Project?

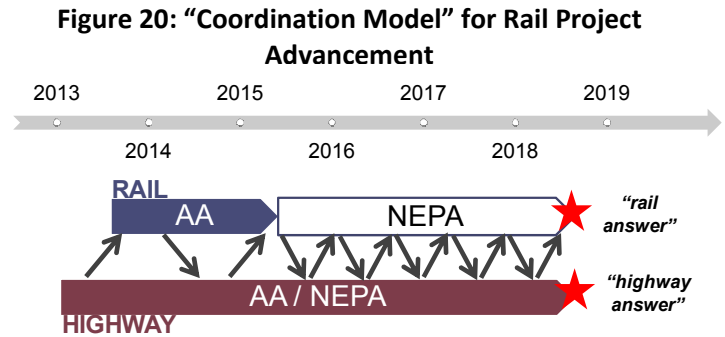
Three primary models are available for advancing a rail project from the conclusion of this AA into the next phase of environmental review:

1. Independent model;
2. Coordination model; and
3. Integration model.

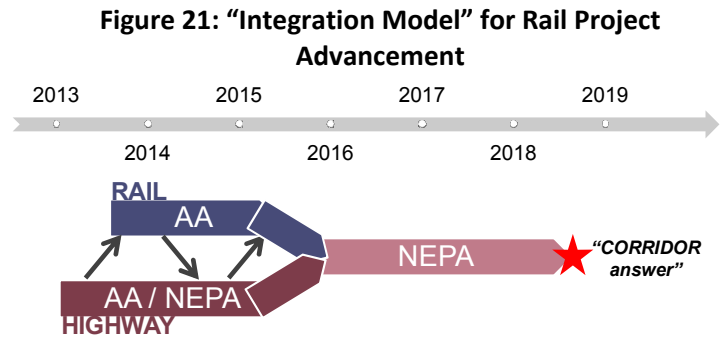
The “Independent Model” assumes that the highway and rail projects advance separately without significant interaction between the two projects. This situation would occur only if the highway project identifies a preferred alternative that does not impact the rail line, and the rail project identifies a preferred alternative that does not impact the highway facility. In theory, a future NEPA process for a rail project could be initiated at any point in time after completion of the AA, but it would not necessarily occur on a concurrent schedule with the highway NEPA process. These parallel and independent processes are illustrated graphically in Figure 19.



The “Coordination Model” assumes independent rail and highway project development processes; however, unlike the “Independent Model”, this approach assumes significant interaction between the two processes, driven by the high likelihood that the preferred rail and highway alternatives will have a high level of physical interaction. As illustrated in Figure 20, two concurrent NEPA processes would proceed on the same general timeline, seeking to produce final results at the same time. The coordination that has occurred during the AA study would increase in frequency and intensity as the two projects advance into more detailed planning.



The “Integration Model” builds upon the Coordination Model by creating a truly integrated NEPA process that combines both rail and highway modes to produce a single corridor answer, rather than the separate rail and highway answers that result from the Independent Model and the Coordination Model. As shown in Figure 21, upon completion of the Rail AA, the rail project development process would merge into the recently-initiated NEPA process for the highway project. A combined process would then occur to develop a comprehensive solution that incorporates both rail and highway elements to produce a corridor-based program of improvements.



Given the findings of this AA, it is clear that all of the most likely alternatives for implementation of a rail project will have significant interaction with I-84, whether in its current alignment or in a potential relocated alignment through the study area. For this reason, the Integration Model provides the best opportunity to generate a holistic result that is in Connecticut’s best interest.

If the NEPA process determines that a more likely outcome is separate and independent rail and highway projects, then a shift to the Coordination Model would be appropriate. However, it is clear that an integrated approach offers the most effective means through which to develop the best program of projects.

5 HOW DO THE ESTIMATED COSTS COMPARE FOR EACH ALTERNATIVE?

5.1 What Were the Assumptions?

The cost estimates for the Hartford Rail AA have been prepared consistent with the current stage of project development and the Federal Transit Administration’s Standard Cost Category Workbook (dated June 2014). The cost estimate is based on project features included in the *Detailed Evaluation of Alternatives Report* plan / profile / section exhibits.

Quantity take-offs were developed for the following main project elements: track; bridges; retaining walls; tunnels; station headhouse; station platform; parking facilities; and excavation. The unit pricing used for these cost estimates were pulled from the 2015 Connecticut Department of Transportation’s Cost Estimating Guidelines.

At this stage, several items are difficult to quantify and have not been included in the estimates:

- Railroad Force Account Work – Construction to be performed by Amtrak. This force account work is difficult to estimate until a design is developed and Amtrak has provided input into as to labor and equipment costs associated with the work. Furthermore, Amtrak’s union agreements require negotiation of labor clearances to for this work. Finally, Amtrak’s labor costs are difficult to predict this early in the project given the variability of wage rates increases. Suffice to say this cost can substantial.
- Utility work / relocation of utilities –Detailed survey and field investigations are required.
- Inflation – Absent a stated timeframe for construction, all prices were calculated at current year (2015) rates.
- Property acquisition costs – Uncertainty with the integration of the I-84 Hartford Project makes it difficult to quantify property acquisition limits. Also, the unknown start date for construction along with fluctuating real estate market values contribute to the uncertainty.
- Environmental costs – Further environmental studies are needed to quantify these impacts and costs.
- Staging/phasing/maintenance and protection of traffic premium – Some alternatives will result in higher costs due to the difficult nature of their construction.
- Cost to temporarily relocate station services under the existing Union Station rail viaduct.

To account for the significant uncertainty that remains at this conceptual level of planning, calculated cost estimates (including contingencies) are presented as a range of potential costs. Several key factors discussed below were used in development of the cost estimates:

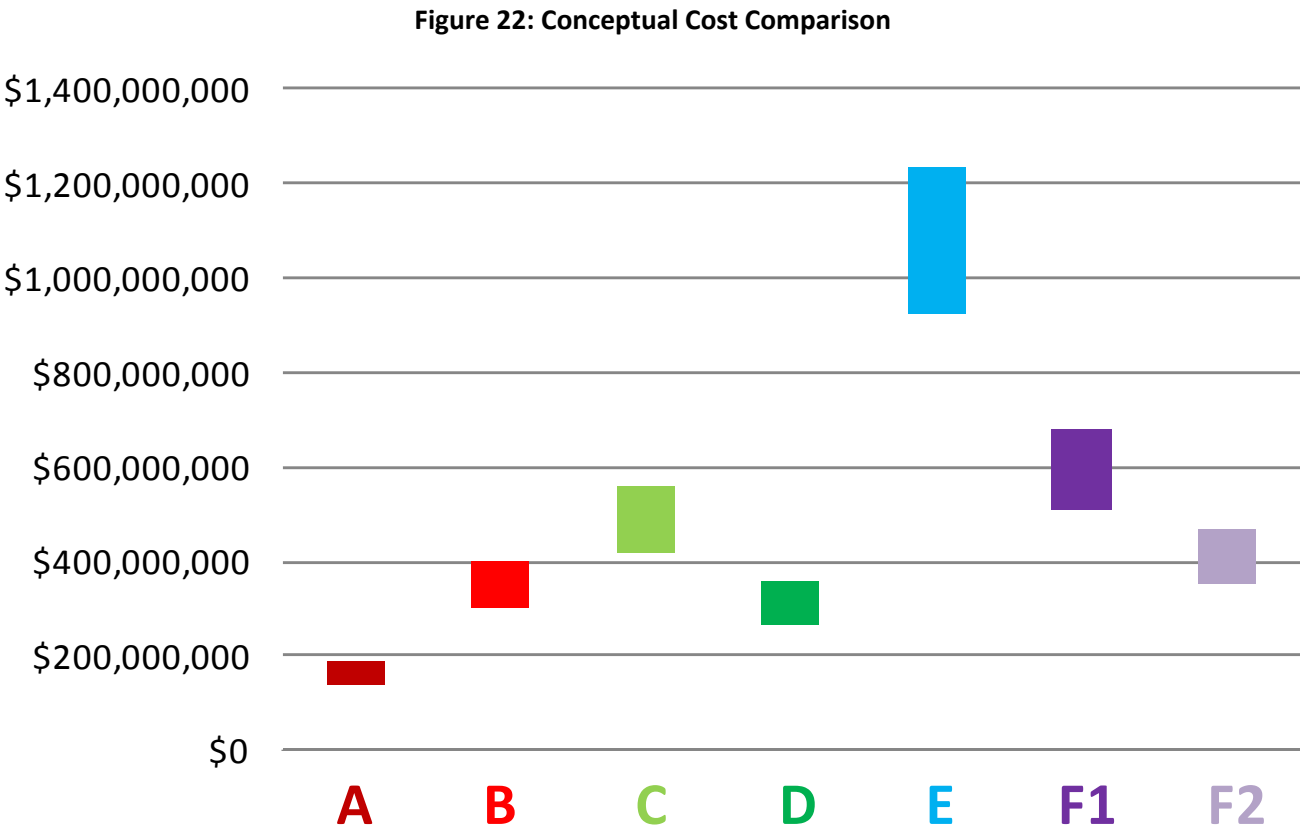
- Mobilization Factor – Calculated as 10% of estimated construction cost in each category which adjusts costs to account for mobilization which is typically included as a separate bid item in construction projects. The Connecticut Department of Transportation’s 2015 Cost Estimating Guidelines recommend using 10% for projects having multiple project locations.
- Allocated Contingency Factor – Adjusts costs to include items which are not anticipated, changes in quantities based on more refined information and potential pricing variations. The allocated contingency factor used for these cost estimates was 30% based on Table 1 – Minor Item and contingency factor guidance from the Connecticut Department of Transportation’s 2015 Cost Estimating Guidelines.
- Unallocated Contingency Factor – Adjusts costs to include items which are not anticipated during design and typically arise during construction. For the cost estimates, the unallocated contingency used for these cost estimates was 30% based on Table 1 – Minor Item and contingency factor guidance from the Connecticut Department of Transportation’s 2015 Cost Estimating Guidelines.

- Inflation – Inflation was not factored into the estimate due to the unknown schedule for construction. The Base Year for the cost estimate is 2015; all costs are calculated in Year 2015 dollars.

5.2 What Is the Estimated Capital Cost Range for Each Alternative?

The potential project costs, as shown in the figure below, are illustrated as a range of 20% to 60% above the calculated base cost including the contingencies described above. This range was selected to account for the significant unknowns highlighted previously, including railroad force account work and costs associated with complex construction staging and phasing in coordination with I-84. Future decisions regarding I-84 solutions could have a significant impact on the costs estimated as part of the rail AA study.

The analysis of costs shows a comparative range of planning-level cost estimates from under \$200 million to over \$1.2 billion. Alternative A (maintenance) has the lowest conceptual cost compared to the others. Alternative E includes a significant tunnel section, which significantly impacts the cost.



Please note that this is a conceptual planning-level cost estimate that should be used only for the purposes of comparing alternatives against each other. It should not be used for estimating the full construction cost of any alternative.

### 5.3 How Could this Project Potentially be Funded?

An outline of potential funding strategies for the implementation of possible projects emerging from the Hartford Rail AA is included in the *Potential Funding Strategies* technical memorandum (March 2015). The rail project options being examined in this AA cover a wide range of investment levels, from relatively modest continuing maintenance of the existing rail infrastructure to a complete relocation of all rail infrastructure in the study area. As such, the total funding needs will also vary significantly depending on the alternative that is ultimately advanced.

As with most major transportation investments, a wide array of funding options will need to be vetted, including federal, state, local, and private sources. Scarce public monies are highly competitive, given the tremendous infrastructure investment needs across Connecticut and across the United States. The more potential funding options that can be identified early, the better the opportunity to develop a multi-faceted funding program that makes the best use of all available resources.

Key principles guiding the development of a funding strategy include the following:

1. Focus on the multimodal nature of the project to better position the project for more funding options. Although viewed as a rail project by this study, the program that ultimately emerges is likely to impact a major freeway (I-84), the CTfastrak service, bus, pedestrian and bicycle connections, in addition to the rail corridor.
2. Recognize that a mix of many funding sources is more likely than reliance on one or two funding sources, especially for large-scale relocation options.
3. Identify potential funding options at all levels of government – federal, state, and local.
4. Consider the appropriateness of private finance opportunities through various forms of public-private partnerships.

It is becoming increasingly clear that a rail “solution” cannot be identified in isolation from a highway “solution”. Indeed, specific highway options fatally flaw certain rail options. Therefore, it is imperative that the rail and highway programs be developed as an integrated, multimodal effort. With regard to funding, the integrated nature of the programs also makes defining costs directly attributable to each mode (and associated funding sources) a greater challenge.

The overall program costs of combining the improvements of I-84 and that of the Hartford rail line certainly outweigh the costs for the rail line only. A long-term solution that will meet the goals of both rail and highway elements will require a major long-term funding commitment. Therefore, all potential avenues for identifying revenues should be explored.

As the Hartford Rail AA study advances into more detailed evaluation as part of subsequent NEPA analysis and preliminary design work, the funding options identified here will need to become more advanced to begin to take the shape of a specific funding strategy. As the project advances, two key focus areas are apparent:

- Re-examine funding options in consideration of the alternative(s) that will be advanced  
As noted earlier, the various alternatives being developed in this AA vary significantly in terms of their cost and their composition. As one or more alternatives are advanced for further study, the funding options and finance strategies should be reviewed and refined to be specific to the candidate options, identifying funding tools that are unique to the elements of the alternative(s) being advanced.
- More fully integrate rail and highway projects to achieve potential project coordination benefits  
The NHHS Rail project, CTfastrak and the I-84 Hartford project offer potential coordination strategies with the Hartford Rail AA project. Both the NHHS Rail project and CTfastrak have been successful in garnering support and funding, which could prove useful to moving the Hartford AA project forward.

CTfastrak and I-84, which both follow and cross the rail line, may also require reconstruction depending on the rail and highway options that are ultimately selected. The more these projects are coordinated, the greater the potential to reduce overall costs associated with the design and construction of these projects as compared to the individual and independent implementation of each project. There is a possibility to achieve cost efficiencies due to reduced construction costs and conflicts, right-of-way issues, and a shortened construction schedule.

The costs of all the alternatives are significant, but the cost of doing nothing is significant as well. The cost to keep the viaduct serviceable will continue to grow in coming years, and the cost of maintenance to reach “state of good repair” approaches \$200 million as described above. This significant cost to simply maintaining the aging rail viaduct infrastructure addresses the ongoing need for serviceability, but falls short of the other project needs to increase regional rail mobility, improve local connectivity, and create a gateway that spurs economic development. The cost for reconstructing the viaduct in place is nearly \$400 million, which will likewise fail to meet all of needs for this project. The key to finding funding options will be to identify a wide range of potential federal, state, and local options, recognizing that while any contributions are helpful, a truly comprehensive solution will require a significant funding outlay.

Given the highly uncertain near-term federal funding outlook, CTDOT should not expect to receive a single, large federal grant to fund the preferred rail alternative. Smaller federal grants (e.g. TIGER monies) may be viable for discrete elements of a larger rail program, as has been demonstrated by the successful grant for improvements at New Haven State Street station as part of the larger NHHS program. However, these types of grants are more likely to help “fill in the gaps” of a funding plan rather than serve as the primary funding source for the entire program.

At the state level, Governor Malloy’s “Let’s GO CT!” statewide transportation plan already includes replacing the I-84 Viaduct through Hartford and double-tracking the entire Hartford line between New Haven and Springfield, so rail viaduct improvements that are closely related to both of these initiatives are a logical extension of what has already been identified in the plan. The plan calls for “a best-in-class transportation system for the long term to be realized through a combination of ambitious statewide, corridor, and local projects across all transportation modes”. The preferred rail investment identified in part through this study process, coupled with the strong synergies between the highway and rail programs, provide a transformative opportunity that is in perfect sync with the principles of the statewide transportation plan.

6 WHAT ARE THE NEXT STEPS?

The findings and conclusions establish the case for focusing on a smaller set of remaining options as the planning process moves forward. The focus of the next phase of study, including environmental review, should be on the options that relocate the rail alignment north of I-84. This subset of rail options should be more fully detailed as part of an integrated approach that also includes highway options being considered as part of the I-84 Hartford Project.



The *Next Steps Implementation Plan* technical memorandum (April 2015) identifies strategies for advancing a rail project from the current AA stage into the next phase of study including detailed environmental review. These strategies focus on how to develop the relationship between a rail project and the I-84 project in the same corridor for the mutual benefit of both efforts. Although an independent rail reconstruction or relocation project would be a complex undertaking by itself, the complexities of such a project are greatly magnified by the concurrent efforts to reconstruct I-84. As such, it is critical to define a viable plan for advancing these two projects together in a highly coordinated manner.

The teams working on the highway and rail projects will need to join together in a cohesive manner. CTDOT will need to provide high-level oversight and guidance from a corridor perspective, rather than from the viewpoint of individual modes. One concept for addressing this need is the creation of a CTDOT multimodal oversight team. This team would include high-level staff with a comprehensive perspective of all transportation in the state, and would be tasked with providing “big picture” direction that could then be implemented by the modal teams working on the rail and highway components of the program.

It is vital that a sense of trust and collaboration be developed within the rail and highway teams, so that all team members can work toward a single common goal of implementing the best corridor solution, rather than individual modal solutions.

In summary, this situation provides the opportunity for CTDOT to create a true transportation solution, rather than a modal solution. Although new in Connecticut, there is precedent for successfully implementing multimodal corridors elsewhere across the country. Addressing this critical corridor in such a creative way is a forward-looking approach consistent with the principles of the recently-published Let’s Go CT! statewide transportation plan – a “transformative strategy to provide the transportation foundation for the future of Connecticut’s economy”<sup>2</sup>.

7 WHERE IS ADDITIONAL INFORMATION AVAILABLE?

A variety of reports and technical memorandums were developed throughout the study process. The documents presented in Table 6 can be referenced for more details about the findings summarized in this report.

<sup>2</sup> [http://www.governor.ct.gov/malloy/lib/malloy/2015.02.18\\_CTDOT\\_30\\_YR\\_Vision.pdf](http://www.governor.ct.gov/malloy/lib/malloy/2015.02.18_CTDOT_30_YR_Vision.pdf)

Table 6: Alternative Analysis Documents for Reference

Report / Technical Memorandum	Purpose of Document	Submittal Date
<i>Peer Review Memorandum</i>	<ul style="list-style-type: none"><li>Investigates rail relocation projects that have been completed in other cities to determine the reasons for the reconfiguration and lessons learned from those projects.</li></ul>	January 2014
<i>Review of Previous Studies</i>	<ul style="list-style-type: none"><li>Review and assess pertinent previous studies that address planned projects in the vicinity of Hartford Union Station.</li><li>The data helped to inform the development of specific alternatives for the reconstruction and/or replacement of the rail viaduct.</li></ul>	March 2014
<i>Project Overview and Summary of Need</i>	<ul style="list-style-type: none"><li>Establishes the basis for needed upgrades to the Hartford rail viaduct.</li><li>Defines the problem and establishes the framework for the definition of alternatives.</li></ul>	March 2014
<i>Existing Conditions</i>	<ul style="list-style-type: none"><li>Assesses of the existing conditions of the rail corridor through downtown Hartford including the rail viaduct, current and proposed rail operations, Union Station facility, and modal connections available at Union Station.</li></ul>	March 2014
<i>Description of Infrastructure Needs</i>	<ul style="list-style-type: none"><li>Identifies the infrastructure needs associated with the potential maintenance, reconstruction, or relocation of the Hartford rail viaduct adjacent to Union Station.</li><li>Serve as design guidelines for the conceptual alternatives.</li></ul>	April 2014
<i>Evaluation Criteria</i>	<ul style="list-style-type: none"><li>Identifies the evaluation criteria and process that will be used for the screening of alternatives.</li><li>Serves as the guideline for how the conceptual alternatives will be qualitatively and quantitatively assessed.</li></ul>	May 2014
<i>Initial Definition of Alternatives</i>	<ul style="list-style-type: none"><li>Describes the initial definitions of the various alternatives to be considered to address the stated project needs.</li><li>Reference point from which to evaluate the options in an objective manner.</li></ul>	August 2014
<i>Initial Screening</i>	<ul style="list-style-type: none"><li>Describes the results of the initial screening process, which is the first stage of a two-phased process to assess options to maintain, reconstruct, or relocate the rail corridor in the vicinity of Hartford Union Station.</li><li>Qualitatively examine the six alternatives to identify key challenges and constraints.</li></ul>	September 2014
<i>Refined Definition of Alternatives</i>	<ul style="list-style-type: none"><li>Describes how each alternative was refined to achieve a more precise definition of its infrastructure components.</li></ul>	November 2014
<i>Potential Funding Strategies</i>	<ul style="list-style-type: none"><li>Outlines potential funding strategies for the implementation of possible projects emerging from this AA.</li><li>Address the various alternatives considered through the screening and evaluation process.</li></ul>	May 2015
<i>Detailed Evaluation of Alternatives</i>	<ul style="list-style-type: none"><li>Presents the results of the detailed evaluation analysis that was undertaken on the refined definitions of alternatives for the Hartford rail viaduct.</li><li>Described a more rigorous planning-level assessment of the strengths, weaknesses, benefits, costs, and impacts of each rail option, building upon the initial screening process.</li></ul>	May 2015
<i>Next Steps Implementation Plan</i>	<ul style="list-style-type: none"><li>Identifies strategies for advancing a rail project from the current AA stage into the next phase of study including detailed environmental review.</li><li>Focus on how to develop the relationship between a rail project and the I-84 project in the same corridor for the mutual benefit of both efforts.</li></ul>	May 2015