I-90 Allston Multimodal Project, Boston, MA

Notice of Project Change

INTERSTATE 90
ALLSTON
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Appendix F| Climate Change and Resiliency

February 18, 2022

I-90 Allston Multimodal Project
Boston, MA

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Appendix F: Climate Change and Resiliency

Submitted to:
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1.0 Introduction

Climate-related hazards are projected to pose increasing threats to the viability and resiliency of infrastructure. The 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan[1] anticipates increasing severity, duration, and/or frequency of several natural hazards as the Commonwealth experiences climate change.[2] This section reviews the potential vulnerability and resiliency of the proposed alternatives to (tropical and extra-tropical) storm-related coastal flooding and to extreme temperatures.

The Massachusetts Climate Change Clearinghouse (resilientMA) provides downscaled climate change projections for the Commonwealth to support "scientifically sound and cost-effective decision-making" (MEMA & EOEEA, 2018) around climate change planning. While the magnitude of eustatic (global) and isostatic (local) sea level rise is not anticipated to affect the Project Area (due to the control and management of the Charles River Dam), the Project Area may experience coastal flooding if the Charles River Dam is overtopped or flanked due to more frequent and more intense coastal storms (storm surge) coupled with sea level rise. If the flanking and overtopping of the dam is addressed, future long-term flood vulnerabilities in the Project Area would be limited to river discharge and stormwater inundation.

Projected increases in average, maximum, and minimum temperatures over the next century may result in fewer days below freezing as well as increased incidence of extreme heat. These changes in temperature may have impacts on the roadway as well as on the broader Project Area.

The Resilient MA Action Team (RMAT) "Climate Resilience Design Standards and Guidelines" project developed guidance for state-funded projects to enhance how the Commonwealth assesses climate resilience as part of its capital planning process. This project is implementing priority actions from the State Hazard Mitigation and Climate Adaptation Plan (SHMCAP). Opportunities for flexible adaptation will be explored further, and appropriately tied to exposure and risk tolerance over the design life of the project following RMAT Climate Resilience Design Standards & Guidelines, in the SDEIR.

2.0 Analysis and Results

2.1 Coastal Inundation

2.1.1 Methodology and Assumptions

The Massachusetts Coastal Flood Risk Model (MC-FRM) was developed for MassDOT to assess how climate change may influence future coastal flooding vulnerabilities for highways and other transportation infrastructure throughout the coastline of Massachusetts.[12] The model is based on mathematical representations of the hydrodynamic processes that affect water levels along the coast, including tides, waves, winds, storm surge, sea level rise, wave set-up, wave run-up and overtopping. MC-FRM tightly couples the ADvanced CIRCulation model's (ADCIRC) predictions of storm surge inundation with the unstructured version of Simulating WAves Nearshore (UNSWAN) model's prediction of storm-induced waves.

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[1] MEMA and EOEEA. 2018. Massachusetts State Hazard Mitigation & Climate Adaptation Plan. https://resilientma.org/shmcap-portal/index.html#/

[2] Douglas, E., P. Kirshen, B. Fradkin, and R. Baker. 2018. Chapter 3: Modeling current and future flooding along the lower Charles and Mystic Rivers, eastern Massachusetts. In E. Douglas. 2018. Assessing the impacts of current and future flooding along the Charles and Mystic Rivers. Prepared for Sen. William N. Brownsberger (MA State Legislature). January 8, 2018.

The MC-FRM quantitatively incorporates sea level rise and climate change influences on tides, waves, storm track, and storm intensity for future time horizons, providing discrete risk estimates in those future years to assist with both near- and long-term planning.

The model brackets sea level rise scenarios for four distinct time periods (Present, 2030, 2050, 2070) and makes adjustments for local subsidence. The sea level rise inputs for MC-FRM are derived from the State's probabilistic projections for relative mean sea level elevation (DeConto and Kopp, 2017) available on the Massachusetts Climate Change Clearinghouse. As summarized in Table 2.1.1-1, the projections under "Intermediate," "Intermediate High," "High," and "Extreme" RSLR scenarios account for a range of assumptions regarding how much global greenhouse gas emissions, ocean thermal expansion, and melting of glaciers and ice sheets will occur and when. All four scenarios anticipate continued acceleration of sea level rise. The State selected the "High" scenario for planning purposes. The High scenario projections are conservative in nature, in that they are very unlikely to underpredict sea level rise across a spectrum of potential greenhouse gas emissions futures (Representative Concentration Pathways or RCPs) that do not meet the targets of the Paris Agreement (both rising or slowly declining scenarios) even when accounting for contributions from ice sheet melt. This scenario used in MC-FRM projects mean sea level in Boston to be no more than 1.3 feet above the 2008 baseline (updated 1999-2017 tidal epoch) by 2030, no more than 2.5 feet above the baseline by 2050, and no more than 4.3 feet above the baseline by 2070. The extreme (maximum physically plausible) scenario was not considered in the model. For reference, the Intermediate scenario a 50% or higher chance of underpredicting sea level rise across the spectrum of potential greenhouse gas emissions futures when factoring in ice sheet melt, and is therefore not ideal for planning large and potentially vulnerable infrastructure projects.

Table 2.1.1-1: Relative mean sea level (ft-NAVD88) projections for Boston, MA

Scenario	Cross walked probabilistic projections	2030	2050	2070	2100
Intermediate	Unlikely to exceed (83%) under RCP8.5	0.7	1.4	2.3	4.0
	• Extremely unlikely to exceed (95%) under RCP 4.5				
	• About as likely as not to exceed (50%) under RCP 4.5 when accounting for possible ice sheet instabilities				
Intermediate-High	Extremely unlikely to exceed (95%) under RCP 8.5	0.8	1.7	2.9	5.0
	• Unlikely to exceed (83%) under RCP 4.5 when accounting for possible ice sheet instabilities				
	• About as likely as not to exceed (50%) under RCP 8.5 when accounting for possible ice sheet instabilities				
High	Extremely unlikely to exceed (99.5%) under RCP 8.5	1.2	2.4	4.2	7.6
	• Unlikely to exceed (83%) under RCP 8.5 when accounting for possible ice sheet instabilities				
	• Extremely unlikely to exceed (95%) under RCP 4.5 when accounting for possible ice sheet instabilities				
Extreme (Maximum physically plausible)	Exceptionally unlikely to exceed (99.9%) under RCP 8.5	1.4	3.1	5.4	10.2
	• Extremely unlikely to exceed (95%) under RCP8.5 when accounting for possible ice sheet instabilities				
2008 (1999-2017 epoch) mean sea level at Boston tide gage was -0.09 feet (NAVD88)					

For coastal storms, MC-FRM evaluates a statistically-robust sample of storms (including hurricanes, tropical storms, and nor'easters) based on the region's existing and evolving climatology (using 5 various global climate models), to estimate the composite (SLR, storm surge, river discharge) probability of flooding. The composite probability of flooding is the chance that a given location in the model will be inundated at least once in any given year under the assumed climate scenario. These inundation probabilities allow asset managers and planners to incorporate risk tolerance into vulnerability assessments and develop appropriate and strategic adaptation interventions. Coastal storm flooding probabilities are presented as a percent annual chance of occurrence; for example, a 1% annual chance storm event has a 1 in 100 chance of occurring each year, and can also be said to have a 1% coastal flood exceedance probability (CFEP).

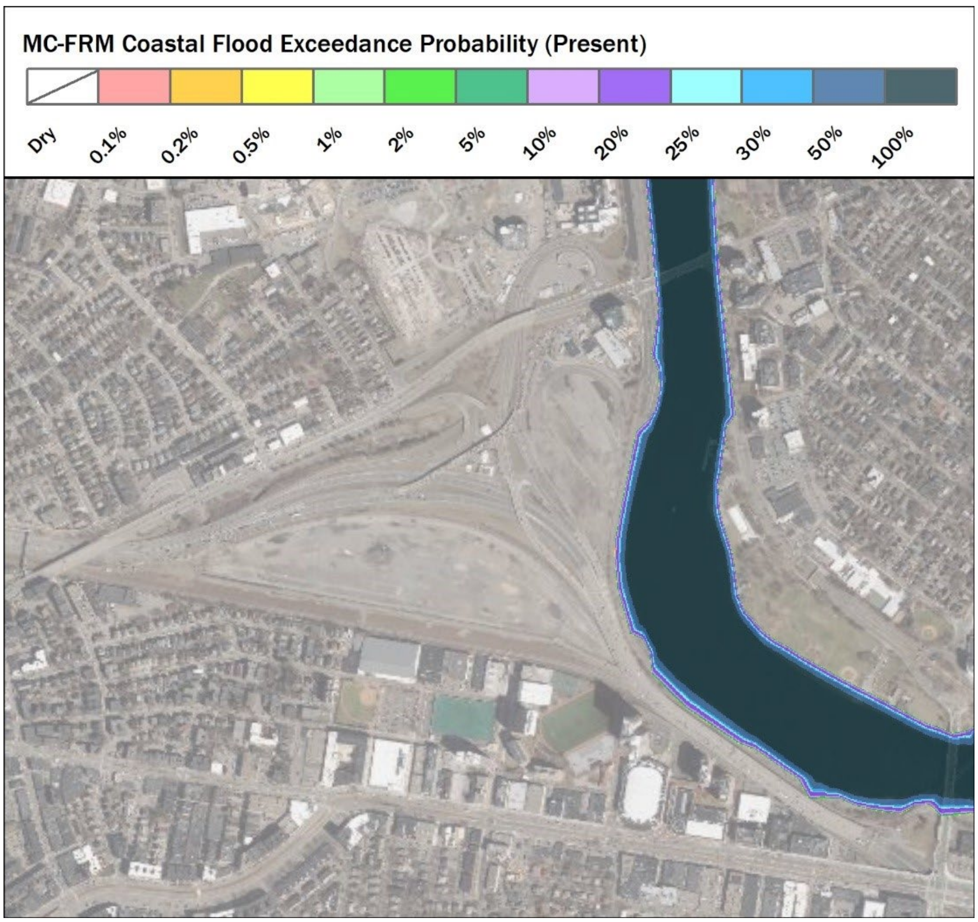
A key aspect of potential flooding in Boston, and in particular at the proposed I-90 Allston Interchange site, includes the influence of the Charles River running through the city and discharging into Boston Harbor. The Charles River was included in the model to evaluate the combined impact of watershed discharge and storm surge based flooding. MC-FRM also simulates flow conditions under storm scenarios (dam closure and pumping) at the New Charles River Dam, allowing for the assessment of pumping operations in managing upstream water levels. In all storm cases for all year scenarios, MC-FRM applies the corresponding present or future 100-year, 24-hour discharge peak, as developed by Douglas et al. (2018), as a constant flow rate to the river. As articulated in the model, the New Charles River Dam is managed to maintain the upstream basin between elevations of 106.5 and 108.5 feet (Metropolitan District Commission [MDC] Datum equals 0.05 to 2.05 feet NAVD88 datum). Three pumps are activated when the operator perceives the water level will exceed elevation 108 (MDC Datum= 1.55 NAVD88), and all six can be activated as needed per the operational guidance. Each pump has a capacity of 1,400 cfs. When a storm is in the forecast, pumps also are activated to proactively reduce the water level in the river to accommodate increased discharge storm waters.

Although MC-FRM accounts for increased Charles River discharge due to climate induced increases in precipitation and overbank flooding, the model does not include precipitation based flooding in the Study Area from upland sources (i.e. stormwater runoff). In other words, MC-FRM does not include potential backups in piped infrastructure, or poor drainage conditions at a specific site. Since precipitation is projected to increase with climate change, these stormwater flooding impacts are also expected to intensify.

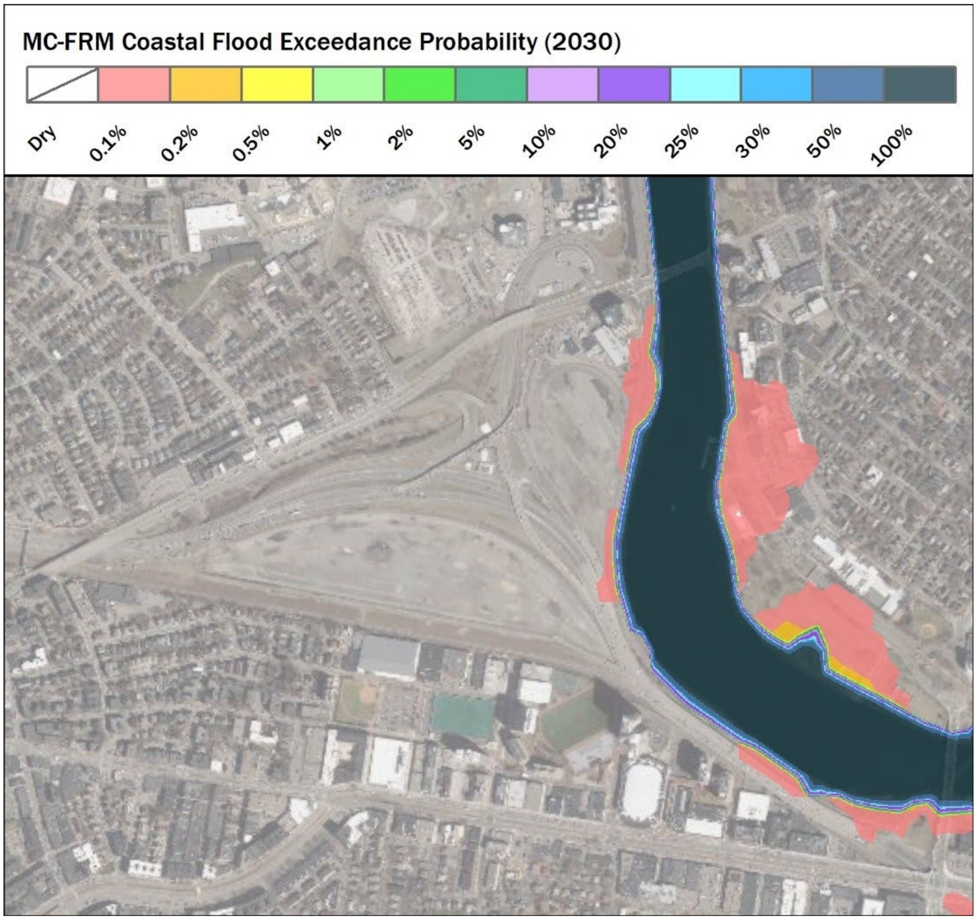
The spatial resolution of the model is intended to capture important changes in topography and physical processes related to storm dynamics. It is important to note that MC-FRM probability and depth data is determined utilizing ground elevations. As buildings and infrastructure within the project area are above ground level, depth of flooding data is important to identify if, for example, water levels will encroach upon a bridge.

2.1.2 No Build

As shown in Graphics 2.1.2-1 and 2.1.2-2, MC-FRM results for Present Day and 2030 conditions predict no chance of flooding in the Project Area outside of the banks of the Charles River at or above the 1% annual chance storm event. 2030 projections indicate only low-probability (0.1% annual chance event) edge flooding along isolated segments of the riverbank within the project. In both these conditions, river discharge does not exceed the dam's pumping capacity and the dam is not expected to be flanked by coastal storm surge. Coastal inundation of the Project Area is only projected to occur when the Charles River Dam is flanked by storm surge (2050 and beyond, based on current modeling). Performance modeling conducted for the City of Cambridge indicates that if the issues of flanking and overtopping of the Charles River Dam (including the flood pathway from Schrafft Center and Sullivan Square in Charlestown) were addressed, future long-term flood vulnerabilities in the Project Area would be limited to river discharge and stormwater inundation through 2070. The U.S. Army Corps of Engineers (USACE) and Massachusetts Department of Conservation and Recreation (DCR) are currently developing a study to assess the climate resiliency of the Charles River Dam.



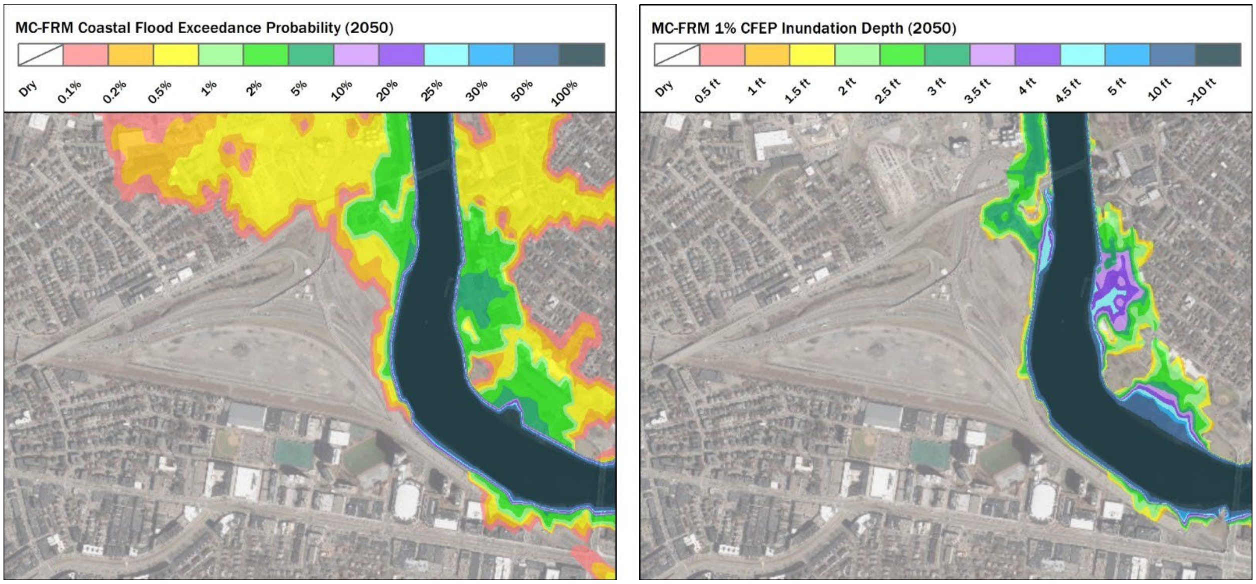
Graphic 2.1.2-1: MC-FRM Coastal Flood Exceedance Probability – Present



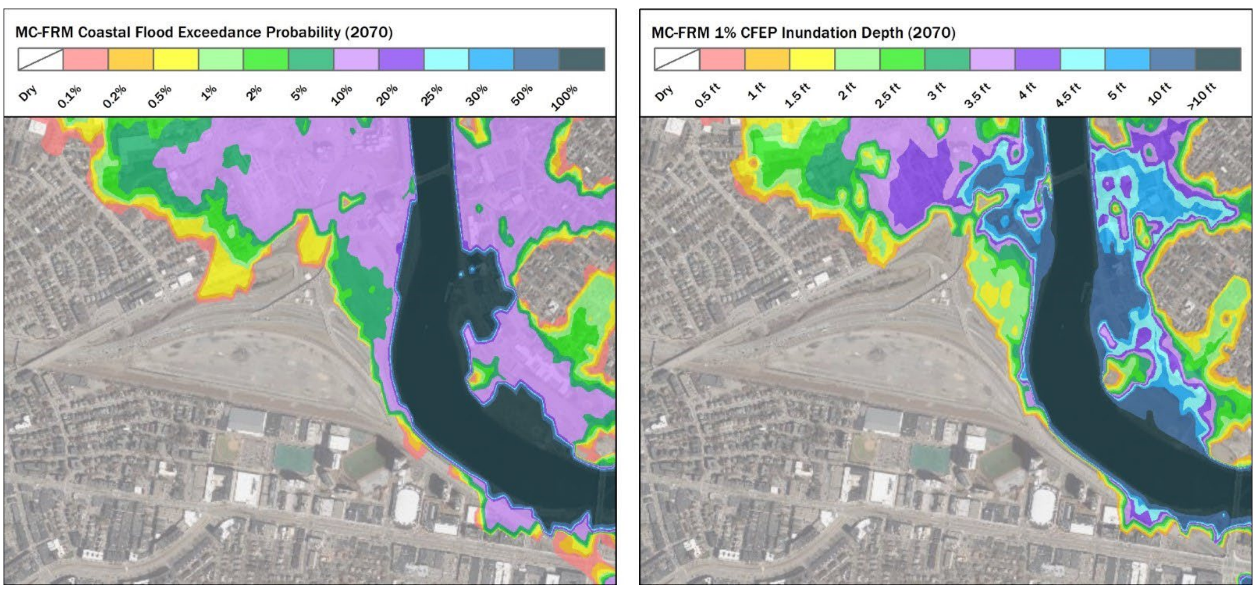
Graphic 2.1.2-2: MC-FRM Coastal Flood Exceedance Probability – 2030

As shown in Graphic 2.1.2-3, under 2050 climate projections, MC-FRM predicts a 2% annual chance storm (or stronger) would produce combined coastal/riverine flooding along the banks of the Charles River, penetrating further inland near Cambridge Street. 2050 inundation during the 1% annual chance event is projected to be more extensive at the northern end of the Project Area, affecting the current layout of the PDW Path, SFR, and a portion of Cambridge Street, extending up to about 700 feet inland. Flooding at this level would cause temporary disruption to traffic, and potentially cause permanent damage to infrastructure.

As shown in Graphic 2.1.2-4, MC-FRM results for 2070 conditions predict more extensive and higher probability edge flooding along the entire Project Area adjacent to the Charles River. Under 2070 climate projections , MC-FRM predicts a 10% annual chance storm (or stronger) would produce combined coastal/riverine flooding along the banks of the Charles River, penetrating further inland near Cambridge Street (up to about 2,600 feet inland). At the 2070 1% annual chance event, flooding may impact the entire length of the current PDW Path and SFR layout in the Project Area, extend across the railway under I-90 at the eastern end of the Project Area and into the BU campus, and extend further into the Cambridge Street interchange area at the northern end of the Project Area. Flooding hazards would extend up to about 3,000 feet inland. Furthermore, inundation depths would increase as high as 10 feet above SFR and adjacent development, decreasing in depth the further inland the flood extends. Flood depths of this magnitude are anticipated to cause permanent damage to infrastructure and pose a serious risk to public health and safety.



Graphic 2.1.2-3: MC-FRM Coastal Flood Exceedance Probability and 1% CFEP Inundation Depth – 2050



Graphic 2.1.2-4: MC-FRM Coastal Flood Exceedance Probability and 1% CFEP Inundation Depth – 2070

2.1.3 Build Alternative

The proposed Project and Throat Area alternatives will result in changes to road surface elevations as well as to the grading of the land in the Project Area. Final grading plans were not available for the proposed actions at the time of this analysis, so it was not possible to run MC-FRM with new topographic and frictional information. Therefore, the assessment of vulnerability to climate change impacts proceeded with the parallel review of:

- Proposed road surface elevations extracted from the design documents,
- Existing LiDAR data, Plan-view and cross-sectional diagrams for the proposed project elements, and
- MC-FRM coastal flood exceedance probability (CFEP) curves for the Charles River in 2050 and 2070 (when coastal flooding is projected to flank the Charles River Dam).

Potential future flooding of proposed roadway segments and land in the Project Area was evaluated by comparing 2050 and 2070 CFEP water surface elevations (WSEs) extracted from MC-FRM to proposed road surface elevations and the existing topography, with due consideration to the condition of all proposed segments (i.e. whether roadway segments in the proposed actions have been designed as at-grade, fill, bridge, or underpass). Table 2.1.3-1 summarizes the water surface elevations for the 2050 and 2070 coastal flood exceedance probability curves for the Charles River used in this analysis.

In advancing project alternatives, reference to the Massachusetts RMAT Climate Resilience Design Standards & Guidelines (resilientma.org/rmat_home/designstandards/) should be made. The RMAT tool uses the latest climate projections to generate a preliminary climate exposure, risk rating, and recommended design standards for projects. The tool also provides guidelines and forms to help project managers integrate site suitability, regional coordination, and flexible adaptation considerations into climate resilient planning and design. For the purposes of this work, the MC-FRM model represents the best available science regarding flood hazard exposure. It is important to note that RMAT requires consideration of target design flood elevations based on flood hazards, but if they can't be feasibility met, the basis of design must explain why and aim to accommodate such hazards by incorporating flexibility, such as a phasing strategy, into design.

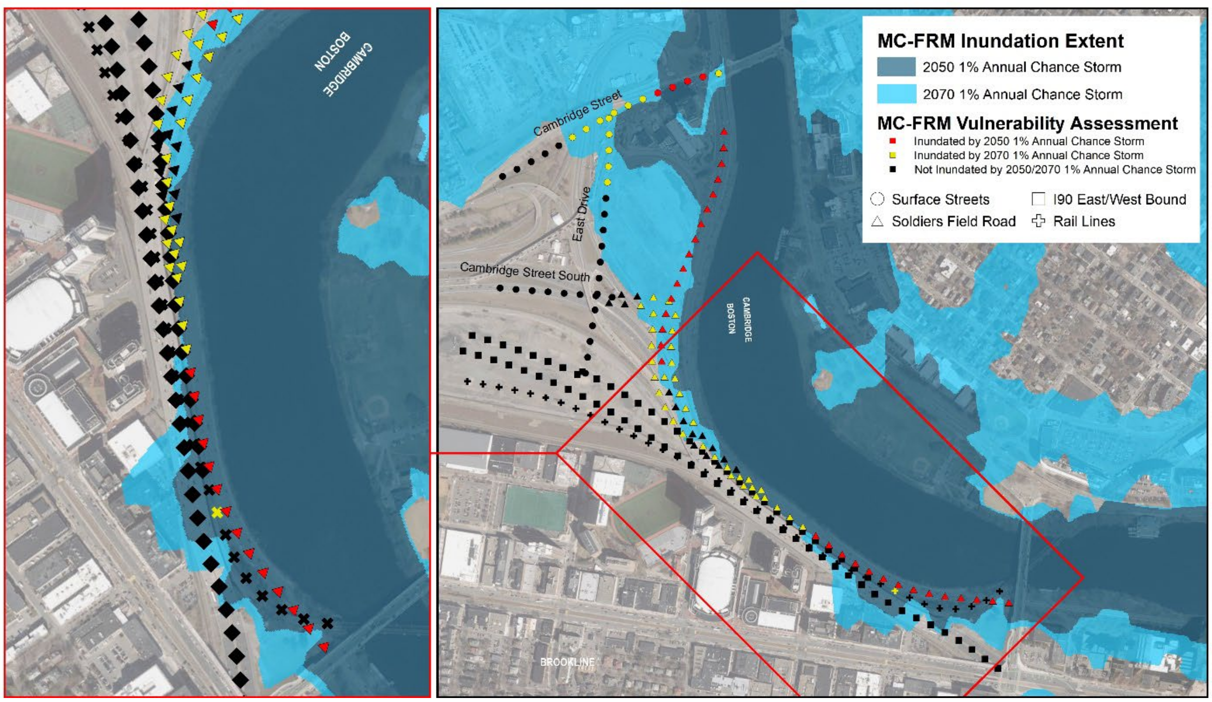
Table 2.1.3-1: 2050 and 2070 Water Surface Elevations

Exceedance Probability	0.1%	0.2%	0.5%	1%	2%	5%	10%	20%	25%	30%	50%	100%
2050 WSE (ft NAVD88)	**11.4**	**10.8**	**10.0**	**9.3**	**——Charles River managed water level (2.1 ft. NAVD88) ——**							
2070 WSE	**13.7**	**13.2**	**12.5**	**12.0**	**11.4**	**10.7**	**10.2**	**9.6**	**Charles River managed water level (2.1 ft. NAVD88)**			

The 2050 1% annual chance event water surface elevation used in this analysis is 9.3 ft NAVD88. The 2070 1% annual chance event water surface elevation used in this analysis is 12.0 ft NAVD88. MC-FRM indicates flanking of the Charles River Dam at the 1% annual chance event in 2050 and the 20% annual chance event in 2070, during which coastal storm surge would flood the Charles River Basin above the managed 2.1 ft NAVD88 water level.

2.1.3.1 Modified Highway Viaduct

The Modified Highway Viaduct roadway layout in the Project Area compared to MC-FRM projected 1% annual chance flooding (existing conditions) for 2050 and 2070 is shown in Graphic 2.1.3-1. Roadway surface elevations were extracted from Modified Highway Viaduct design drawings at regular intervals for comparison to MC-FRM 1% annual chance event WSEs. This analysis shows that 2050 1% annual chance coastal flooding may impact Cambridge Street, the northern end of East Drive, portions of SFR at the northern and southeastern extents of the Project Area (including the underpass), and potentially a small portion of I-90 at the Commonwealth Avenue underpass (depending on final grading of the adjacent land). 2070 1% annual chance coastal flooding may impact additional portions of Cambridge Street and East Drive, additional portions of SFR (only a small segment south of the underpass is not vulnerable), and large portions of both SFR ramps. In this variant, most of I-90 is not vulnerable to future flooding due to the elevated viaduct design. Although final grading is not yet available, the current Modified Highway Viaduct layout is not expected to significantly mitigate future flooding in the northern portion of the Project Area, but the railways below the viaduct may provide some flood protection to the vulnerable portion of the BU campus.



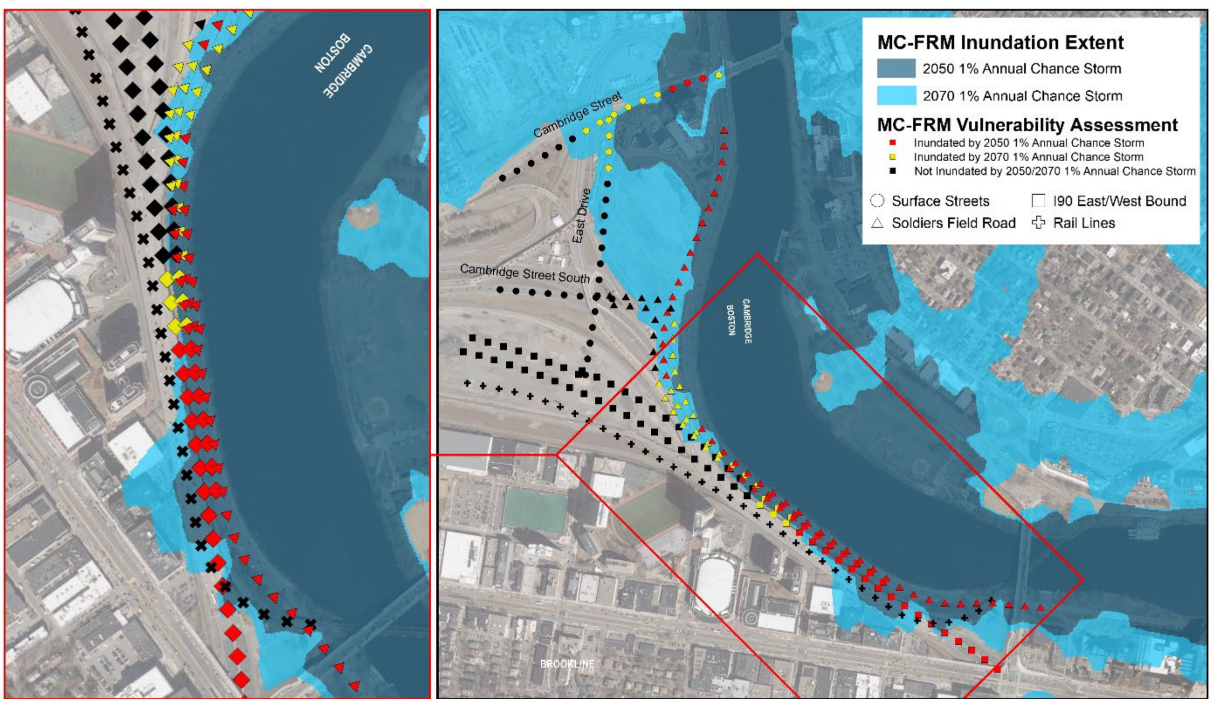
Graphic 2.1.3-1: Modified Highway Vulnerability – 3L Realignment Plan

The Modified Highway Viaduct Throat layout compared to MC-FRM 1% and 0.2% annual chance event water surface elevations for 2050 and 2070 is shown in Figures 1-2. This cross-sectional analysis in the potentially vulnerable eastern portion of the Throat shows that the PDW Path and SFR (westbound and eastbound) are vulnerable to flooding in 2050 and 2070. The GJR and WML are also potentially vulnerable to flooding in 2050 and 2070, depending on location. I-90 is not vulnerable to future coastal flooding according to this analysis since it is elevated on the viaduct. There is potential for flooding in western portions of the Modified Highway Viaduct Throat (Sections 1 and 2) to convey to eastern portions of the Throat, flanking the elevated GJL berm and inundating WML (Section 4).

For the Modified Highway Viaduct, flood vulnerability in the Throat could be mitigated by elevating the PDW Path and associated open space, building a flood barrier in the PDW open space, or constructing a flood barrier system along the outer piers of the viaduct (which would only protect the railway). In the northern portion of the Project Area, adding elevation to landscape elements and/or at-grade roadways (SFR and Cambridge Street) would enhance resilience of both the project and future development in the vicinity.

2.1.3.2 Modified At-Grade

The Modified At-Grade roadway layout in the Project Area compared to MC-FRM projected 1% annual chance flooding (existing conditions) for 2050 and 2070 is shown in Graphic 2.1.3-2. Roadway surface elevations were extracted from Modified At-Grade design drawings at regular intervals for comparison to MC-FRM 1% annual chance event WSEs (Table 2.1.3-1). This analysis shows that 2050 1% annual chance coastal flooding may impact Cambridge Street, most of Soldiers Field Road (including the underpass), lower sections of both SFR and I-90 ramps, as well as the portion of I-90 from the throat to the Commonwealth Avenue underpass. 2070 1% annual chance coastal flooding may impact additional portions of Cambridge Street, the northern end of East Drive, additional parts of both SFR and I-90 ramps, and additional portions of I-90 west of the Throat. Although final grading is not yet available, the current Modified At-Grade layout is not expected to significantly mitigate future flooding in the northern portion of the Project Area, but the elevated fill railway may provide some flood protection to the vulnerable portion of the BU campus.



Graphic 2.1.3-2: Modified At-Grade Vulnerability – 3L Realignment Plan

The Modified At-Grade roadway layout in the Project Area compared to MC-FRM 1% and 0.2% annual chance event water surface elevations for 2050 and 2070 is shown in Figures 3-4. This cross-sectional analysis in the potentially vulnerable eastern portion of the Throat shows that the PDW Path, SFR (westbound and eastbound), and I-90 (westbound and eastbound) are vulnerable to flooding in 2050 and 2070. The GJR and WML lines are both elevated on fill (or protected by other elevated landforms) and not vulnerable to future coastal flooding according to this analysis. Although I-90 in the eastern end of the Modified At-Grade Throat is inland of an elevated landscape feature and GJL rail berm, there is potential for flooding in western portions of the I-90 layout (Sections 1, 2 and 3) to convey eastward, flanking the elevated GJL berm and inundating I-90 (Section 4).

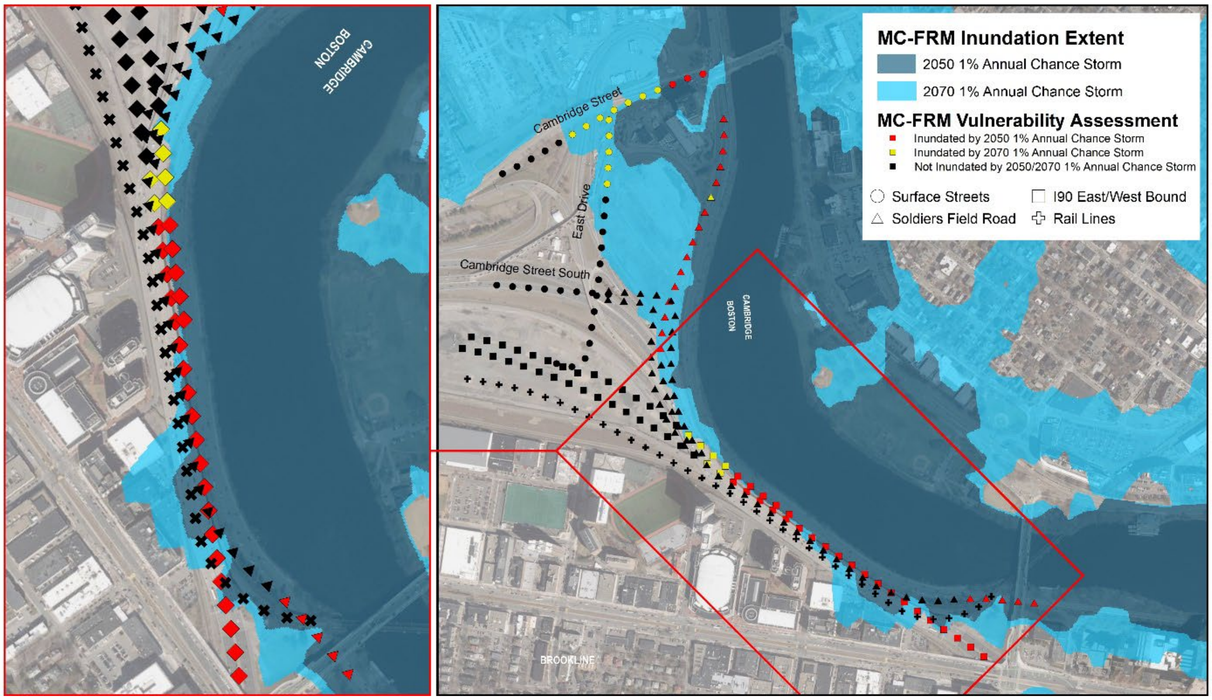
For the Modified At-Grade, flood vulnerability in the Throat could be mitigated by elevating the roadways or by constructing a flood barrier between two of the roadways (which would only protect those roadways behind the barrier). In the northern portion of the Project Area, adding elevation to landscape elements and/or at-grade roadways (SFR and Cambridge Street) would enhance resilience of both the Project and future development in the vicinity.

2.1.3.3 SFR Hybrid

The SFR Hybrid roadway layout in the Project Area, compared to MC-FRM projected 1% annual chance flooding (existing conditions) for 2050 and 2070, is shown in Graphic 2.1.3-3. Roadway surface elevations were extracted from SFR Hybrid design drawings at regular intervals for comparison to MC-FRM 1% annual chance event WSEs (Table 2.1.3-1). This analysis shows that 2050 1% annual chance coastal flooding may impact eastern portions of Cambridge Street, the northern portion of SFR (including the underpass), a small segment of SFR near the BU Bridge, a large portion of I-90, and part of the I-90 WB Ramp. 2070 1% annual chance coastal flooding may impact additional portions of Cambridge Street and East Drive, additional portions of SFR (only a small segment south of the underpass is not vulnerable) and extend slightly west on I-90 and the I-90 WB ramp. Although final grading is not yet available, the current SFR Hybrid layout is not expected to significantly mitigate future flooding in the northern portion of the Project Area, but the railways (which are elevated on fill) may provide some flood protection to the vulnerable portion of the BU campus.

The SFR Hybrid Throat layout compared to MC-FRM 1% and 0.2% annual chance event water surface elevations for 2050 and 2070 is shown in Figures 5-6. This cross-sectional analysis in the potentially vulnerable eastern portion of the Throat shows that the PDW Path and I-90 (westbound and eastbound) are vulnerable to flooding in 2050 and 2070. The GJR and WML lines, and SFR (except for a low-lying at-grade eastern section of SFR near the BU Bridge), are not vulnerable to future coastal flooding SFR is mostly elevated on the viaduct and the rail lines are elevated on fill. Although I-90 in the eastern end of the SFR Hybrid Throat is inland of an elevated landscape feature and GJL rail berm, there is potential for flooding in western portions of the I-90 layout (Sections 1, 2 and 3) to convey eastward, flanking the elevated GJL berm and inundating I-90 (Section 4).

For the SFR Hybrid, flood vulnerability to I-90 in the Throat could be mitigated if the proposed wall/fence was constructed to sufficient elevation and floodproofing standards. In the northern portion of the Project Area, adding elevation to landscape elements and/or at-grade roadways (SFR and Cambridge Street) would enhance resilience of both the Project and future development in the vicinity.



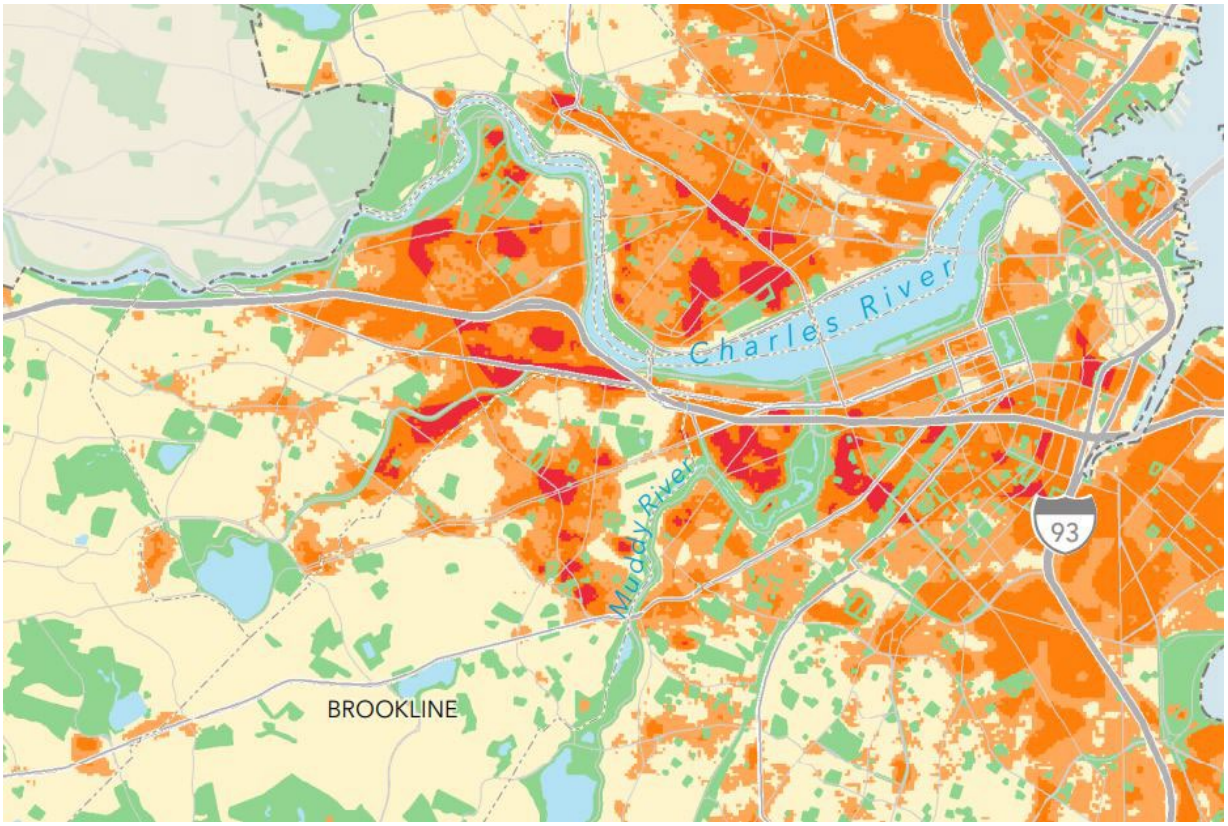
Graphic 2.1.3-3: SFR Hybrid Vulnerability – 3L Realignment Plan

2.2 Heat

Temperature projections for the Commonwealth of Massachusetts were developed by the Northeast Climate Adaptation Science Center (NECASC) using the Local Constructed Analogs statistical downscaling approach based on fourteen IPCC global climate models, selected for their applicability to the Northeast US region, and medium and high greenhouse gas emissions pathways (RCP4.5 and RCP8.5).

As shown on Graphic 2.2-1, the temperature projections for the Charles River Basin (NECASC, 2018)[3] indicate that the Project Area will experience increasing average (1), maximum, and minimum temperatures throughout the 21^{st} century. Compared to the observed baseline (1971-2000 average) of 49.4°F, annual average temperatures are projected to increase 2.7°F to 6.1°F by mid-century and 3.5°F to 10.7°F by end of century. Compared to the observed baseline (1971-2000 average) of 81.0°F, summer maximum temperatures are projected to increase 2.5°F to 6.9°F by mid-century and 3.6°F to 12.9°F by end of century. Compared to the observed baseline (1971-2000 average) of 18.8°F, winter minimum temperatures are projected to increase 2.9°F to 7.0°F by mid-century and 4.1°F to 10.3°F by end of century.

[3] National Integrated Heat Health Information System and CAPA Strategies. 2019. Heat Watch Report – Boston, Massachusetts. https://nihhis.cpo.noaa.gov/Urban-Heat-Island-Mapping/UHI-Campaigns/Campaign-Cities



Graphic 2.2-1: Temperature Projections for Charles River Basin

The projected increases in average and maximum temperatures may result in additional extreme heat days. NECASC (2018) projects that, compared to the observed baseline (1971-2000 average) of 9 days annually above 90°F, the region will experience an additional 10 to 35 extreme heat days by mid-century and an additional 15 to 76 extreme heat days by end of century. The projected increases in average and minimum temperatures may result in fewer days below freezing. NECASC (2018) projects that, compared to the observed baseline (1971-2000 average) of 136 days annually with minimum temperatures below 32°F, the region will experience 17 to 39 fewer days below freezing by mid-century and 22 to 63 fewer days below freezing by end of century.

These climate change projections for increasing temperatures, increasing frequency of extreme heat events, and decreasing frequency of below freezing conditions have several implications for the vulnerability of the proposed roadway and railway infrastructure (MEMA & EOEEA, 2018 and Gopalakrishna et al., 2013). Increasing annual average and summer maximum temperatures may result in increasing structural impacts to pavement and bridge joints due to thermal expansion and stress. Extreme heat can also cause railroad tracks to expand, increasing the risk of train derailment. Warming winters and a shifting rain/snow line may reduce the need for snow removal (reducing winter travel hazards as well as the impacts of plowing to the roadbed) but may simultaneously increase the need for stormwater and ice management as melted snow and rain accumulate and cycle above and below freezing. If temperatures fluctuate around freezing, there is also the potential for rapid freeze/thaw cycles to damage pavement and bridge joints.

The climate change projections for increasing average and maximum temperatures, and for increasing frequency of extreme heat events, also has implications for the Project Area as a whole. Urbanized areas experience heat island effects, which may be exacerbated by climate change. Since the project is set within a transportation corridor in a highly developed area, has little vegetation, and has a high proportion of impervious surface cover, it is highly vulnerable to urban heat island impacts. Metro Mayors data from July-August 2015 (TPL and MAPC, 2017)[4], using daytime and nighttime satellite imagery, identified the Project Area as an urban heat island hotspot where land surface temperatures average at least 1.25 degrees above the mean daily temperature (See Graphic 2.2-2). Additionally, a 2019 National Integrated Heat Health Information System Heat Watch Report for Boston (NIHHIS-CAPA, 2019)[5] documented the incidence and retention of high temperatures and heat index in the Project Area.

Table 2.2-1 compares existing landcover in the Project Area to the estimated landcover for the proposed alternatives. Impervious surface area is a primary driver of the urban heat island effect. Impervious surfaces in the urban fabric can be paved surfaces (such as roads, sidewalks and parking lots) or building surfaces (such as roofs). Since the proposed Project would alter roadways, these are the focus of this assessment.

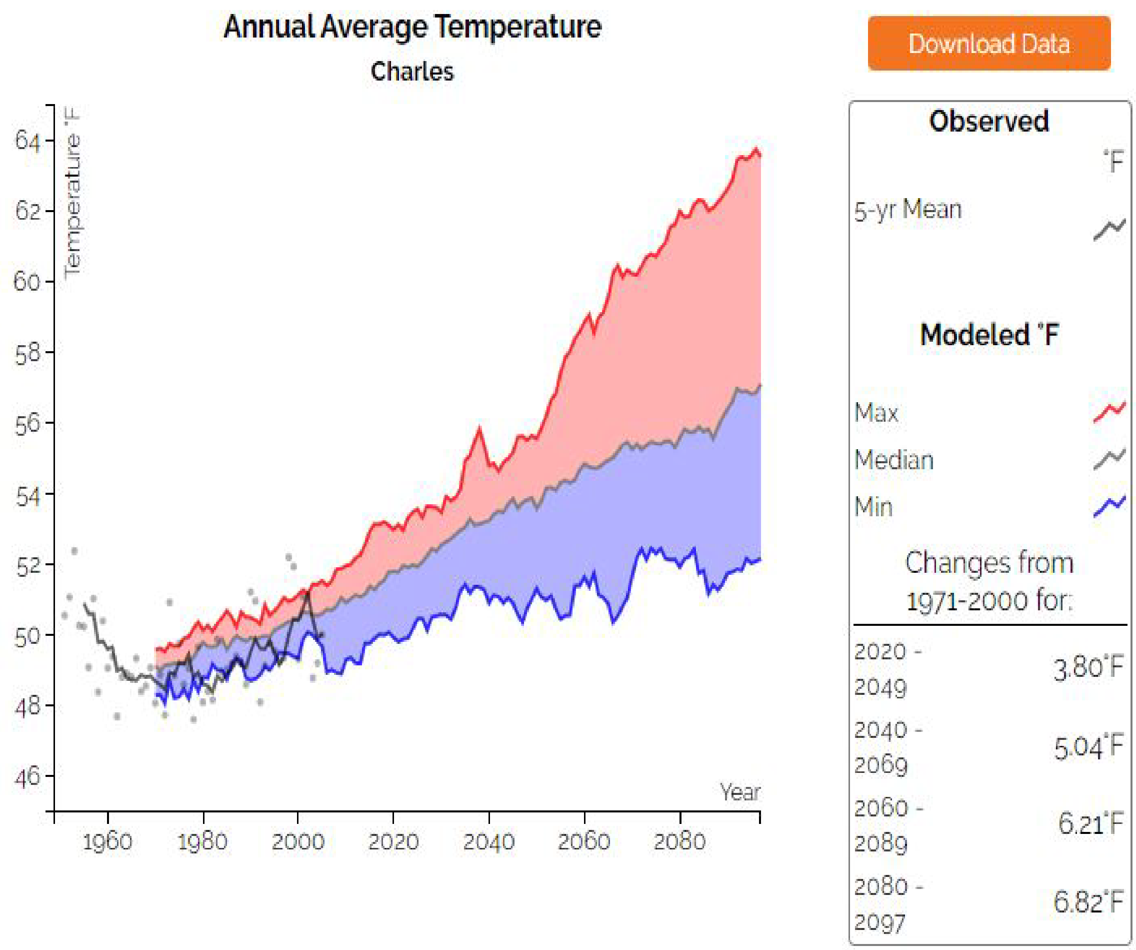
Table 2.2-1: Comparison of existing landcover in the Project Area to Estimated Landcover for the Proposed Alternatives

Cover Type	Existing	3L At Grade	3L HV	3L SFR
Impervious (acres)	78.9	77.6	77.6	77.7
Pervious (acres)	62.8	64.1	64.1	64.0

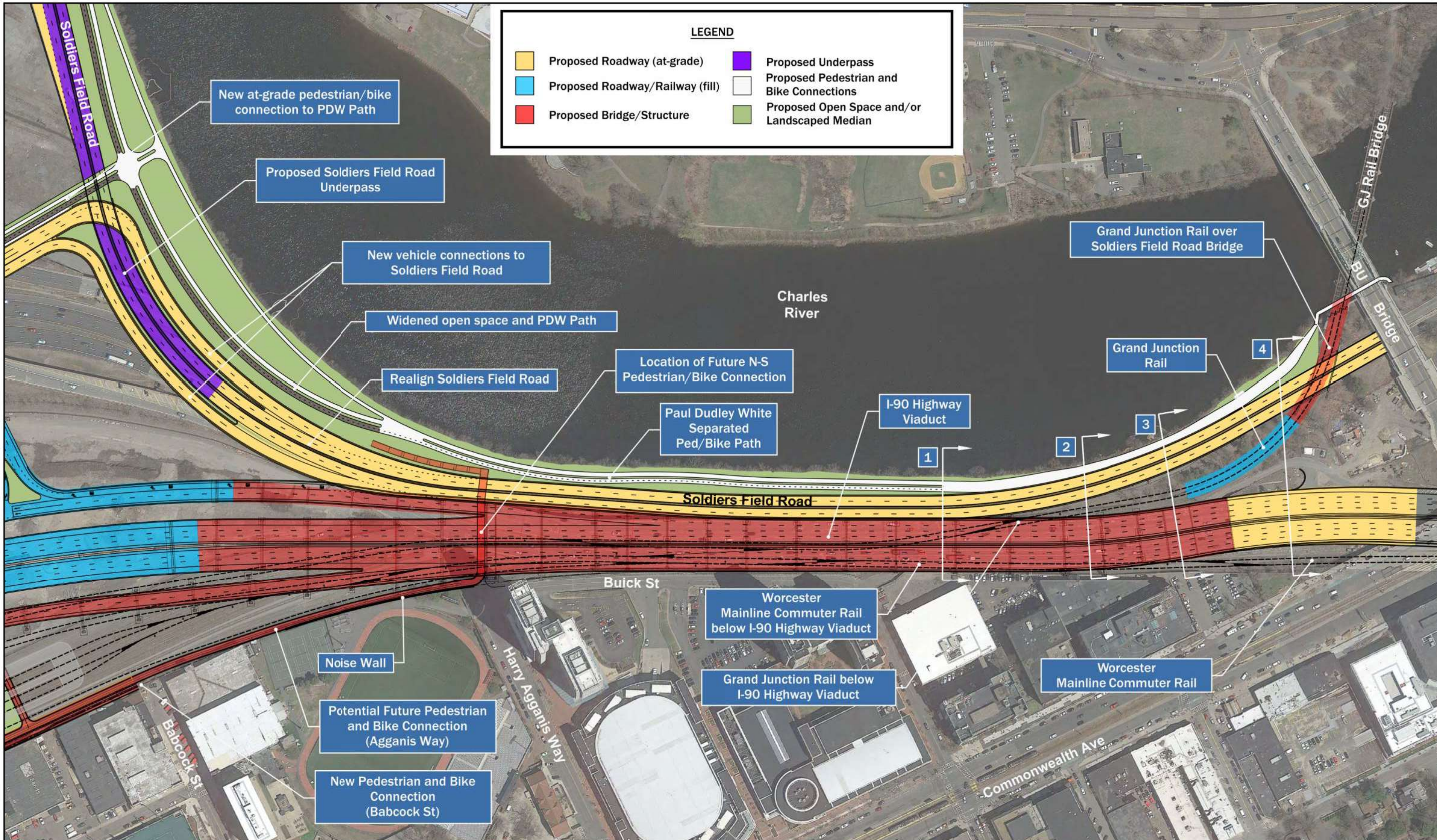
All three proposed alternatives would reduce impervious area within the Project Area from current levels. Given the relatively small reduction in impervious surface cover (1.2 to 1.3 acres depending on alternative) in the context of the Project Area, no alternative is likely to significantly reduce the urban heat island effect in the Project Area on its own. However, integration of high-albedo surfaces, street trees, and potentially increasing vegetated impervious surface area within the layout would all help to reduce heat-related impacts in the Project Area.

[4] Trust for Public Land and Metropolitan Area Planning Council. 2017. Urban Heat Islands – Climate Smart Cities: Metro Mayors Climate-Smart Region. https://web.tplgis.org/bostonmetromayorsecure/pdfmaps/ClimateSmart_MetroBoston_Cool_Combined_34x44_20171113.pdf

[5] National Integrated Heat Health Information System and CAPA Strategies. 2019. Heat Watch Report – Boston, Massachusetts. https://nihhis.cpo.noaa.gov/Urban-Heat-Island-Mapping/UHI-Campaigns/Campaign-Cities



Graphic 2.2-2: Comparison of existing landcover in the Project Area to the estimated landcover for the proposed alternatives



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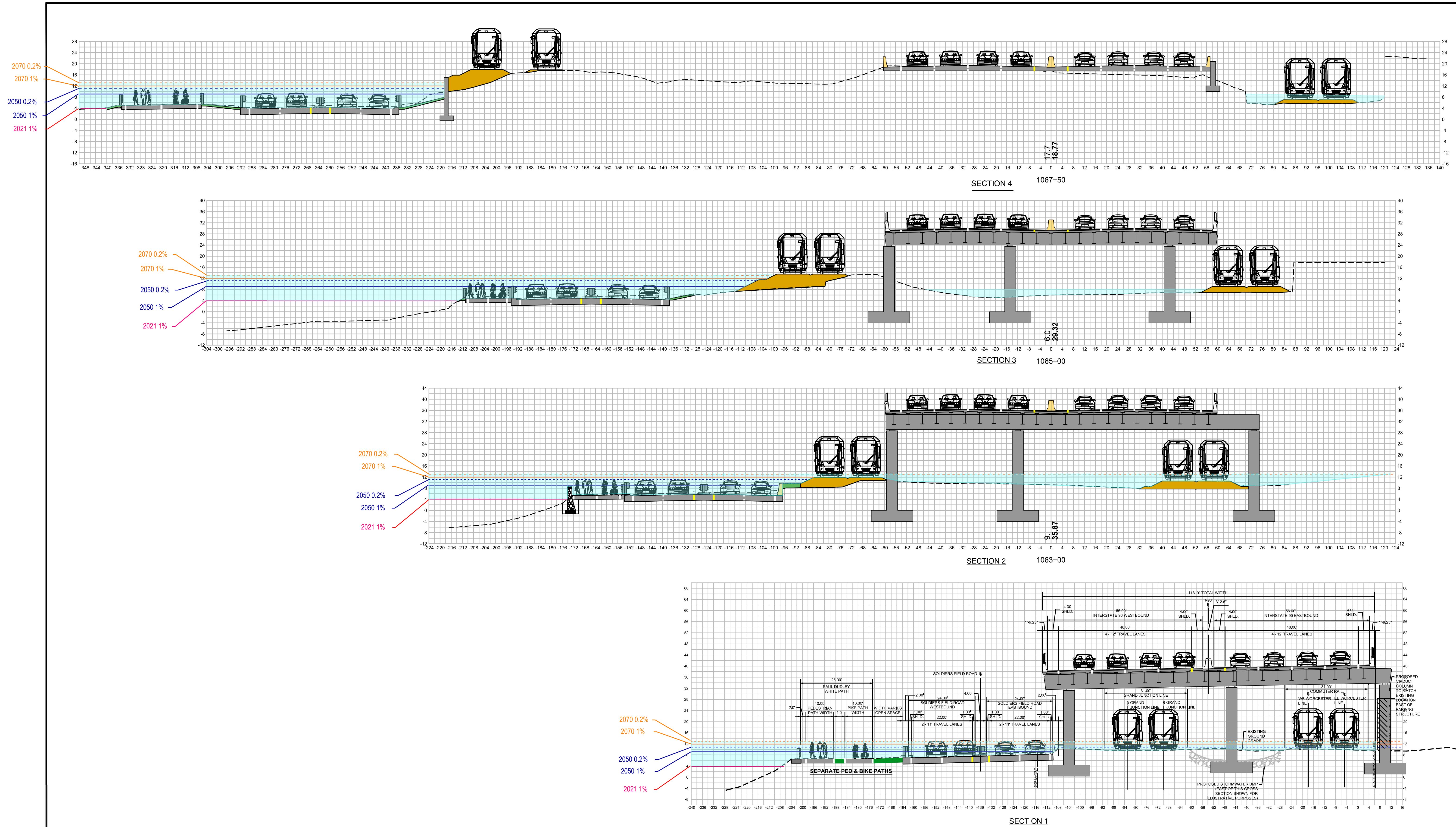
Feet

Allston Multimodal Project
Notice of Project Change

Modified Highway Viaduct Cross Section Locations

FIGURE
1

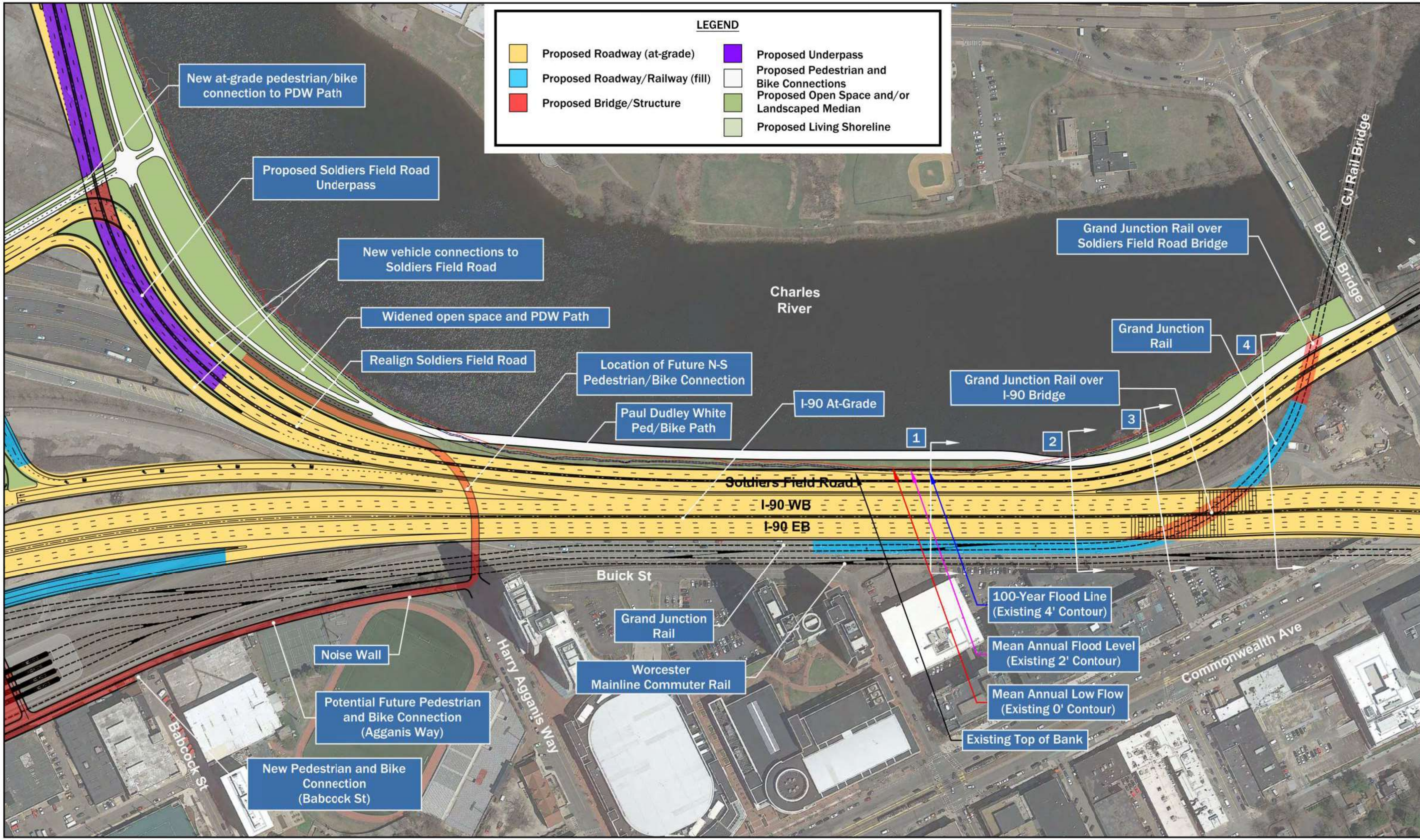


0 16' 32'
Feet

Allston Multimodal Project
Notice of Project Change

Modified Highway Viaduct Vulnerability
Throat Area Option Cross Sections

FIGURE
2



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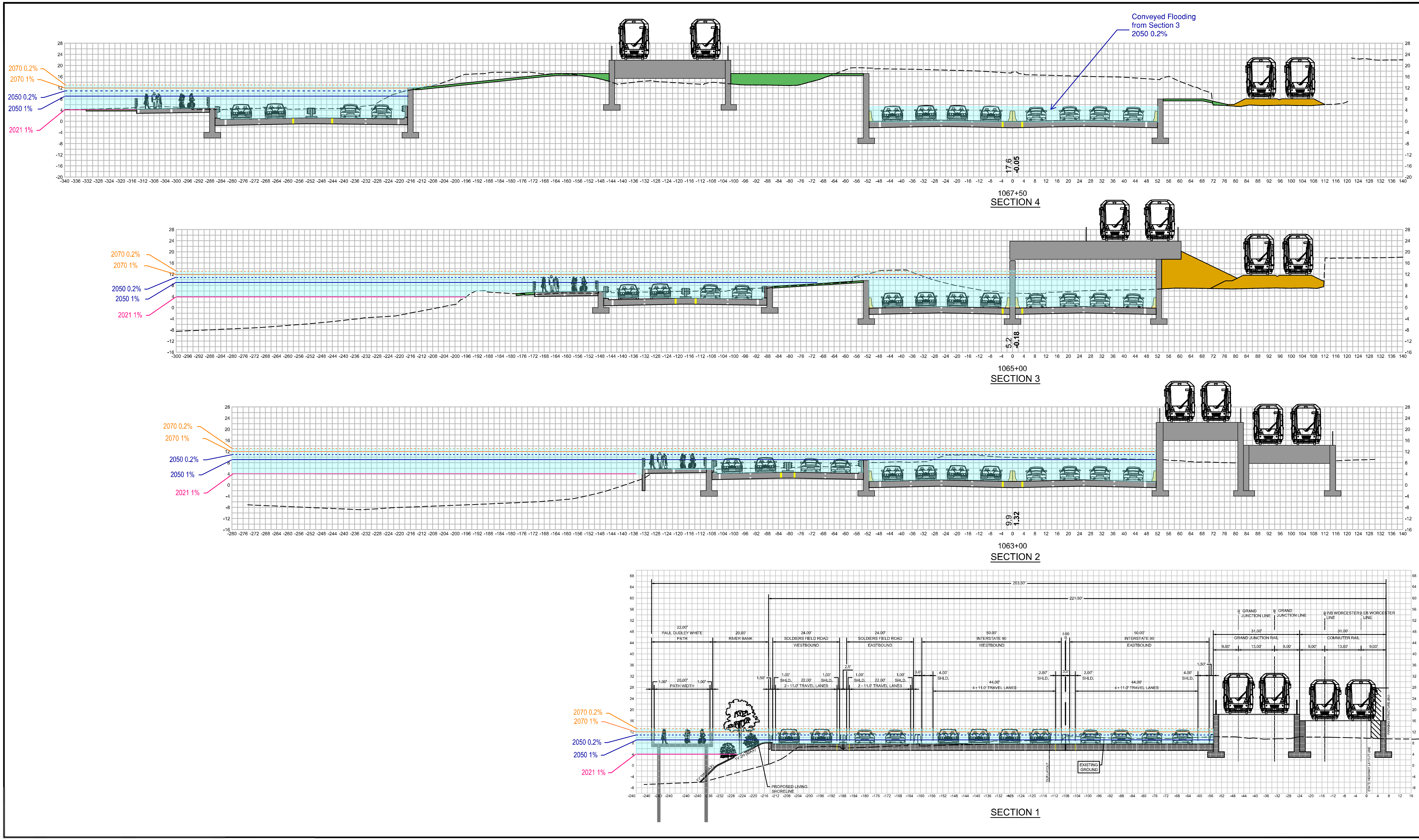
Modified At-Grade Cross Section Locations

FIGURE 3

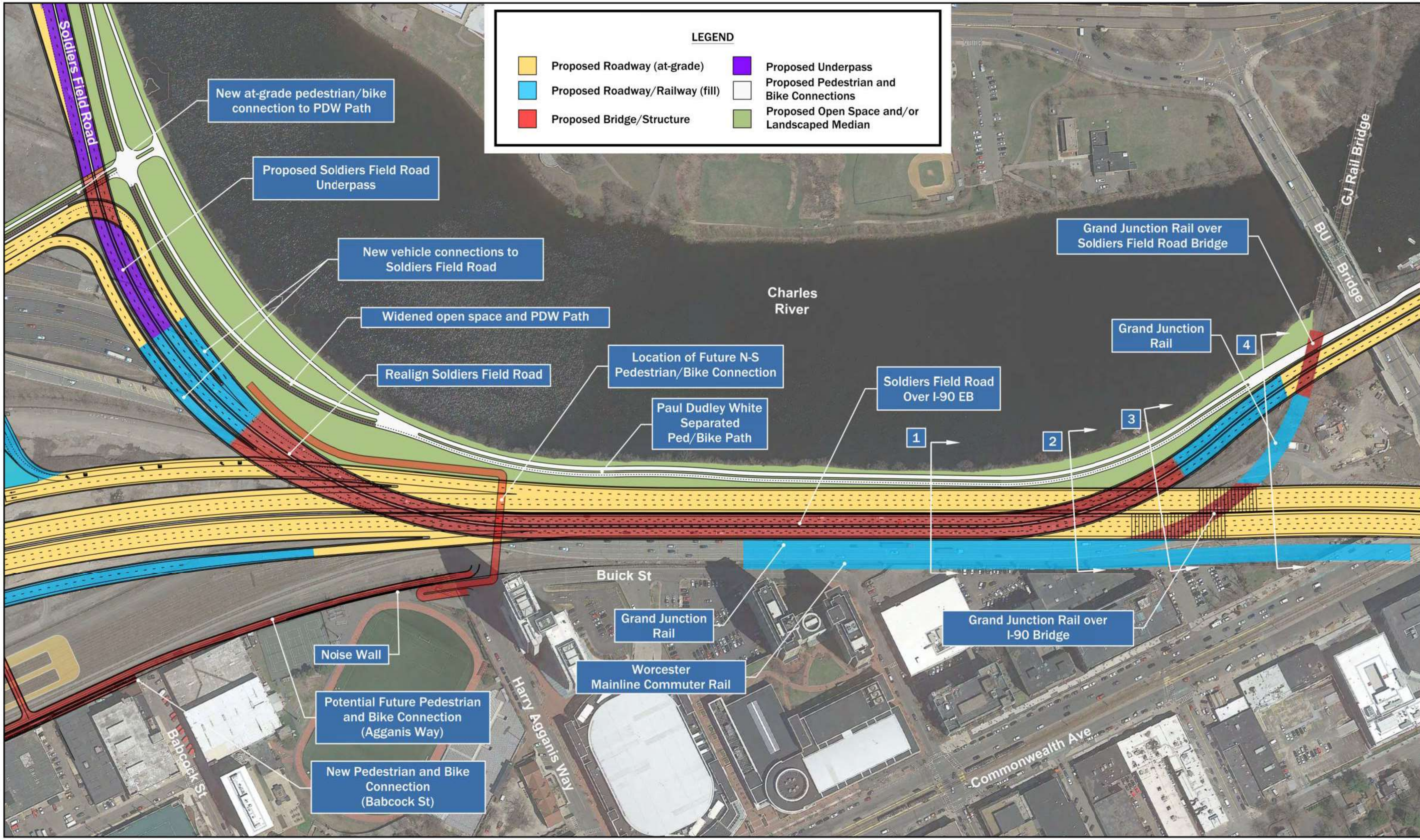


0 16' 32'
Feet

Allston Multimodal Project
Notice of Project Change

Modified At-Grade Vulnerability
Throat Area Option Cross Sections

FIGURE
4



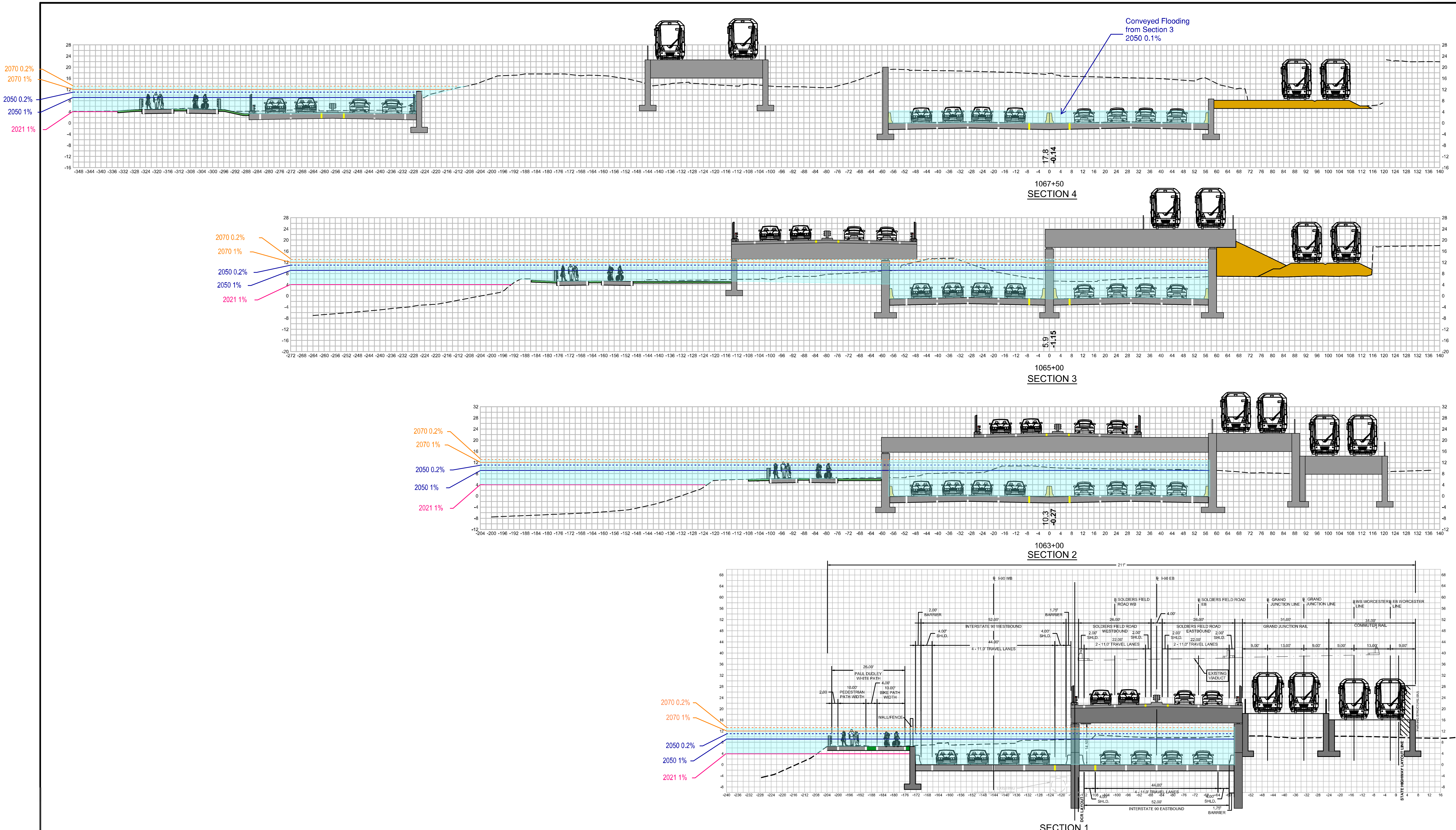
ALLSTON INTERCHANGE — INTERSTATE 90

massDOT Massachusetts Department of Transportation Highway Division

Allston Multimodal Project
Notice of Project Change

SFR Viaduct
Cross Section Locations

FIGURE 5



0 16' 32'
Feet

Allston Multimodal Project
Notice of Project Change

SFR Hybrid Vulnerability Throat Area Option Cross Sections

FIGURE 6