Basis of Design Report

Belmont BRIDGE

Belmont Bridge Replacement Project
VDOT Project: 0020-104-101-UPC #75878

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PREPARED FOR

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Revision Record

Revision	Issue Date	Pages Affected	Description of Revisions
1	03/28/18	1-4,2-5,3-6,3-7,3-8,3-10,3-11,4-12,5-13,5-14,5-16	Comments from Jeanette Janiczek and Amanda Poncy.

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CHAPTER 1 INTRODUCTION

This report is the basis of design (BOD) for the engineering elements of the Belmont Bridge Replacement Project. This report has been prepared based on project planning meetings, data collection, and input from the project stakeholders gathered during the public engagement process. The BOD serves as a record to document design criteria and project decisions made during the design development process that affect the development of the Belmont Bridge replacement.

Field survey, utility survey, a traffic study, conceptual structural analysis, steering committee and technical committee meetings, stakeholder groups and public input supported the development of the BOD for the project.

The Belmont Bridge in Charlottesville, Virginia is scheduled for replacement as part of VDOT Project 0020-104-101, UPC 75878. The vision for the Belmont Bridge is to provide a community connection for bikes, pedestrians, buses, and cars between the surrounding neighborhoods and the City's downtown/urban core. The project limits are from the intersection of Avon Street, 9th Street, Garrett Street and Levy Avenue to the intersection of 9th Street and Levy Avenue to the intersection of 9th Street and East Market Street.

This report provides the proposed roadway and structural design parameters based on applicable local, state, and federal guidelines, standards, and requirements for the corridor.

1.1 Project Area

Figure 1.1: Overall Project Area

CHAPTER 2 EXISTING CONDITIONS

The existing conditions were documented through field and utility survey and compiled from various data sources. Field survey mapping for the entire project corridor was developed by H&B Survey and Mapping, LLC in January 2017. Underground utility mapping was performed by Accumark in February 2017. General information outside of the project area was gathered from City of Charlottesville GIS databases. A vertical and horizontal datum of NAVD ’88 and horizontal coordinate system of NAD ’83 have been set as the datum for the project.

CHAPTER 3 PROPOSED ROADWAY DESIGN CRITERIA

Roadway and structural design of general travel lanes, bridges and other geometric roadway features within the right-of-way will follow this established set of design criteria. These criteria are a collection of design standards and/or guidance from local, state, and national sources. The American Association of State Highway and Transportation Officials (AASHTO) is the national body that has developed design standards and guidance for transportation infrastructure through practice, policy testing, research, and experience. This project will be designed in accordance with the manuals below:

City of Charlottesville

- The current edition of the *City of Charlottesville's City Standards and Design Manual*
- The current edition of the *City of Charlottesville's Streets that Work Guidelines*

VDOT

- The current revision to the 2016 Edition of the *VDOT Road and Bridge Standards*
- The current revision to the, the current edition of the *VDOT Survey Manual*
- The current edition of the *VDOT Drainage Manual*
- The current edition of VDOT Hydraulic Design Advisories
- The current edition of the *2013 Virginia Stormwater Handbook*
- The current edition of the *1992 Virginia Erosion and Sediment Control Handbook*
- The current edition of the *VDOT Urban Construction Initiative Program Administrative Guide*
- The current edition of the *VDOT Locally Administrated Projects Manual*
- The current edition of the *VDOT Traffic Operations and Safety Analysis Manual (TOSAM)*

AASHTO

- The *2011 edition of the American Association of State Highway & Transportation Officials (AASHTO) Policy on the Geometric Design of Highways and Streets* (AASHTO Green Book)
- The current edition of the *AASHTO LRFD Bridge Design Specifications*
- The current edition of the *2012 AASHTO Guide for the Development of Bicycle Facilities*
- The current edition of the *2004 AASHTO Guide for the Planning, Design and Operation of Pedestrian Facilities*

NACTO

- The current edition of the *NACTO Urban Street Design Guide*
- The current edition of the *NACTO Urban Bikeway Design Guide*

FHWA

- The current edition of the *2009 Manual on Uniform Traffic Control Devices (MUTCD)*

Department of Justice

- The 2010 ADA *Standards for Accessible Design*

United States Access Board

- Proposed Right-of-Way Guidelines (PROWAG)

The map in Section 1.1 shows the project area. All streets within the City of Charlottesville are owned and maintained by the City. The following tables outline which standards will be utilized for each street within the project are. All the roadway segments with work beyond the curb return within the project limits are included in the table to outline governing criteria in case additional modifications are needed.

Table 3.1: Design Criteria

	Street Segment	9th Street (Route 20)	Old Avon Street and South Street	Water Street
	From:	**Levy Avenue**	**South Street**	**Transit Center**
	To:	**E. Market Street**	**Old Avon Cul de Sac**	**Water Street Trail Project Limits**
Design Criteria	**Source**			
Design Speed	VDOT Road Design Manual (RDM) Appendix A-4	25 mph	25 mph	25 mph
Posted Speed		25 mph	25 mph	25 mph
Location	VDOT 2005 Functional Classification Map	Urban	Urban	Urban
Functional Class	VDOT 2014 Functional Classification Map	Minor Arterial	Local Street	Major Collector
Geometric Standard	VDOT RDM Appendix A	GS-6	GS-8	GS-7
STW Typology	City of Charlottesville Streets that Work Guidelines	Downtown	Downtown	Downtown
Curb/Curb & Gutter Standard	City of Charlottesville City Standards and Design Manual	CG-2/CG-6/ RT-1/SW-2	CG-2/CG-6/ RT-1/SW-2	CG-2/CG-6
Min. Horizontal Radius (ft)	2011 AASHTO Greenbook Table 3-8, RDM Page A-16, A-17	154 feet	154 feet	154 feet
Inter. Section Sight Distance SDL/SDR (ft)	RDM, Page F-40	280/280	280/280	280/280
Stopping Sight Distance	RDM Page A-16, A-17	200	200	200
Min. Crest K Value	2011 AASHTO Greenbook, Table 3-34	12	12	12
Min. Sag K Value	2011 AASHTO Greenbook, Table 3-36	26	26	26
Superelevation Standard	RDM Page A-16, A-17	Urban Low Speed (ULS) – Normal Crown	Urban Low Speed (ULS) – Normal Crown	Urban Low Speed (ULS) – Normal Crown
Max. Grade	RDM Page A-16, A-17; 2011 AASHTO Greenbook, Table 7-4, Table 6-8 City Standards & Design Manual Page 24	9%	10%	10%
Min. Bridge Vertical Clearance over Roads (ft)	VDOT Structure and Bridge Manual Part 2, Chapter 6, File No. 06.02-8, 06.02-10	16.5	14.5	14.5

Min. Bridge Vertical Clearance over Railroads (ft)	VDOT Structure and Bridge Manual Part 2, Chapter 6, File No. 06.06-1	23 feet	23 feet	23 feet
Min. Horizontal Offset from CL of nearest rail to Face of Pier	VDOT Structure and Bridge Manual Part 2, Chapter 6, File No. 06.06-1	18 feet Min (with Crash Wall) or 25 feet with no Crash Wall	18 feet Min (with Crash Wall) or 25' with no Crash Wall	18 feet Min (with Crash Wall) or 25 feet with no Crash Wall
Maximum Gutter Spread (ft)	VDM, Page 9-3	½ Driving Lane + Gutter Width (Maximum 10 feet)		
Minimum Storm Pipe Slope	VDM, Page 9-5	0.20%		
Storm Pipe Design Year	VDM, Page 9-3, Table 9-2	10 Year		
Design Vehicle		WB-67	WB-40	WB-67

3.2 Design Vehicles

Due to width of Old Avon and South Street a WB40 is the largest vehicle that would be able to maneuver both in the existing and proposed condition. In both the existing and proposed condition the WB-40 must track into oncoming lanes to navigate the turns from one side street to another.

Table 3.2: Design Criteria: Project-Wide Standards

Design Criteria	Source	Project-Wide Standard
Min. Width of Parallel Parking Lanes	Streets that Work page 81	8.0 feet
Min. Vertical Clearance to Signs, Adjacent to Sidewalk	VDOT RDM Appendix A-174	7.0 feet to Bottom of Sign
Min. Vertical Clearance to Signs, Adjacent to Bike Lanes	Guide for the Development of Bicycle Facilities page 5-4	4.0 feet to Bottom of Sign
Min. Width of In Road Bike Lane Wo C&G/W C&G (ft)	Guide for the Development of Bicycle Facilities, Section 4.6.4, page 4-15	5 feet

Min. Width of Sidewalk Buffer Strip (ft)	Streets that Work page 46	3 to 6 feet Soil volume minimums: small trees = 250 ft3; medium trees = 400 ft3; large trees = 400 ft3 (700 ft3 preferred)
Min. Width of Sidewalk	Streets that Work page 46	6 feet (Clear)
Min. Width of Shared Use Path (ft)	Guide for the Development of Bicycle Facilities, Section 5.2.1, page 5-3	8
Min Width of Shared Use Path Shoulder (ft)	Guide for the Development of Bicycle Facilities, Section 5.2.1, page 5-5	3
Max. Grade of Sidewalk	VDOT RDM Appendix A-161	5.0% or longitudinal slope of adjacent street, whichever is greater
Max. Grade of Sidewalk Ramps	VDOT RDM Appendix A-152	12:1 (8.3%)
Max. Cross-slope of Sidewalk	VDOT RDM Appendix A-152	48:1 (2.0%)
Min Turn Lane Taper	VDOT RDM Appendix F page F-55	100 Single 150 Dual
Min. Turn Lane Storage	VDOT RDM Appendix page F-55	100 feet*
Clear Zone (ft)	VDOT RDM Appendix A page A-27	16 to 18
Min. Width of Pedestrian "Refuge"	AASHTO Greenbook 4-64 – 4-66	6.0 feet median width
Min. Lateral Offset to Obstructions	VDOT RDM Appendix A-29	1.5 feet from Curb Face 3.0 feet at Intersections
Min. Lane Shift	VDOT RDM Appendix A-10	L = W x S2 / 60
* To be determined by traffic analysis, 100' is minimum		

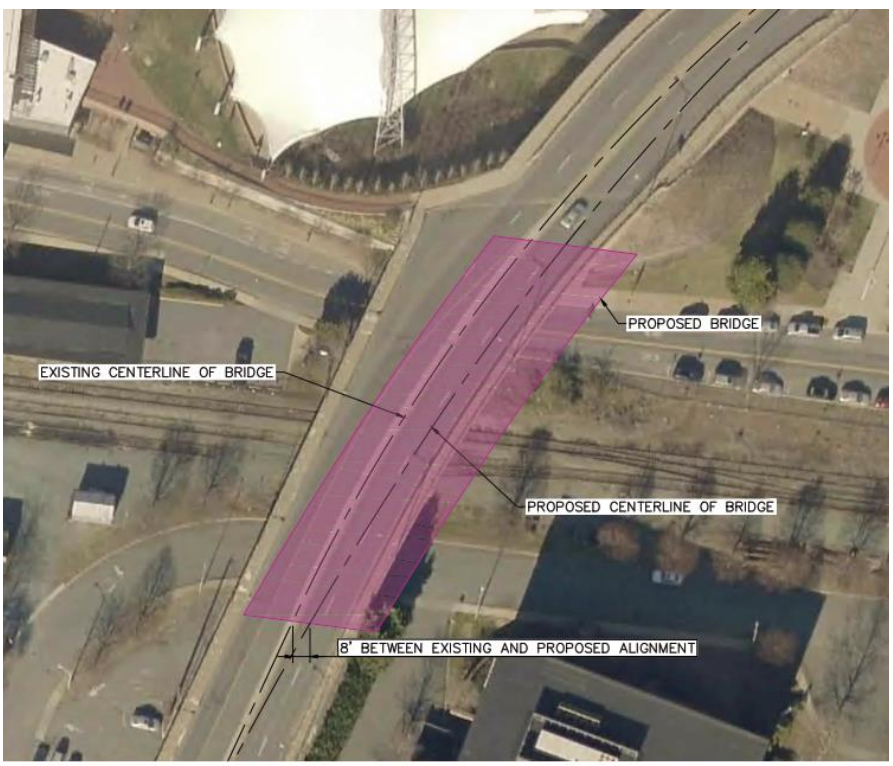
The design vehicle will be analyzed for turning movements at all intersections along the corridor. AutoTURN® is the CAD-based program that can graphically show the full apron and turning path of a bus, truck, or other design vehicle when making different turning movements. Critical turning movements along the corridor will be identified by the project team and the City of Charlottesville to ensure the design vehicle can make turns from modified, improved or created intersections within the project area without unacceptable encroachment onto adjacent lanes or running over curbs, median, or sidewalk.

Portions of the existing surface parking lot and parallel parking along Old Avon Street are proposed to be removed with this project. Impacts, remediation and replacement concepts for parking within the project was studied with the development of the conceptual design and the design concept will show proposed parking provisions within the project area as plans are developed.

3.3 Horizontal Alignment

The horizontal alignment for 9th Street was developed to be able to utilize as much existing pavement as possible while still maintaining traffic during construction. To avoid a full closure of the bridge during construction the bridge will be built in two stages. First traffic will flow on approximately 34 feet of the existing part of the bridge along the west side. The center line of the new proposed bridge must be shifted a minimum of 8 feet, see Figure 3.1 below, to accommodate two travels lanes and a sidewalk for pedestrians which will maintain traffic circulation during construction. To accomplish this the alignment of 9th Street is proposed to include a compound curve made up of a 2000 foot radius curve followed by a 1335 foot radius curve, which does not exceed the maximum 1.5:1 ratio for compound curves from chapter 3 in the AASHTO Green Book. This compound curve alignment allows for minimum alignment shift needed on the bridge as well as providing the minimum impact on the northeast parcel of the bridge.

Figure 3.1: Typical Section – North of Belmont Bridge (Looking North on 9th St.)



3.4 Vertical Alignment

The vertical profile design of 9th Street closely resembles the existing profile on the south side of the bridge so to utilize as much existing pavement as possible. The profile for the portion of the 9th Street on structure was developed to maintain a minimum vertical clearance of 23 feet between the top of the highest rail of the Buckingham Branch Railroad and the bottom of the bridge. Currently 4 feet and 9 inches bridge structure depth is assumed plus an allowance for 2% cross slope for 31 feet from centerline to edge to bridge which adds an additional .62 feet or a total structure depth of 5.37 feet. At Water Street and Avon Street the profile must provide a minimum vertical clearance of 14.5 feet; however, given the proximity of both roadways to the Buckingham Branch Railroad more than the minimum vertical clearance will be provided over both roadways.

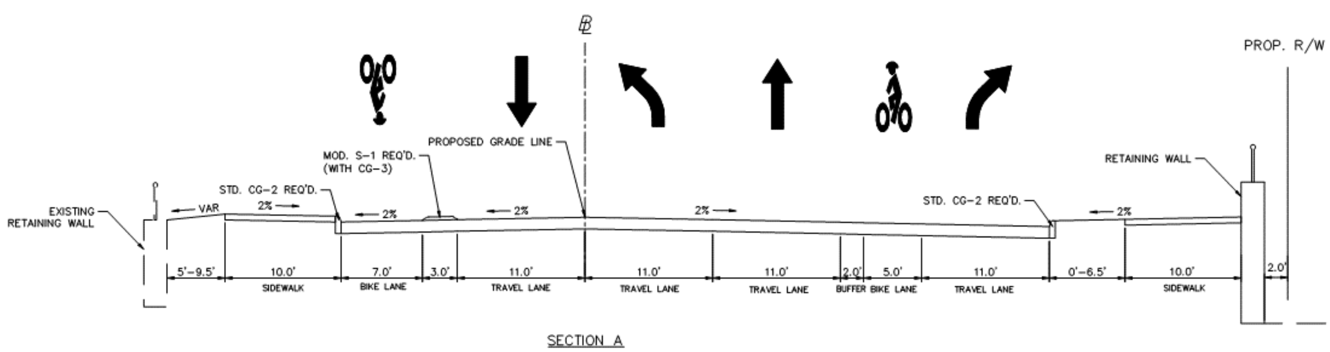
On the north side of the bridge the proposed centerline and crown location is shifted east of the existing crown. The proposed profile will allow for extension of the existing southbound cross slope (approximately 2%) to shift the crown location to the proposed centerline. This approach will allow for much of the existing pavement and the existing retaining wall(s) behind the Pavilion to remain and/or be adjusted with milling and overlay. This approach minimizes the cost of replacement asphalt and simplified maintenance of traffic on the north side of the proposed bridge replacement.

3.5 Typical Sections

Typical sections were created for the areas both north and south of Belmont bridge based on the constraints of the design criteria above, to minimize right of way impacts, maintain/enhance pedestrian and bike accessibility, and supported by the traffic study. On the north side of the Belmont bridge there are four 11 feet lanes; one northbound through, one northbound left, one northbound right, and one southbound lane through lane. In addition, there is a 7 foot bike lane heading in each direction. There is a 3 foot MS-1 median between the southbound through lane and the southbound bike lane. The northbound bike lane is located between the northbound through and northbound right turn lanes. Figure 3 shows the typical section. Additionally, there is a 10 foot sidewalk heading on the back of the curb in either direction.

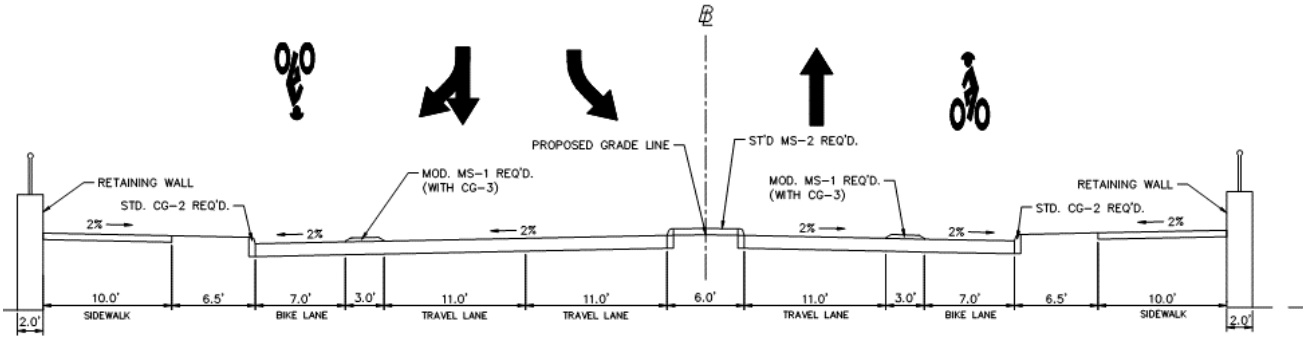
Figure 3.2 shows the proposed typical section North of Belmont Bridge.

Figure 3.2: Typical Section – North of Belmont Bridge (Looking North on 9th St.)



The typical section on the south side of the Belmont bridge consists of three 11 feet lanes; one southbound shared through/right turn lane, one southbound left, and one northbound through. There is a 6 foot median on the centerline that divides the southbound left and northbound through lanes. 7 foot Bike lanes, which are separated from vehicle traffic by a 3 foot MS-1 median, are located next to the curb in each direction. In both directions, there is a 10 foot sidewalk which is contained by a 6 foot greenspace on the traffic side and a retaining wall on the opposite side. The typical section for south of the bridge is shown in Figure 3.3 below. The southbound left turn lane is utilized to reduce the delay on the southbound through motion at the 9th Street and Levy Street intersection.

Figure 3.3: Typical Section – South of Belmont Bridge (Looking North on 9th St.)



3.6 Superelevation

All streets within the project limits are urban streets with posted speed limits of 25 mph; therefore, the streets are to utilize normal crown superelevation in accordance with TC5.11 Urban Low Speed (ULS).

3.7 Design Waivers and Exceptions

Because all streets improved within this project are maintained by the City of Charlottesville, no design waivers for elements that do not meet the requirements of the Virginia Department of Transportation but exceed AASHTO standards require a design waiver to be submitted. However, the project is required to either fully comply with AASHTO standards or obtain a Design Exception that must be approved by both the City and VDOT. Based on a review of the current design, Kimley-Horn anticipates no need for design exceptions on this project.

CHAPTER 4 DRAINAGE AND STORMWATER MANAGEMENT STRATEGY

This project is "grandfathered" under Part IIC technical criteria rather than being required to meet the "new" Part IIB criteria. VODT IIM 195.9 allows for a project to be grandfathered if it was partially (or wholly) funded prior to July 1, 2012. The Belmont Bridge project had funding shown in the 2013 Six Year Improvement Plan. To maintain this grandfathered status, construction activities must begin prior to July 1, 2019. Therefore, the minimum requirement for this project could be to meet Part IIC "old" technical criteria that include the Performance/ Technology-Based methodology for determining compliance with water quality requirements and MS-19 criteria for determining compliance with stream channel flooding and erosion requirements. However, the City of Charlottesville has determined that the project will comply with Part IIB criteria to meet the City's Goal 3 to support A Beautiful and Sustainable Natural and Built Environment and limit construction revisions if construction does not start prior to July 1, 2019. Existing conditions relating to feasibility, effectiveness and cost were evaluated to determine the current stormwater management plan is to construction two onsite BMP's (likely Level II Biofiltration) within the limits of the Old Avon Street plaza and purchase nutrient credits for the remaining water quality credits required for the project.

Water quantity requirements are to be met by reducing the quantity of stormwater run-off by conversion of impervious surface to pervious surface, regrading or underground detention.

CHAPTER 5 ANCILLARY DESIGN CONSIDERATIONS

Other guidelines and factors will influence the design of the Belmont bridge replacement. The following sections briefly describe a few of them and how they will affect the roadway and bridge design.

5.1 ADA Compliance

The project will comply with federal and state Americans with Disabilities Act (ADA) requirements. VDOT guidance includes the Americans with Disabilities Act Compliance document (TE-377.0) and IIM-LD-55.16 (Guidelines for the Placement of Curb Ramps and Pedestrian Access Routes) dated July 15, 2014, which pertain specifically to curb ramps and pedestrian access routes. Curb ramps will conform to VDOT Road and Bridge Standards CG-12 Types A, B, or C (see VDOT Road and Design Manual, Appendix A, Section A-5). The project's compliance with ADA requirements is summarized in a memorandum entitled 'Belmont Bridge Replacement Project ADA Requirements' dated October 20, 2017. PROWAG, while not formally adopted, will be used to evaluate and design for future compliance with upcoming ADA requirements/guidance.

5.2 Traffic Studies Design Integration

This basis of design report is one of numerous studies/reports being completed for the Belmont Bridge replacement project. For additional information on traffic analyses and traffic operations please see the report entitled 'Belmont Bridge Traffic Report'.

5.3 Maintenance of Traffic

All maintenance of traffic plans will comply with the latest editions of the Manual on Uniform Traffic Control Devices (MUTCD), Virginia Work Area Protection Manual (VWAPM), and local City of Charlottesville requirements. Traffic control measures will need to meet location specific characteristics for this high density, urban environment with close intersection spacing and posted speed limits of 25 MPH. Typical types of traffic control applications found in the VWAPM related to this project include the following:

- Work Beyond the Shoulder Operation (TTC-1.1)
- Mobile or Short Duration Shoulder Operation (TTC-2.0)
- Stationary Operation on Shoulder (TTC-4.1)
- Shoulder Closure Operation with Barrier (TTC-6.1)
- Shoulder Closure with Barrier and Lane Shift Operation (TTC 7.0)
- Short Duration Operation on a Multi-Lane Roadway (TTC-15.1)
- Outside Lane Closure Operation on a Four-Lane Roadway (TTC-16.1)
- Inside Lane Closure Operation on a Four-Lane Roadway (TTC-17.1)
- Lane Closure on a Two-Lane Roadway Using Flaggers (TTC-23.0)
- Lane Closure Operation – Near Side of an Intersection (TTC-26.1)
- Lane Closure Operation – Far Side of an Intersection (TTC-27.1)
- Lane Closure Operation in an Intersection (TTC-28.1)
- Turn Lane Closure Operation (TTC-29.1)
- Flagging Operation at a Signalized Intersection (TTC-30.1)
- Sidewalk Closure and Bypass Sidewalk Operation (TTC-35.0)
- Crosswalk Closure and Pedestrian Detour Operation (TTC-36.1)

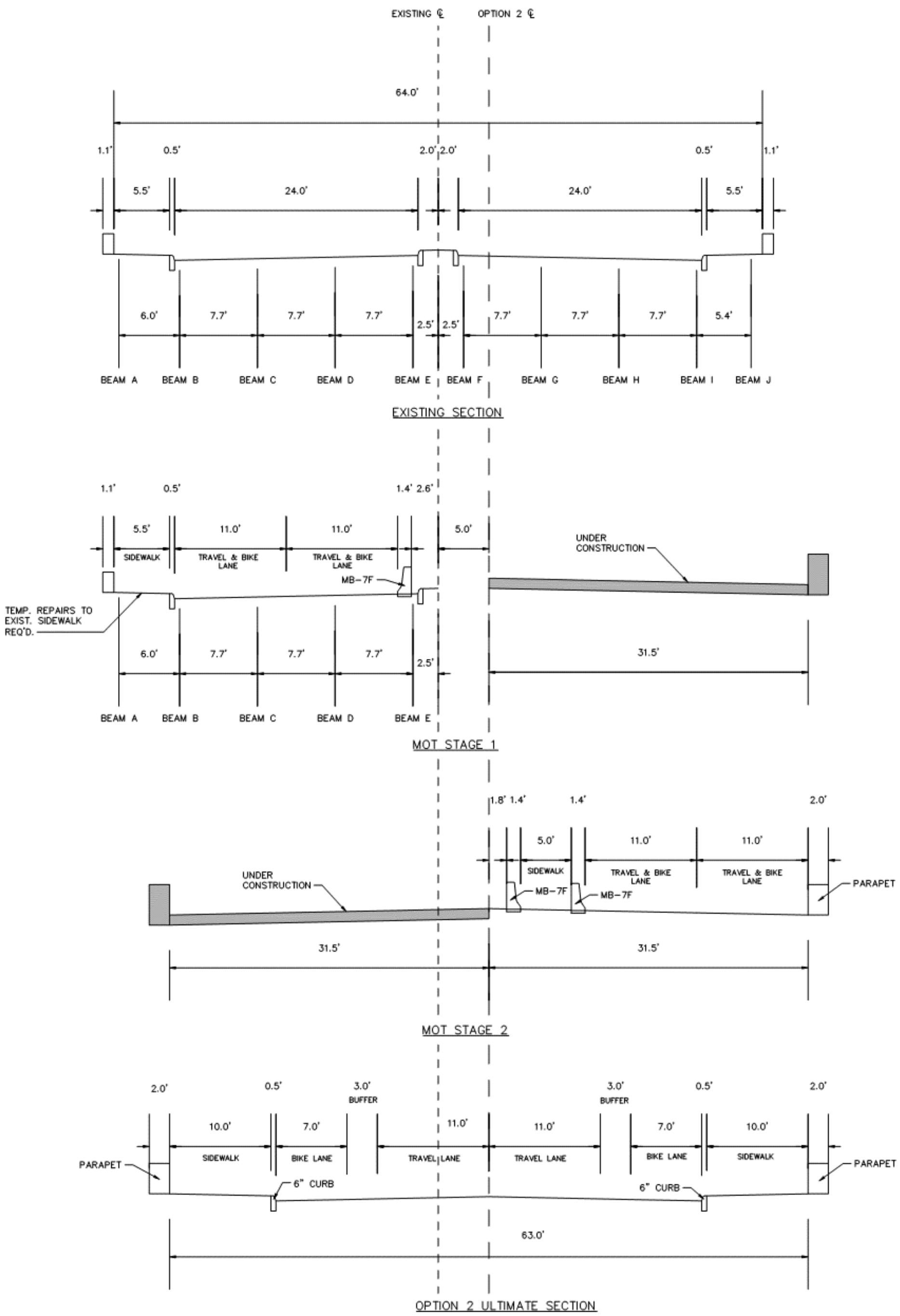
In addition, Charlottesville's Pedestrian Accessibility in the Public Way During Construction must be followed during construction. Any construction that impacts a public street or sidewalk should consider the following:

- Advanced warning and guidance signs

- Adequate illumination and reflectors
- Use of temporary walkways
- Channeling and barricading to separate pedestrians from traffic
- Adequate barricading to prevent visually impaired pedestrians from entering work zones
- Wheelchair accessible alternate pedestrian circulation routes with appropriate signage

During development of the conceptual design, the decision was made to maintain two-way traffic on 9th Street at all times through construction. This design decision was made with input from the City and the project's Steering Committee. This decision required the conceptual design to accommodate staged construction of the proposed bridge replacement, which will construct the bridge in two stages. Please see the description in Section 3.1 Horizontal Alignment for the impact of this decision on the proposed horizontal alignment. The proposed bridge design was developed to provide a minimum of 28.5' of proposed bridge constructed in Stage 1. Further, to simplify staging the demolition of the existing bridge is proposed along the existing joint at the bridge's centerline. Lastly, the existing Belmont Bridge provides one of the only convenient pedestrian connections over the Buckingham Branch Railroad in this area of the City, so one pedestrian sidewalk is proposed to be maintained at all times.

Figure 5.1: MOT Concept – Conceptual Maintenance of Traffic Concept for 9th Street



5.4 Pedestrian/Bicycle Accommodations

The project will comply with guidelines published by the National Associations of City Transportation Officials (NACTO) entitled Urban Bikeway Design Guide and Urban Street Design Guide for pedestrian and bicycle accommodations. The conceptual design was developed with significant input from the public, City Staff and the City's Bicycle and Pedestrian Advisory Committee. The conceptual design as proposed will enhance the following bicycle and pedestrian accommodations with the following measures:

- Separated bicycle lanes from north of the intersection with Levy Avenue to the north end of the replacement bridge (both northbound and southbound on 9th Street/Avon Street).
- Northbound separated bicycle lane from north end of the replacement bridge to the south side of the intersection with E. Market Street.
- Southbound Buffered bicycle lane from the north end of the replacement bridge to the south side of the intersection with E. Market Street.
- 10 foot wide sidewalks from the intersection with Levy Avenue to the intersection with E. Market Street (both northbound and southbound on 9th Street/Avon Street).
- Signalized pedestrian crossings of 9th Street and side streets at signalized intersections with Levy Avenue and E. Market Street.
- A new pedestrian passageway below 9th Street from the east to the west of 9th Street in the vicinity of the Graves Street and Monticello Avenue intersection.
- Extension of the existing pedestrian passageway below 9th Street into the Pavilion.
- Stair towers from 9th Street to the adjacent street network in the Southwest quadrant (to Old Avon Street), in the Northwest quadrant (to Water Street west) and Northeast quadrant (to Water Street east).
- Connection to the proposed Water Street Trail east of the replacement bridge.
- Pedestrian Plaza with closure of Old Avon Street at Levy Avenue which simplified pedestrian crossings and improves signal timing for pedestrians at Levy Avenue/Avon Street.

5.5 Bridge Design

The Kimley-Horn team will develop bridge plans that detail substructure, superstructure and foundation designs for the bridge depicted in the concept drawings. Please see the Stage 1 bridge report for the Belmont Bridge Replacement project (for details. However, basic design components for the replacement bridge are as follows:

- Three spans over Old Avon Street, Buckingham Branch Railroad and Water Street
- Total Bridge Length of approximately 235.89'
- Proposed Typical Section as shown below:

Figure 5.2: Typical Section – Belmont Bridge over Buckingham Branch Railroad, Water Street and Old Avon Street