GetOnBoardBRT
BUS RAPID TRANSIT IN MONTGOMERY COUNTY
MD 355

MD 355 BRT Corridor Planning Study

Phase 2

Alternatives Technical Report

June 17, 2019

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1 Introduction

The Montgomery County Department of Transportation (MCDOT) is preparing a Corridor Summary Report for Phase 2 of the MD 355 Bus Rapid Transit (BRT) Planning Study. The project is evaluating detailed alternatives for providing enhanced transit service along MD 355 from Bethesda to Clarksburg in Montgomery County, Maryland.

Phase 2 of the MD 355 BRT Planning Study builds upon work completed in Phase 1, which developed Conceptual Alternatives that were evaluated to determine which should move forward for more detailed analysis. These alternatives have been refined and analyzed in further detail in Phase 2. The purpose of this Alternatives Technical Report is to describe the alternatives development and screening approach used. Information in this report, described below, will support discussions presented in the *Corridor Summary Report*.

1.1 MD 355 BRT Project Purpose and Need

The purpose of the MD 355 BRT Planning Study is to provide a new transit service with higher speed and frequency along MD 355 between Bethesda and Clarksburg. The purpose and need statement has been consolidated into four distinct goals to guide the development of alternatives and as a framework for comparing alternatives:

Goal 1. Provide an appealing, functional, and high-quality transit service

Goal 2. Improve mobility opportunities, accessibility, and transportation choices

Goal 3. Support planned development

Goal 4. Support sustainable and cost-effective transportation solutions

2 Existing Conditions

2.1 Existing Transit Operations

The Project Team conducted a thorough analysis of existing conditions along the MD 355 corridor, with an emphasis on the local bus network which included Montgomery County Ride On and Washington Metropolitan Area Transit Authority (WMATA) Metrobus. Productivity metrics for Metrobus and Ride On routes were used to evaluate the efficiency and performance of the local bus network, including on-time performance, average weekday boardings, passengers per trip, revenue hour, and revenue mile. Stop-level ridership was used to identify high-ridership activity areas and maximum vehicle loads.

A review of existing local transit was performed to gather data to help inform the Project Team's recommendations regarding how to integrate future BRT service and existing local service. Additionally, the review revealed a few key points:

- Most existing local bus routes are considered "feeder service": they connect riders in the surrounding neighborhoods with locations along the MD 355 corridor, typically at a Metrorail station;
- Many of the highest ridership study routes run east and west, connecting the Shady Grove side of the Red Line with the Glenmont side;
- Study routes generally have high ridership relative to their level of service. Only a few of the study routes do not meet their agency's relevant performance standards; and
- Stop-level ridership data reveal that the bulk of ridership on study routes occur at Metrorail stations along the corridor. Other high-ridership locations include the Montgomery College - Rockville Campus, Lakeforest Transit Center, Germantown Transit Center, Kingsview Park and Ride, Montgomery Village, and the Veirs Mill Road corridor.
- Along the study corridor, both Metrobus and Ride On bus service suffers from service reliability issues: Metrobus on-time performance is 78 percent and Ride On on-time performance is approximately 73 percent.

2.2 MD 355 Transit Market Analysis

The Project Team performed a transit market analysis for all of Montgomery County, with a special emphasis on the MD 355 study area. This analysis included a transit needs assessment and a service gap analysis. The transit needs assessment involved developing four unique indices to measure different types of demand for transit. These included transit-oriented populations, commuters, work destinations, and non-work destinations. These indices, developed at the block group level and using U.S. Census Bureau American Community Survey and Longitudinal Employer-Household Dynamics data, helped inform where there is strong demand for transit service along the corridor.

Using these indices, the Project Team then developed a service gap analysis, resulting in an all-day service score and a peak service score. These scores consider the transit needs assessment indices, as well as the

existing levels of peak and non-peak service, resulting in scores which reveal where additional service could possibly be supported based on unmet demand.

Unsurprisingly, the study area contains several locations that attain the highest demand for various types of transit services, including both peak and all-day service, within the county. Many of these communities are served by existing transit, but the reliability of this service along the MD 355 corridor does not meet agency goals. Along the MD 355 corridor, Metrobus and Ride On bus both suffer from service reliability, with Metrobus operating on-time performance of 77.6 percent (goal of 79 percent) and Ride On operating on-time performance of 71-74 percent (goal of 90 percent).

Additionally, there are gaps in existing service and growing demand in the northern half of the corridor, north of Shady Grove where the Metrorail terminates. In the southern half of the corridor Metrorail station spacing does not support the types of short trips associated with the majority of non-work trips. There are a few areas which scored high in certain indices but do not currently have robust transit service, including the Fox Chapel area in Germantown, Eastern Germantown, and the area around the 270 Center and Shady Grove Shopping Centers. By combining certain indices, the service gap analysis revealed, with even more precision, a few areas where existing levels of transit service do not meet the demand for peak and all-day service. Southeastern Gaithersburg, the area north of the National Institute of Health, and Northern Rockville are underserved by all-day transit, while the area directly north of NIH is underserved during peak hours. These findings suggest that there is un-met demand in these communities for additional transit service. The Project Team took this information into account when creating the BRT service plan.

2.3 Existing MD 355 Roadway Conditions

MD 355 is a busy commercial corridor that extends the entire length of Montgomery County, from urban mixed-use centers in the south, through a range of suburban communities of varying densities before entering an exurban environment in the northernmost reaches of the County. The roadway changes in character as it crosses multiple local jurisdictions, spanning areas of high urban density that include features such as wide sidewalks and on-street parking; to more rural areas containing wide shoulders and open drainage systems. MD 355 is generally a six-lane roadway between Bethesda and Germantown, with wider cross sections that incorporate multiple turning lanes at many signalized intersections.

The portion of MD 355 in the project area is approximately 22 miles long and begins at the future southern entrance to the Bethesda Metrorail Station near Elm Street and ends at Stringtown Road in Clarksburg. It is classified as an Urban Other Principal Arterial from Elm Street to Ridge Road, and as an Urban Minor Arterial from Ridge Road to the project terminus at Stringtown Road. The posted speed limit changes multiple times along the MD 355 corridor and is summarized in **Table 2-1**. See **Figure 2-1** for a map of the Study Area.

Figure 2-1: Study Area Map

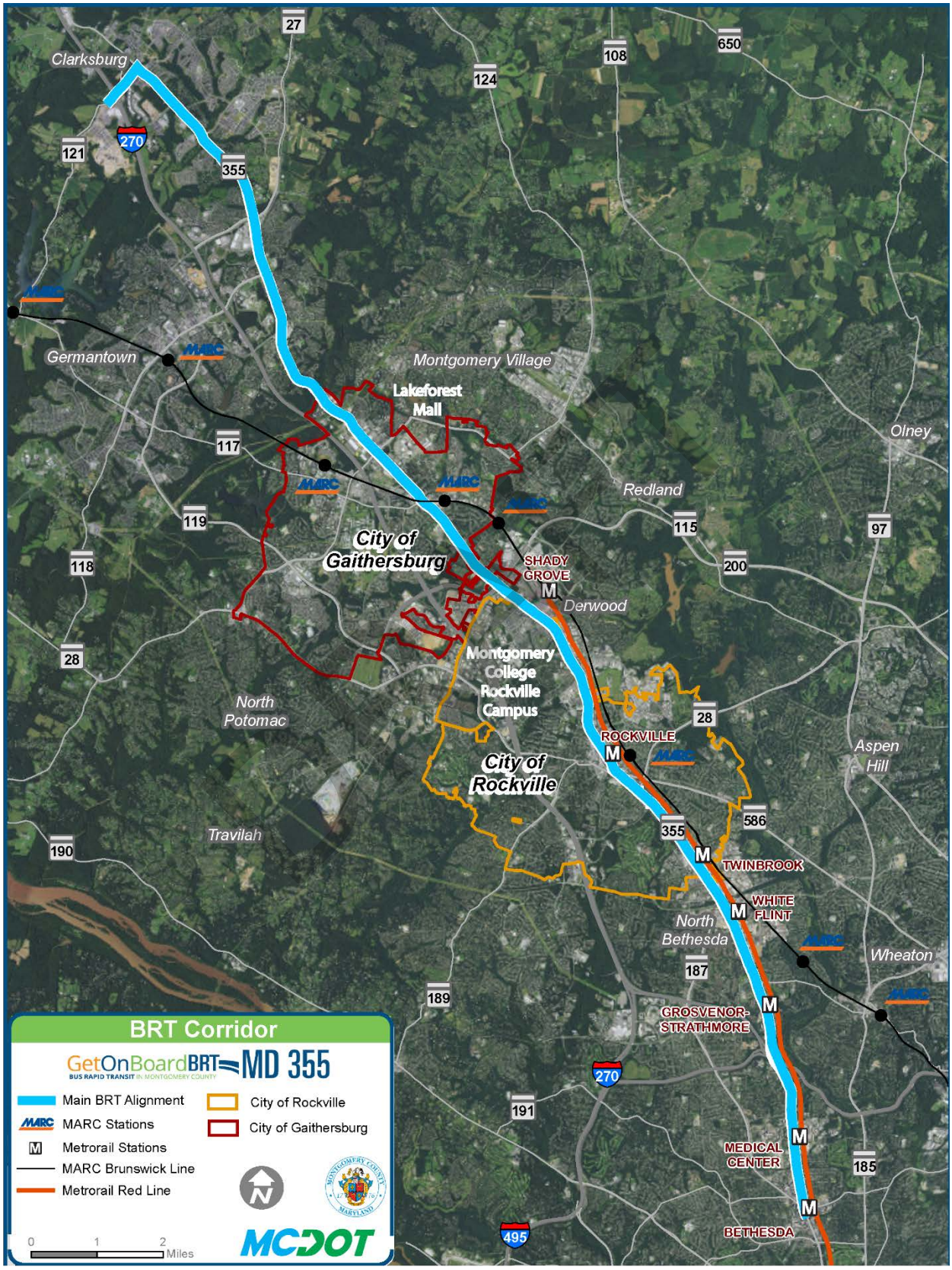


Table 2-1: Posted Speed Limit along MD 355

Posted Speed Limit (mph)	From	To
25	Elm Street	Jones Bridge Road
35	Jones Bridge Road	I-495 Interchange
45	I-495 Interchange	Strathmore Avenue
40	Strathmore Avenue	Mount Vernon Place
30	Mount Vernon Place	Middle Lane
35	Middle Lane	Gude Drive
40	Gude Drive	Central Avenue
35	Central Avenue	Summit Avenue
30	Summit Avenue	Montgomery Village Avenue
40	Montgomery Village Avenue	Middlebrook Road
45	Middlebrook Road	Canterfield Way
40	Canterfield Way	Saint Clair Road
30	Saint Clair Road	Stringtown Road

Source: Maryland Department of Transportation State Highway Administration and Maryland iMap, July 2016

2.3.1 Bethesda

Within Bethesda, MD 355 is predominantly three lanes in each direction with turn lanes at key intersections. In the downtown urban core, the rightmost travel lanes serve as off-peak parking. The typical section includes 11 to 12-foot wide travel lanes, a varying width raised concrete and landscaped median, and sidewalks located immediately adjacent to the roadway.

At the MD 355 intersection with Jones Bridge Road, the roadway leaves downtown Bethesda, and passes the Walter Reed National Military Medical Center and the National Institutes of Health. The typical section remains the same except landscape buffers are added between the sidewalk and the roadway and are widened to function as shared use paths in some locations.

2.3.2 Strathmore, White Flint, and Twinbrook

North of the MD 355 interchange with I-270, the MD 355 corridor becomes more suburban and commercial. The roadway remains predominantly three lanes in each direction with turn lanes at key intersections. The typical section includes 11 to 12-foot wide travel lanes, a varying width grass and concrete median, and sidewalks located on both sides of the roadway, both with and without landscape buffers. North of Montrose Parkway, the median becomes a continuous center left turn lane to access businesses.

Between the I-495 and MD 355 interchange and Rockville Town Center, the corridor is dominated by commercial and mixed-use development, driveways spaced close together, and no access control. The CSX railroad right-of-way, which is used by Metrorail's Red line, MARC's Brunswick Line, and Amtrak, is located just to the east of and roughly parallel to MD 355 along this portion of the roadway corridor.

2.3.3 Rockville

Rockville Town Center is an urban core along the MD 355 corridor with high rise buildings located adjacent to MD 355 on the west and the CSX railroad right-of-way on the east behind a strip of commercial properties. The roadway remains three lanes in each direction with turn lanes at key intersections. Due to the right-of-way constraints in this area, the typical section includes 11-foot wide travel lanes, a concrete median, and sidewalks on both sides of the roadway with no landscape buffers. Just north of Monroe Place, a pedestrian bridge crosses MD 355 to connect the dense development of Rockville Town Center to the Rockville Metrorail Station. From Mannakee Street to College Parkway, the CSX railroad right-of-way is immediately adjacent to MD 355.

North of College Parkway, the MD 355 corridor returns to a more suburban character including commercial development and the residential community of King Farm. The roadway typical section widens to include 12-foot wide travel lanes, sidewalk buffers, and varying width grass and concrete medians.

MD 355 crosses under and intersects with I-370 just north of Shady Grove Road.

2.3.4 Gaithersburg

North of the I-370 interchange, the MD 355 corridor continues the same pattern of suburban character, with commercial development, residential communities, and community-oriented land uses along the roadway including churches, community centers, and Gaithersburg High School. The roadway typical section consists of three 11-foot wide through lanes in each direction with sidewalk buffers, grass and concrete medians until Summit Avenue. After crossing over the Father Cuddy Bridge, the roadway transitions to a five-lane typical section with a two-way center turn lane in this mostly commercial area. The center left-turn lane is utilized to access businesses up to Odendhal Avenue with a sidewalk adjacent to the curb on both sides in this constrained area. Many buildings along this section of the corridor are set back only to the back of sidewalk.

Forest Oak Cemetery is located on the west side of MD 355, near the intersection at Montgomery Avenue. North of the intersection with Odendhal Avenue, the roadway transitions back to three 11-foot wide through lanes in each direction with raised medians and trees along the back of sidewalk. North of MD 124 (Montgomery Village Avenue), the corridor maintains a largely commercial character, typified by several car dealerships and large-scale office campuses.

2.3.5 Germantown/Clarksburg

MD 355 transitions from a six-lane to a four-lane roadway at Middlebrook Road. This section of MD 355 is mostly residential, passing by Neelsville Middle School, and Milestone Center Mall. MD 355 then transitions from a four-lane divided roadway to a two-lane undivided roadway north of MD 27 (Ridge Road). Character and land use along MD 355 changes considerably from a suburban to a rural and low-density residential environment in this section of MD 355.

2.4 Existing Observation Drive Roadway Conditions

Observation Drive is an arterial roadway that extends from Middlebrook Road to Woodcutter Drive/Waters Discovery Lane in the south. In the north, there is a short segment from Roberts Tavern Drive to Stringtown Road. Between Middlebrook Road and Germantown Road, Observation Drive is a two-lane roadway that serves Holy Cross Germantown Hospital and transects the Montgomery College Germantown Campus.

North of Germantown Road, Observation Drive is a closed section, four-lane divided roadway, with wider roadway widths that incorporate turning lanes at median openings. Observation Drive is planned to ultimately continue north to Stringtown Road in Clarksburg. The segment between Woodcutter Drive/Waters Discovery Lane and Roberts Tavern Drive is currently not constructed.

2.5 Shakespeare Boulevard

Shakespeare Boulevard begins at Observation Drive and extends to Germantown Road. Within the BRT service area, Shakespeare Boulevard is a closed section, four-lane divided roadway with a landscaped median. Turn lanes are provided at median openings to major entrances and at signalized intersections. The land use along Shakespeare Boulevard within the project area is commercial to the north and residential to the south. There is a park and ride lot situated on the north side of the roadway. Shakespeare Boulevard is classified as an arterial.

2.5.1 Stringtown Road

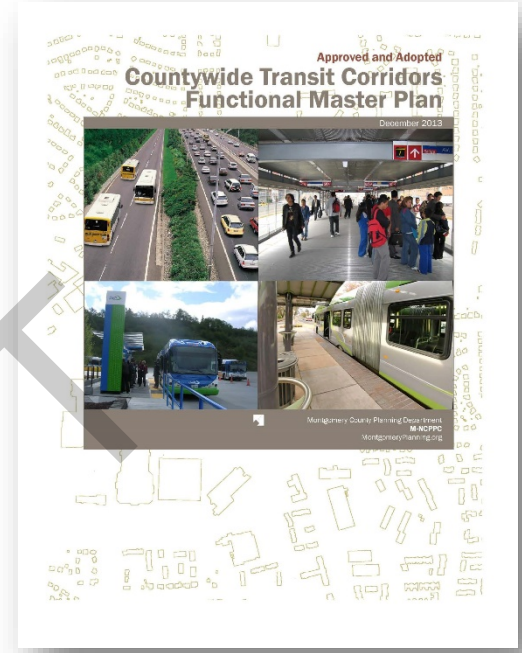
Stringtown Road extends from Kings Valley Road in the east to Gateway Center Drive in the west, at which point it turns into Clarksburg Road. Within the service area, Stringtown Road is classified as an arterial; however, east of Snowden Farm Parkway it is classified as a rustic road and maintains a two-lane section. Within the service area, Stringtown Road is a two-lane to four-lane roadway with some median-divided segments.

2.6 Existing Snowden Farm Parkway Roadway Conditions

Snowden Farm Parkway, within the service area between Ridge Road and Stringtown Road, is generally a closed section, four-lane divided roadway. Snowden Farm Parkway starts at Ridge Road to the south and extends up to Clarksburg Road to the north. It is classified as an arterial. Along the corridor, median openings with turn lanes provide access to residential communities. There are two roundabouts along Snowden Farm Parkway.

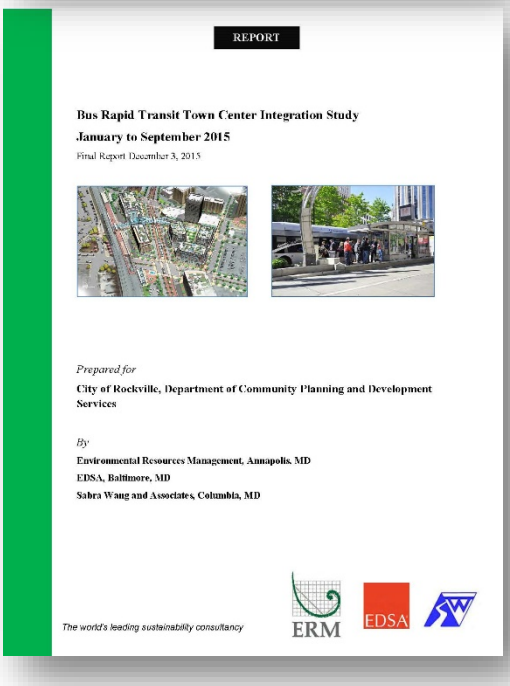
3 Previous Studies

Phase 2 of the MD 355 BRT Planning Study is informed by several previous studies including Phase 1 of the study; the City of Rockville Bus Rapid Transit Town Center Integration Study; City of Gaithersburg MD 355 Bus Rapid Transit Study; and the Countywide Transit Corridors Functional Master Plan. These studies are summarized below.



3.1 Countywide Transit Corridors Functional Master Plan (2013)

The Countywide Transit Corridors Functional Master Plan (CTCFMP) was approved by the Montgomery County Planning Board on July 25, 2013 and adopted by the County Council in December 2013. The Plan incorporated Bus Rapid Transit into the County's Master Plan of Highways along eleven corridors. MD 355 is divided into two segments in the plan: South, extending from Bethesda Metrorail Station[1] to Rockville Metrorail Station, and North, from Rockville Metrorail Station to Clarksburg Town Center. The Master Plan allowed for the extension of MD 355 South to Friendship Heights should the District of Columbia move forward with BRT service along Wisconsin Avenue. The Plan set right-of-way recommendations for corridors, assigned dedicated lane and mixed traffic treatments for different portions of the corridor, and proposed an initial set of station locations. The Plan envisioned that later studies would set the precise location of stations along the corridors. The adoption of the CTCFMP required the creation of the Corridor Advisory Committees (CACs) to advise the advancement of planning for BRT corridors like MD 355.

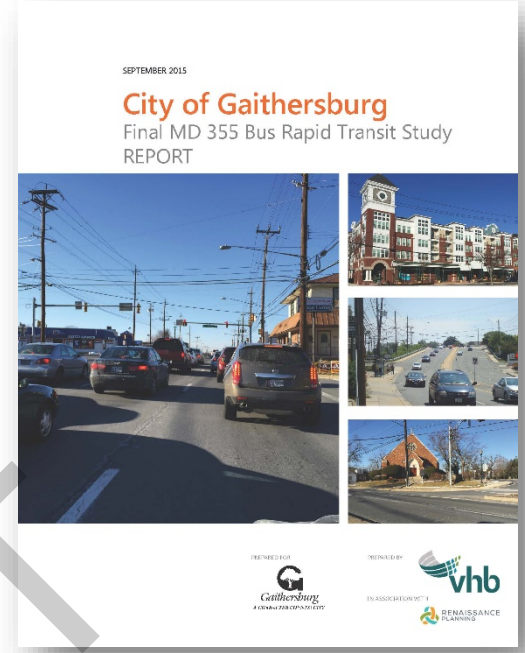


3.2 City of Rockville Bus Rapid Transit Town Center Integration Study (2015)

In response to the County and State's BRT planning work along MD 355, the City of Rockville moved forward with its own study evaluating possible approaches for incorporating the MD 355 BRT in the constrained area of Rockville Town Center. This study evaluated possible reconfiguration of the Rockville Metrorail Station bus bays to facilitate mixed-use development and integration with BRT. It also proposed a tunnel through Rockville

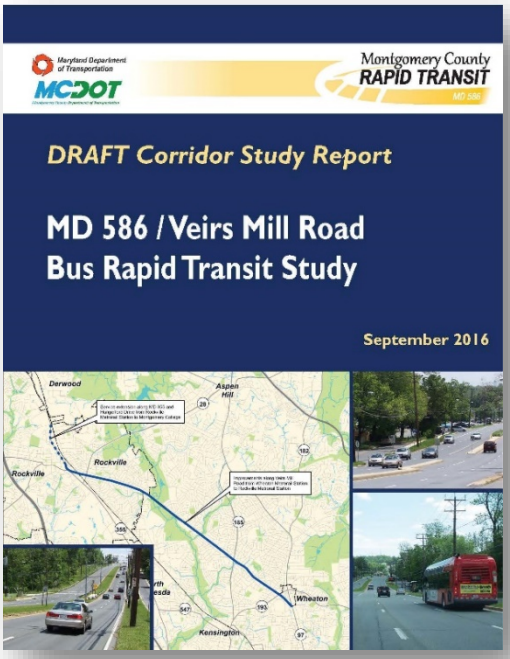
[1] The Bethesda Downtown Sector Plan, approved by the County Council in 2017, confirmed that the southern extent of the corridor is the future southern entrance of the Bethesda Metrorail Station.

Town Center to accommodate vehicular through traffic. MCDOT has continued to coordinate with City of Rockville staff regarding potential alignments in the Town Center and station locations throughout the portions of the MD 355 corridor in Rockville.



3.3 City of Gaithersburg MD 355 Bus Rapid Transit Study (2015)

The City of Gaithersburg also performed a study to evaluate how the MD 355 BRT could be accommodated along the portions of MD 355 within the City. This plan considered potential right-of-way configurations to address the most constrained portions of the corridor and evaluated different station locations. The study recommended a mix of dual-lane and single-lane guideways throughout the portions of the corridor in the City. A hybrid alternative, involving construction of a single-lane reversible guideway between the Father Cuddy Bridge and Odendhal Avenue, emerged from a review of previously proposed guideway alternatives to achieve the greatest balance of BRT operations, traffic impacts, and property impacts throughout the corridor. It produced the lowest impact on traffic operations with minimal traffic diversions onto Perry Parkway and Russell Avenue, while maintaining acceptable levels of service at the signalized intersections. The proposed alternative would not require reconstruction of the Father Cuddy Bridge and reduces the number of impacted properties relative to other guideway options.



The study evaluated a set of potential station locations beyond those recommended in the Countywide Transit Corridors Functional Master Plan. Based on this evaluation, stations were recommended at North Westland Drive, Education Boulevard, Cedar Avenue/Fulks Corner Avenue, Chestnut Street/Walker Avenue, Lakeforest Boulevard/Perry Parkway, Watkins Mill Road, and Professional Drive. The Gaithersburg City Council adopted the study's recommendations in September 2015. MCDOT has continued to engage with City of Gaithersburg staff regarding right-of-way, station, and other planning issues.

3.4 MD 586 / Veirs Mill Road Bus Rapid Transit Study (2016)

MDOT SHA conducted a planning study that evaluated BRT alternatives along MD 586 from the Wheaton Metrorail Station to the Rockville Metrorail Station and the extension of enhanced bus service from the Rockville Metrorail Station to Montgomery College – Rockville. BRT was identified as a solution for this transit-dependent and congested corridor because it would increase transit reliability and opportunities for low-income and

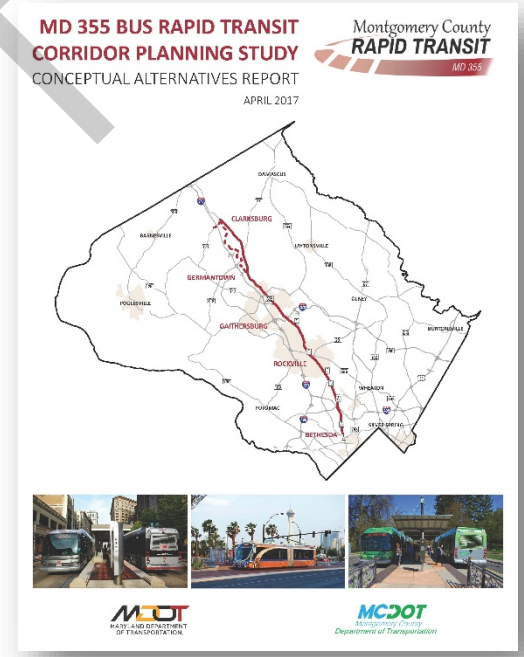
minority populations, as well as access to a larger supply of affordable housing. Additionally, enhanced transit access could play an integral role in revitalizing the adjacent neighborhoods, relieving congestion, supporting land conservation, and improving safety for bicyclists and pedestrians. It is expected that BRT improvements would increase the mobility, safety, and sustainability of the study corridor.

While the Veirs Mill Road BRT Study was not included in the Constrained Long Range Plan (CLRP) when traffic projections were developed for the MD 355 BRT project, it has been added to the 2045 CLRP and future planning for the MD 355 BRT would further consider it.

The Veirs Mill Road extension to Montgomery College – Rockville was considered when developing service patterns for the MD 355 BRT project.

3.5 MD 355 Bus Rapid Transit Corridor Planning Study Conceptual Alternatives Report (2017)

The Maryland Department of Transportation Maryland Transit Administration (MDOT MTA) managed the MD 355 Bus Rapid Transit Corridor Planning Study, referred to as the Phase 1 study in this report. This study developed a draft Purpose and Need and identified eight Conceptual Alternatives, including six BRT Alternatives. The study conducted a preliminary screening to evaluate the BRT Alternatives.



The No-Build Alternative and TSM Alternatives have been retained and refined in this round of study. Elements of the six BRT Alternatives are included in the three BRT Alternatives evaluated in this study. These six BRT Alternatives are further described in **Chapter 4**, *Alternatives Previously Considered.*

The Phase 1 study also developed initial service planning options and proposed a set of station locations based on input from the Rockville and Gaithersburg studies and the County Functional Master Plan. The Phase 1 study was developed with substantial consultation and engagement with the two Corridor Advisory Committees (CAC), MD 355 North and MD 355 South.

4 Alternatives Previously Considered

In Phase 1 of this study, MDOT MTA and the MDOT State Highway Administration (SHA) evaluated Conceptual Alternatives for providing enhanced transit service along MD 355. This evaluation was summarized in the *April 2017 MD 355 BRT Corridor Planning Study Conceptual Alternatives Report.* The alternatives that were evaluated, in addition to the No-Build Alternative (Alternative 1) and TSM Alternative (Alternative 2), are described below.

4.1 Alternative 3A

Alternative 3A in Phase 1 included new BRT service from the Clarksburg Outlets to the Grosvenor Metrorail Station. The service would be in mixed traffic from the Clarksburg Outlets to Middlebrook Road along Observation Drive and on dedicated median lanes from Middlebrook Road to the Grosvenor Metrorail Station along MD 355.

4.2 Alternative 3B – Median Option

Alternative 3B in Phase 1 included new BRT service from Redgrave Place in Clarksburg to the Bethesda Metrorail Station. The service would be mostly on dedicated median lanes from Redgrave Place to the Bethesda Metrorail Station, running its full length along MD 355.

4.3 Alternative 3C – Median Option

Alternative 3C in Phase 1 included new BRT service from Redgrave Place in Clarksburg to the Bethesda Metrorail Station, primarily in median lanes. The service would be mostly on dedicated median lanes from the Grosvenor Metrorail Station to Middlebrook Road, and in mixed traffic along Observation Drive between Middlebrook Road and Clarksburg.

4.4 Alternative 4A

Alternative 4A in Phase 1 included new BRT service from Redgrave Place in Clarksburg to the Grosvenor Metrorail Station. The service would be mostly on dedicated curb lanes from Redgrave Place to the Grosvenor Metrorail Station, running its full length along MD 355.

4.5 Alternative 4B – Curb Option

Alternative 4B in Phase 1 included new BRT service from Redgrave Place in Clarksburg to the Bethesda Metrorail Station. The service would be mostly on dedicated curb lanes from Redgrave Place to the Bethesda Metrorail Station, running its full length along MD 355.

4.6 Alternative 4C – Curb Option

Alternative 4C in Phase 1 included new BRT service from Redgrave Place in Clarksburg to the Bethesda Metrorail Station, primarily in curb lanes. The service would be mostly on dedicated curb lanes from the Grosvenor Metrorail Station to Middlebrook Road, and in mixed traffic along MD 355 between Summit Avenue and MD 124 and along Observation Drive between Middlebrook Road and Clarksburg.

4.7 Alternatives Recommended For Further Study

Four Alternatives were identified to advance to Phase 2 of the study. These alternatives were refined based on the analysis conducted, input received from the CACs and public, and coordination with project stakeholders. These alternatives were the No-Build Alternative (Alternative 1), the TSM Alternative (Alternative 2), Alternative 3C, and Alternative 4C. These were the basis of the alternatives development for Phase 2 of the study.

5 Measures of Effectiveness

The purpose statement included in **Section 1.1** described four distinct goals to assess the ability of each alternative to meet the Purpose and Need of the MD 355 BRT Planning Study. These goals were further developed into a set of criteria called Measures of Effectiveness (MOEs) to evaluate the alternatives. More information on the Purpose and Need and MOEs can be found in **Chapter 2** of the *MD 355 BRT Corridor Summary Report.*

5.1 Provide an appealing, functional, and high-quality transit service

Measures to be evaluated under this goal focus on improving overall transit performance along the corridor. A successful BRT system will provide recognizable advantages for the rider in comparison to other travel modes. Consequently, a higher-quality transit service is needed to increase transit ridership and attract new riders that would otherwise opt to use an automobile.

Each alternative was assessed for its ability to improve the quality of transit service by making bus trips faster and more competitive with automobile travel times; improve transit quality and level of service in the corridor.

5.2 Improve mobility opportunities, accessibility, and transportation choices

The addition of BRT components along MD 355 provides for the opportunity to maximize the capacity of the existing transportation infrastructure and move more people through the corridor. A well-used transit service has the potential for higher person-throughput than a general-purpose lane for automobile users and traditional bus service. This means that a BRT vehicle operating in a dedicated lane may move more people than a stream of single-occupant vehicles utilizing that same space.

Optimizing multimodal facilities within the roadway design facilitates the inclusion of other roadway users, such as pedestrians and cyclists, further improving the access to multimodal facilities. The improved connectivity between automobiles, transit, pedestrians, and cyclists increases choices and the overall efficiency of a regional transportation network.

Each alternative was assessed for its ability to improve mobility opportunities and choices along the MD 355 corridor by making the most productive use of the roadway capacity; providing improved accessibility to jobs and activity centers for corridor residents, and those coming to the corridor; balancing the mobility needs of automobiles, trucks, and transit users; enhancing pedestrian and bicycle connections and options in the corridor; and improving transit services for underserved populations.

5.3 Support planned development

Transit service improvements along MD 355 are conducive to value-capture from public and private investments. Value-capture benefits of transit oriented developments may include increased ridership, joint development opportunities, increased supply of affordable housing, and returns on investment to those who own land and businesses near transit stops. Furthermore, strategic selection of station locations for a high-quality transit service may support infill and redevelopment, which serve as catalysts for revitalizing neighborhoods. Current master plans and sector plans propose TODs at the Bethesda,

White Flint, Twinbrook, Rockville, and Shady Grove Metrorail stations, as well as in proposed TODs along MD 355 near White Flint, Halpine Road in Rockville, and other locations.

Each alternative was assessed for its ability to support planned development by increasing trips by transit to master planned developments. Strategic selection of some station locations for a high-quality transit service may support infill and redevelopment, which serve as catalysts for revitalizing neighborhoods.

5.4 Support Sustainable and Cost-Effective Transportation Solutions

Preserving environmental resources is a key component in enhancing the quality of life, but it is also an essential metric for sustainability and driver of capital cost that aligns with the County's vision as part of Thrive 2050. Transit improvements through BRT facilities and service generally involve infrastructure which is less disruptive to communities and the environment than rail systems.

A successful transit service along MD 355 must carefully consider natural and cultural activity centers and minimize impacts on these resources. The commitment to environmental stewardship also requires stringent mitigation measures for impacts to environmental resources. At a regional scale, public transportation investments like BRT help reduce overall single-occupant vehicle trips, including reducing the carbon footprint and emissions associated with automobile travel. Overall capital investments required by BRT, including vehicles, station development, operating costs, and maintenance requirements, are also typically less significant than for rail transit. With proper performance, the cost-effectiveness of BRT represents a more prudent use of public funds.

Each alternative was assessed for its ability to support sustainable and cost-effective transportation solutions by minimizing: environmental impacts; impacts to private and public property; and, the cost of building and operating transportation services.

6 Alternative Design Details

The Build Alternatives include a variety of elements that contribute to the typical section and create the complete alternatives, including the design criteria, roadside design and limits of disturbance (LOD); station design; stormwater management; detailed technical analyses; traffic modeling and ridership forecasting; and service and operations planning. These elements are described below.

6.1 Design Criteria

The Build Alternatives were based upon MDOT SHA and/or local agency standards, and American Association of State Highway and Transportation Officials (AASHTO) standards, including *AASHTO Policy on the Geometric Design of Highways and Streets (2011)*, *MDOT SHA Book of Standards for Highway and Incidental Structures (2017)*, and *MCDOT Road Code (2008)*. The design criteria used in the development of the alternatives are presented in **Table 6-1**.

Table 6-1: Roadway Design Criteria

Design Elements	Preferred	Minimum
Design Vehicle	Interstate Semi-trailer (WB-67) /Articulated-Bus (A-BUS)	WB-67/A-BUS
Design Speed[1]	40 mph	25 mph
Dedicated Median BRT Lane	12', plus 1' for gutter pan	11', plus 1' for gutter pan
Dedicated Curbside BRT Lane	12', plus outside bike lane	11', plus 1' for gutter pan
Pedestrian Refuge at Signalized Intersections	10'	6'
General Purpose Lanes[2]	Existing lane width	10', plus 1' for gutter pan
Median Refuge (if included)	6'	4' between opposing traffic
Gutter Pans[3]	1'	1'
On-road Bicycle Compatibility: Bike Lanes[4]	Design speed <= 35 mph: 4' > 35 mph Design speed <= 45 mph: 5' > 45 mph: 6' (excluding gutter pan)	No on-road bike lane
On-road Bicycle Compatibility: Buffer between Bike Lane and Traffic Lane (where feasible)	2'	no buffer
Buffer between Curb and Sidewalk or Shared Use Path	6'	3' to provide minimum buffer 0' to provide no buffer
Sidewalk	6' or existing, whichever is greater	5'
Shared Use Path[5]	10' (14' maximum)	8'
Grading / Clear Zone – Desirable Minimum	20-22' at 6:1 (2' w/barrier)	Traffic barrier or crash cushion can be provided

1. Design speed at station approaches (300' on each approach to station platform) is recommended to be 25 mph and will be a minimum of 20 mph.

2. Lane widths may vary from 10 to 12-feet wide. Lane widths of 10 feet may be used in more constrained areas where truck and bus volumes are relatively low, and speeds are less than 35 mph. Lane widths of 11 feet are used extensively for urban arterial street design. 12-foot wide lane widths are desirable, where practical, on high-speed, free flowing principal arterials. An 11-foot wide lane width is adequate for through lanes, continuous two-way left-turn lanes, and lanes adjacent to a painted median. (AASHTO, 2011 pg. 7-29). Design exception required to be approved by MDOT SHA for 10-foot wide lanes.
3. For closed section typical sections
4. See MDOT SHA 2015 Bicycle Policy and Design Guidelines for full detail
5. See Montgomery County Road Code Bill 33-13 for full detail

6.2 Limit of Disturbance

The Limit of Disturbance (LOD) was developed for the Build Alternatives using the proposed pavement width, any necessary proposed pedestrian improvements, proposed stormwater management facilities, and grading behind the curb or pedestrian improvements. This LOD is used to quantify environmental impacts and serve as the proposed right-of-way line where it is located outside the existing right-of-way line.

In most locations, the LOD was offset ten feet behind the cut/fill line or retaining wall in order to accommodate drainage and construction easements and to account for the conceptual level of engineering. In some constrained locations, the offset was reduced to five feet to avoid or minimize impacts to adjacent properties.

6.3 Station Design

The Metropolitan Washington Council of Governments (MWCOG) commissioned the Montgomery County Bus Rapid Transit Station Prototype Design Project. The purpose of the project was to develop customizable station prototypes for the proposed BRT corridors throughout Montgomery County. The project proposed station elements that would be adaptable to curb drop off and center median stops; and would respond to a range of ridership.

The Station Framework assumes a 65-foot long, 15 to 20-foot wide platform to accommodate a 60-foot long articulated low-floor bus with level boarding, a station platform height of ten to 12 inches above the roadway, and off-board fare collection.

Nine station types were proposed based on initial ridership projections and specific context, while also being adaptable to potential increases. These station types, used in the Phase 2 MD 355 BRT Planning Study, are shown in **Figures 6-1 and 6-2**. Stations in downtown Bethesda and Rockville Town Center, were modified to accommodate Station Type 1 due to the urban environment and existing constraints. All other stations were designed to accommodate Station Types 2 through 6, which is a side-loading BRT station.

Figure 6-1: Station Types 1 through 6

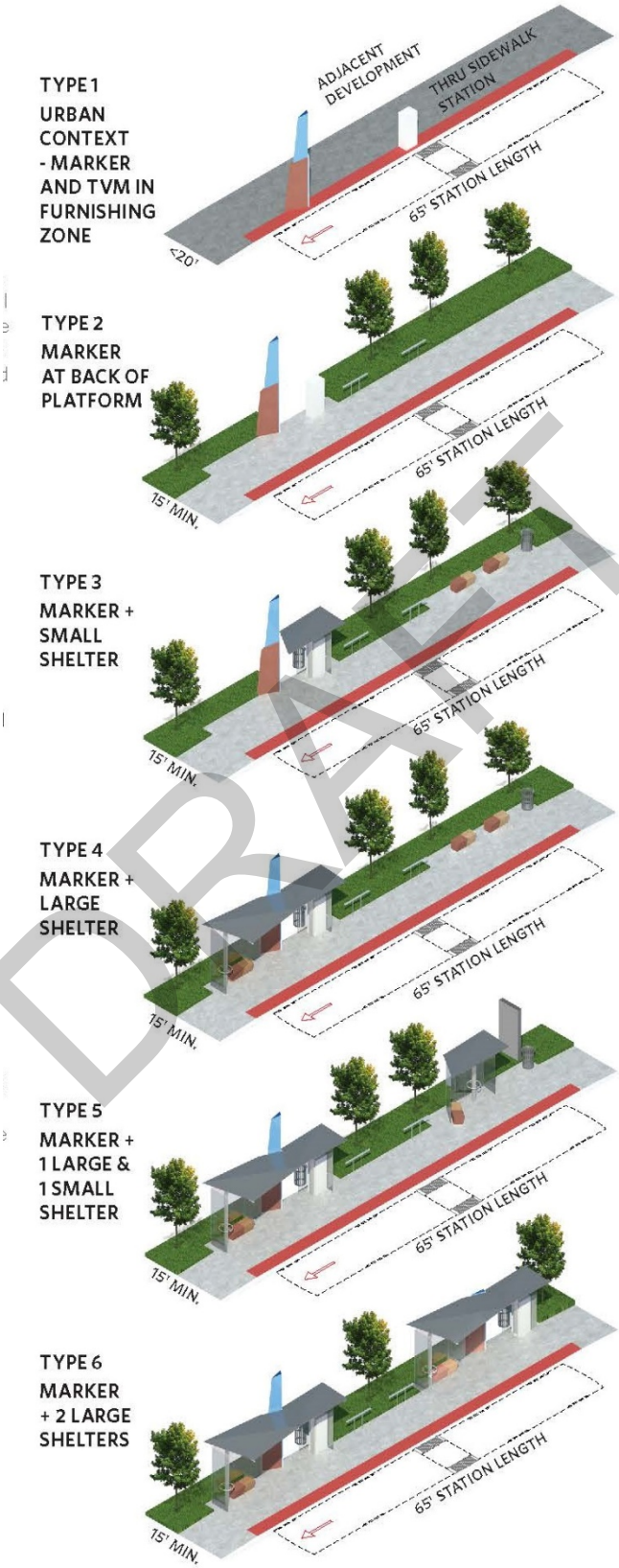
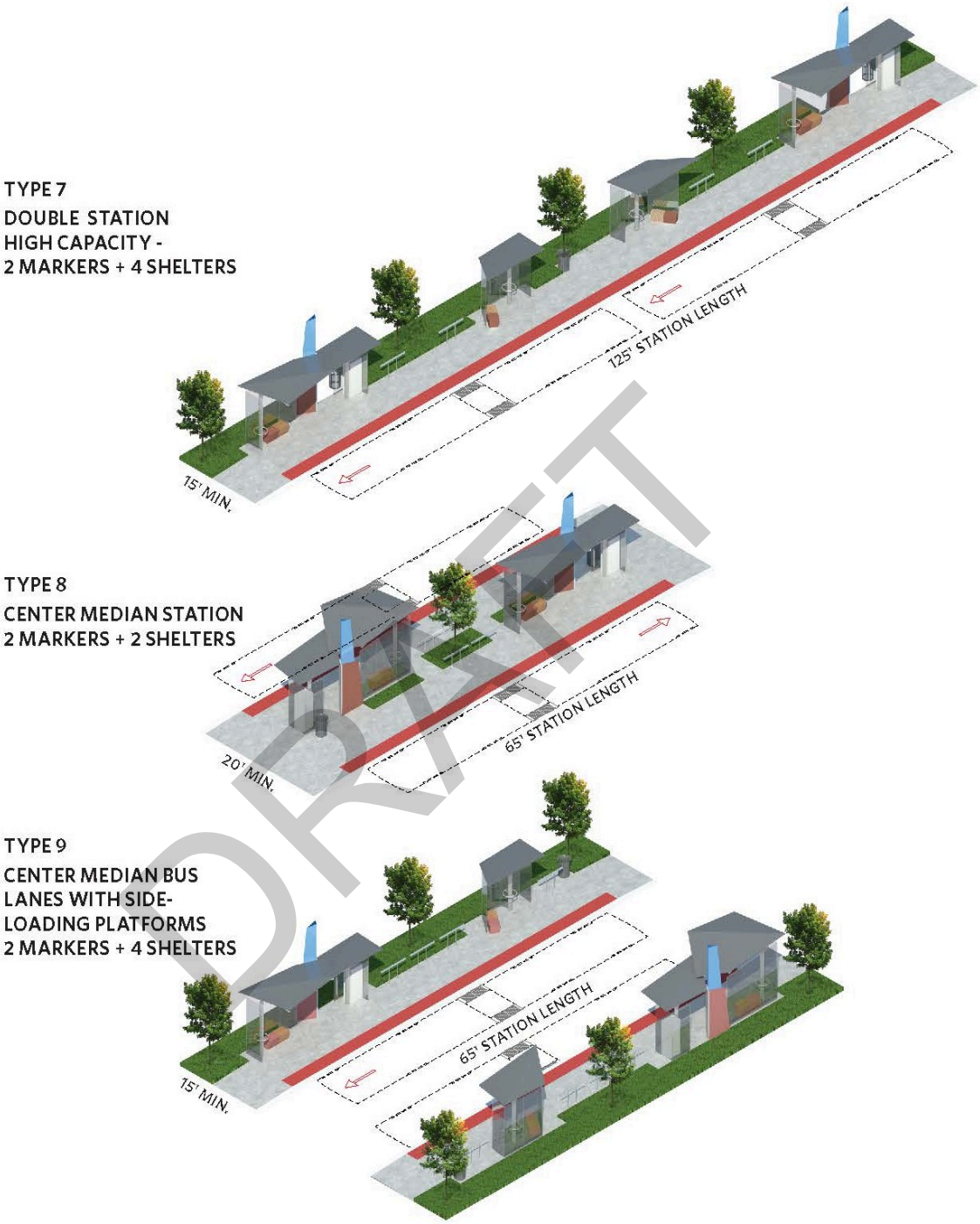


Figure 6-2: Station Types 7 through 9



6.4 Stormwater Management

In order to more accurately establish the LOD and develop construction cost estimates, preliminary stormwater management facilities were designed for the Build Alternatives. The stormwater facilities were designed to meet Montgomery County stormwater management requirements through Best Management Practices (BMPs). The review and approving authority for the stormwater management designs is assumed to be the Montgomery County Department of Permitting Services.

All impervious area within the LOD would contribute to the volume requirements. Stormwater management would be implemented to manage runoff for the project within the LOD for water quality and quantity control. Stormwater management for the proposed alignment for water quality would be provided using environmental site design (ESD) to the maximum extent practicable (MEP). Stormwater quantity management would be provided for the one-year storm (ESDv) for the entire alignment and for the ten-year storm where flooding problems or inadequate drainage conveyance has been identified by the County within the project corridor.

Six different types of stormwater management BMP facilities were utilized in the preliminary design for Phase 2. They are described in **Table 6-2**.

Table 6-2: Proposed Stormwater Management Facilities

Facility Type (BMP)	Description
Planter Boxes (Bioretention)	Planter Boxes have vertical side slopes which reduces the grading / LOD impact. They can be placed in open spaces with a minimum open width of six feet (assuming a bottom width of four feet). Because of their small footprint and linear nature, planter boxes were utilized both onsite and offsite.
Bioswales	Bioswales are a linear practice, with multiple inlet points, preferably from sheet flow, to the treatment area that can operate in an open area as wide as 20 feet (assuming an eight-foot wide buffer on each side for grading and minimum bottom width of four feet). Bioswales require mild slopes and an outfall point, usually a yard inlet. Unlike planter boxes, bioswales have graded side slopes at four horizontal to one vertical (4:1) allowing them to be deeper and offer more storage volume.
Microbioretention and Bioretention	In situations where suitable amounts of open space are available, bioretention or microbioretention would be the preferred facility. Bioretention basins offer good treatment credit, are aesthetically pleasing, and are relatively easy to maintain.
Underground Water Quality Structures	Underground facilities used for stormwater quality treatment have been designed as concrete structures with a seven-foot minimum width, a height of six feet and a five-foot buffer on all sides for maintenance access. The facility is assumed to be a Rainstore3 type of facility (or similar) and guidelines from that product line were used in sizing and crediting. In areas where underground facilities were proposed, it was assumed that there were either no underground

Facility Type (BMP)	Description
	utilities or that they could be easily relocated. Facilities were placed at least 15 feet away from structures. Facilities were mainly placed under parking lots, open areas, and dedicated bus lanes in Alternative B. With the exception of the bus lanes, facilities were not placed under roadways.
Water Quantity	Stormwater quantity requirements were satisfied where possible by either an underground detention structure or a retrofit expansion of an existing management pond. Underground quantity structures were designed to be a large concrete detention structure placed in areas adjacent to the existing storm sewer network and away from roadway travel lanes. These units were used throughout the study area in points of investigation (POIs) that had quantity management requirements. Opportunities to use ponds and surface BMPs were limited due to a lack of open space and strict criteria of meeting quantity objectives within the POI.
Pervious Pavement	Pervious Pavement was been proposed in several shared use path areas because it supports pedestrian traffic and stormwater management.

Analysis was completed for Alternative A and Alternative B. Alternative C used the analysis for Alternative B, since the amount of widening needed would be similar. Facilities were located accordingly for each alternative.

More detailed information, including drainage area maps and calculations, can be found in the *Stormwater Management Technical Report*.

6.5 Side Alignment Studies and other Technical Analyses

Additional technical analyses were completed as a part of Phase 2 of the MD 355 BRT Planning Study which informed the development of the Build Alternatives.

6.5.1 Side Alignment Studies

Numerous requests were received from the public and other stakeholders to look at potential side alignments that would deviate from the originally proposed base alignments in Phase 1. These side alignments were evaluated to determine their merits, and included a review of engineering feasibility, an assessment of the impacts of the side alignment on BRT travel time, and a transit operations evaluation. The side alignment locations that were evaluated included the following:

- Woodmont Avenue
- Around the White Flint Mall

- Jefferson Street
- North Stonestreet Avenue
- North Washington Street
- Tunnel under MD 355 through Rockville Town Center
- Russell Street
- Lost Knife Road
- Seneca Meadows Parkway

As a result of these side alignment studies, Alternatives A, B, and C were modified to include the diversion to Lakeforest Transit Center on Lost Knife Road. Without providing this connection at the Lakeforest Transit Center, current and potential transit users in this area would either have a substantial walk to access the BRT route, or other local bus routes would have to be changed to provide the necessary connection to this route. The existing Lakeforest Transit Center is located to the east of Lakeforest Mall, approximately three-quarters of a mile away from MD 355. Lakeforest Mall is largely vacant, and redevelopment of the site has been mentioned. Future plans to redevelop the Lakeforest Mall should include examination and strong consideration for shifting the transit center to the west, creating a shorter diversion for the BRT and placing the transit center closer to the activity along MD 355.

Additionally, Alternative A was modified to include the Seneca Meadows Parkway side alignment to evaluate the potential increase in ridership and access to jobs and people on that corridor.

6.5.2 Unbuilt Segment of Observation Drive

There are two disconnected segments of Observation Drive. In the south, Observation Drive currently extends from Middlebrook Road up to Woodcutter Drive/Waters Discovery Lane. In the north, there is a short segment from Roberts Tavern Drive to Stringtown Road.

Montgomery County is leading a project, which is currently under design, to connect these two existing segments of Observation Drive as a continuous roadway from Middlebrook Road to Stringtown Road. The design maintains a similar typical section to the existing Observation Drive with four lanes and a wide median. There are portions of the roadway that would have a shoulder and other segments that would include curb and gutter. There would be two new major intersections along the proposed corridor at Old Baltimore Road and Shawnee Lane.

The feasibility of this connection for BRT service was analyzed as part of Alternative B. The BRT would utilize the fully continuous Observation Drive, operating in mixed traffic from Middlebrook Road to Stringtown Road.

6.5.3 Reversible Guideway Evaluations

In Rockville Town Center in Segment 3 and in the City of Gaithersburg in Segment 5, Alternative B would include a stretch of one-way guideway due to existing constraints.

The Project Team analyzed two different dedicated single median lane options in Segment 3: a peak-period reversible dedicated BRT lane and a one-way southbound BRT lane. Overall, the better option for the downtown Rockville bus rapid transit lane would be the one-way southbound option because it is less expensive and less impactive than the reversible lane. When analyzing the reversible lane option, it was shown that providing an exclusive lane for the northbound movement during PM Peak hours did not have substantial benefits that would warrant its selection.

Additionally, a single-lane reversible median dedicated BRT guideway lane is considered for Alternative B in Segment 5. The MDOT Phase 1 *MD 355 BRT Corridor Study* technical report recommended evaluating the single-lane guideway treatment as part of the Phase 2 planning process: ". . . a reversible dedicated median BRT lane would be provided in Alignment Section 5. Transit exclusivity would be provided for southbound BRT vehicles in the AM peak and northbound vehicles in the PM peak. BRT vehicles in the off-peak direction would run in mixed traffic (northbound in the AM peak and southbound in the PM peak)." This design would largely repurpose the existing center two-way left turn lane and minimize right-of-way impacts. Perhaps most importantly, the single reversible lane would virtually eliminate safety concerns from head-on conflicts and scheduling impacts for peak direction travel because BRT vehicles would only travel in one direction in the guideway at all times. Mixed traffic BRT operations would be subject to prevailing traffic congestion in the off-peak direction of travel, but that would involve lower traffic volumes and ridership than the peak direction. Prioritizing the BRT operational efficiency for the peak direction supports increased passenger throughput and better overall service through the segment.

6.5.4 Bridge Widening Evaluation

Based on a review of the most recent bridge inspection reports, both the Father Stanislaus Cuddy Memorial Bridge and Great Seneca Creek Bridge were determined to be "not deficient" according to FHWA's Structure Inventory and Appraisal Report guidelines. There is no information regarding the bridge condition contained in the reports suggesting that either bridge should be rehabilitated or replaced.

Widening one or both of the bridges to accommodate a wider roadway section for the MD 355 BRT would result in significant impacts requiring mitigation through the structural engineering and permitting process. None of the proposed BRT alternatives require widening to accommodate an allowable typical section for the roadway and BRT guideway.

7 Alternatives

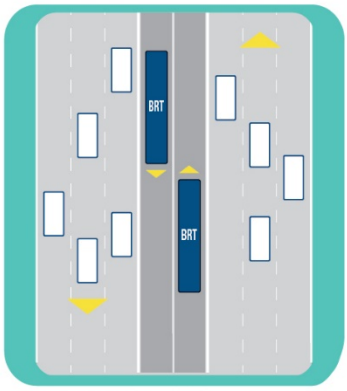
Five alternatives, including the No-Build Alternative, were fully evaluated as part of Phase 2 of the MD 355 BRT Planning Study. Each technical report and memorandum prepared in support of the Corridor Summary Report assesses existing conditions and environmental impacts for each alternative. An additional alternative, called Alternative B Modified, was added near the end to attempt to minimize cost and right-of-way. This alternative was not fully evaluated but was deemed feasible and is described in more detail in **Chapter 10**.

7.1 BRT Alternative Components

BRT combines elements such as dedicated guideways, specialized buses, specialized signal operations, and bus stations with level boarding and off-board fare collection. Some of the roadway elements that may be incorporated into the MD 355 BRT alternatives are defined in more detail in the following sections.

7.1.1 Guideway

Transit service can be provided via a variety of guideway treatments: a dedicated two-lane median guideway, a dedicated one-lane median guideway (to accommodate transit service in one direction or in both directions), dedicated curb lanes, or running in mixed traffic. The guideways can be mixed and matched along the corridor to best fit within the existing constraints and needs of the area. These treatments are described in more detail below.

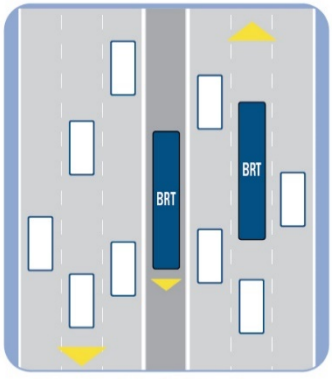


Dedicated Two-Lane Median Running Way

7.1.1.1 Dedicated Two-Lane Median Guideway

Two lanes located in the center of the roadway would be dedicated for use by the BRT and may be physically separated from traffic by a raised curb or median. Median BRT lanes would minimize conflicts with general traffic and allow the BRT to operate faster and more reliably. However, the BRT lanes would interact with other traffic at intersecting cross streets. To avoid conflicts and address safety concerns, general traffic could only make left turns at signalized intersections.

7.1.1.2 Dedicated One-Lane Median Guideway

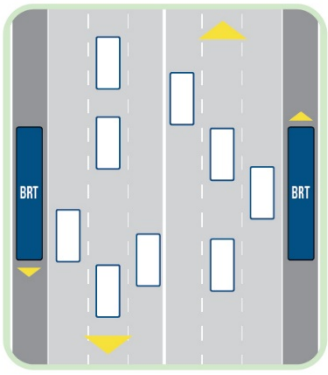


Dedicated One-Lane Median Running Way

Multiple types of one-lane BRT operations are being considered: bi-directional, fixed direction, and reversible operations. In bi-directional operations, BRT vehicles traveling in both directions would share a single dedicated lane in the center of the roadway. Since the BRT travels within this one lane in both directions, passing zones would be created, generally at station locations, so BRT vehicles moving in opposite directions would not conflict with each other.

In fixed-direction operations, a single median BRT lane would be used solely by a single direction of the BRT. The other direction would travel in mixed traffic. In reversible-direction operations, the direction of the BRT in the one median lane

would vary depending on the time of day. BRT vehicles traveling in the peak direction would use the median BRT lane and BRT vehicles traveling in the non-peak direction would be in mixed traffic.



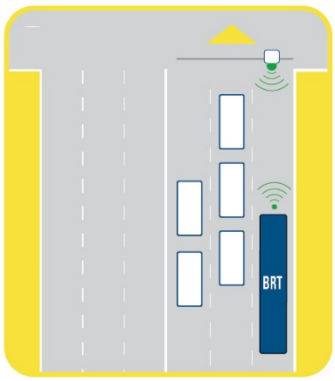
Dedicated Curb Lanes

7.1.1.3 Dedicated Curb Lanes

The lanes adjacent to the curb would be used exclusively by the BRT, local buses, and right-turning vehicles. The roadway surface may be painted or otherwise marked to reinforce the lane designation. Similar to the median guideways, multiple types of dedicated curb lane operations are being considered including two lanes (one on each side of the roadway), and one curb BRT lane in locations where existing constraints make additional widening impactive and where off-peak BRT vehicles can efficiently operate in mixed traffic.

7.1.2 Transit Signal Priority

Transit Signal Priority (TSP) would give priority to BRT vehicles when certain conditions are met by either extending a green light or shortening a red light to allow an approaching BRT to pass through the intersection. TSP was implemented on the MD 355 corridor between Medical Center and the Lakeforest Transit Center as part of Ride On extRa service.

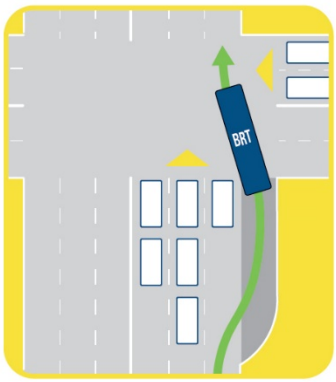


Transit Signal Priority

7.1.3 Queue Jumps

Queue jumps are a short section of widened roadway or an existing right turn lane used to allow BRT vehicles to bypass congestion or delays at intersections. In most applications, queue jumps are used in conjunction with TSP to provide a lane and dedicated BRT signal that allows BRT vehicles to enter an intersection and "jump" ahead of the other vehicles stopped at the light.

Queue jumps are proposed in Alternatives A and C and the locations are listed in **Table 7-1.** The locations were selected based on projected intersection delay, average queue lengths, geometric feasibility, and right-of-way requirements.



Queue Jumps

Table 7-1: Proposed Queue Jump Locations in Alternatives A and C

Segment	Location	Northbound	Receiving Lane	Southbound	Receiving Lane
2	Tuckerman Lane	✓	No		
2	Strathmore Avenue	✓	No	✓	No
2	Nicholson Lane	✓	Yes		
2	Marinelli Road	✓	Yes		
2	Edmonston Drive	✓	No		
2	Wootton Parkway	✓	No	✓	No
2	Monroe Place	✓	No		
3	East Middle Lane	✓	No	✓	No
4	Redland Boulevard	✓	No		
4	Watkins Pond Boulevard			✓	Yes
4	Rockville Corporate Center			✓	Yes
4	Gude Drive			✓	No
6	Little Seneca Parkway	✓		✓	Yes
6	Germantown Road	✓	Yes		
6	Foreman Boulevard	✓	Yes	✓	Yes
6	Middlebrook Road	✓	Yes		

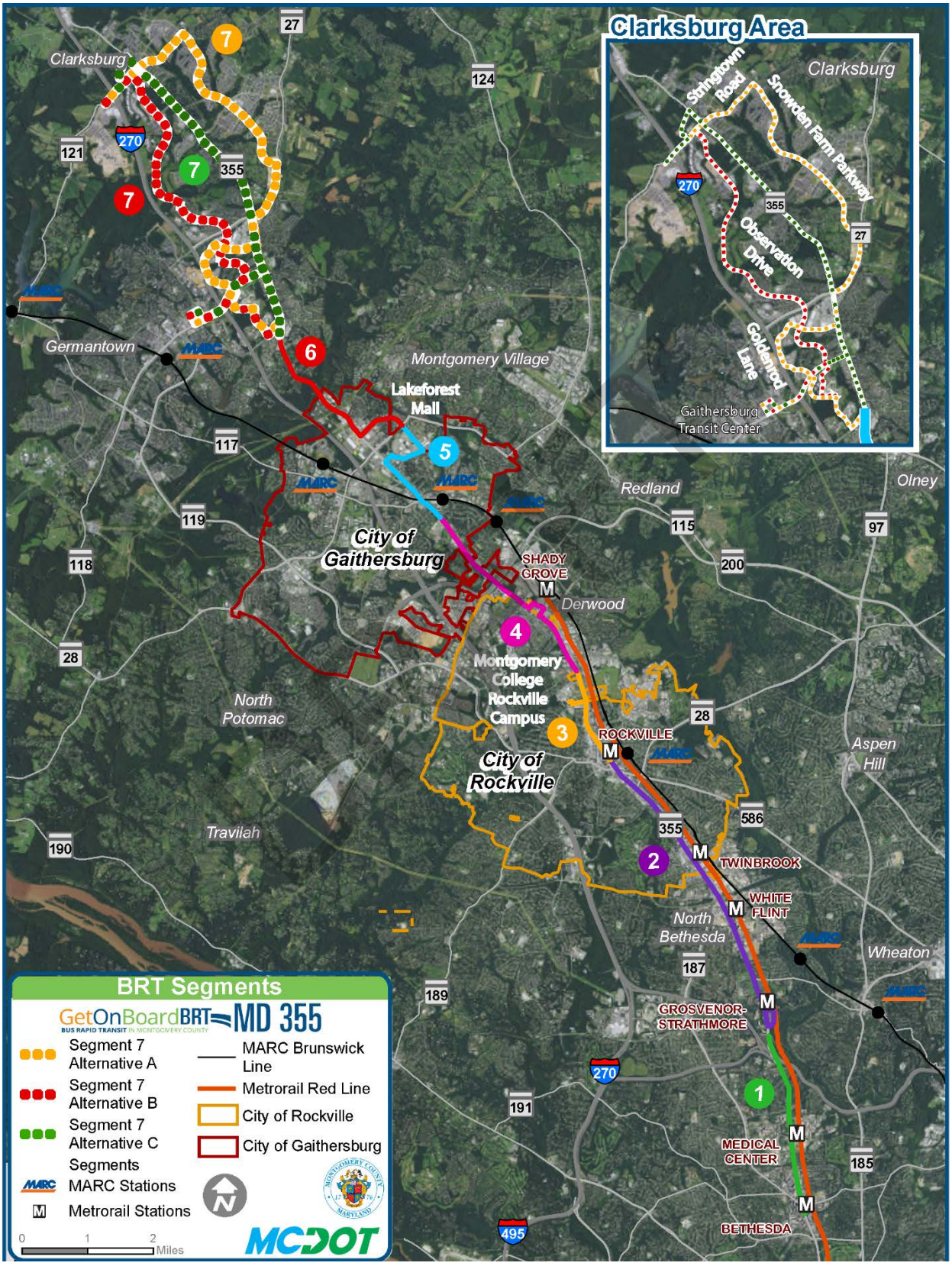
7.2 Alignment Segments

Due to the existing conditions that vary along MD 355 as the roadway transitions from an urban environment in downtown Bethesda to an exurban setting in Clarksburg, the corridor was divided into seven segments during Phase 1 of this study and carried forward into Phase 2. The segments are primarily geographically based with each having its own set of characteristics, opportunities, challenges, and constraints. The seven segment methodologies were retained for Phase 2 and are used to describe the alternatives in detail below. They are listed in **Table 7-2** and shown in **Figure 7-1**.

Table 7-2: Alternative Alignment Segments

Segment	Geographic Description
1	Bethesda Metrorail Station to Grosvenor Metrorail Station
2	Grosvenor Metrorail Station to Dodge Street
3	Dodge Street to College Parkway
4	College Parkway to Summit Avenue
5	Summit Avenue to MD 124
6	MD 124 to Middlebrook Road
7	Middlebrook Road to Clarksburg

Figure 7-1: Alternative Alignment Segments



7.3 No-Build Alternative

The No-Build Alternative would include no additional infrastructure or operational improvements other than those already planned and programmed, including the Ride On extRa service launched in October 2017 from the Medical Center Metro Station to Lakeforest Transit Center. This service includes Transit Signal Priority (TSP) at key locations along the corridor. Ride On extRa stop locations are listed in **Table 7-3**.

Table 7-3: Ride On extRa Stop Locations

Segment	Location
1	Medical Center
2	Tuckerman Lane
2	Security Lane
2	Marinelli Road
2	Halpine Road
2	Edmonston Road
3	Rockville Metrorail Station
3	Montgomery College
4	Shady Grove Metrorail Station
4	Westland Drive
5	Summit Avenue
5	Lakeforest Transit Center

7.4 Transportation System Management (TSM) Alternative

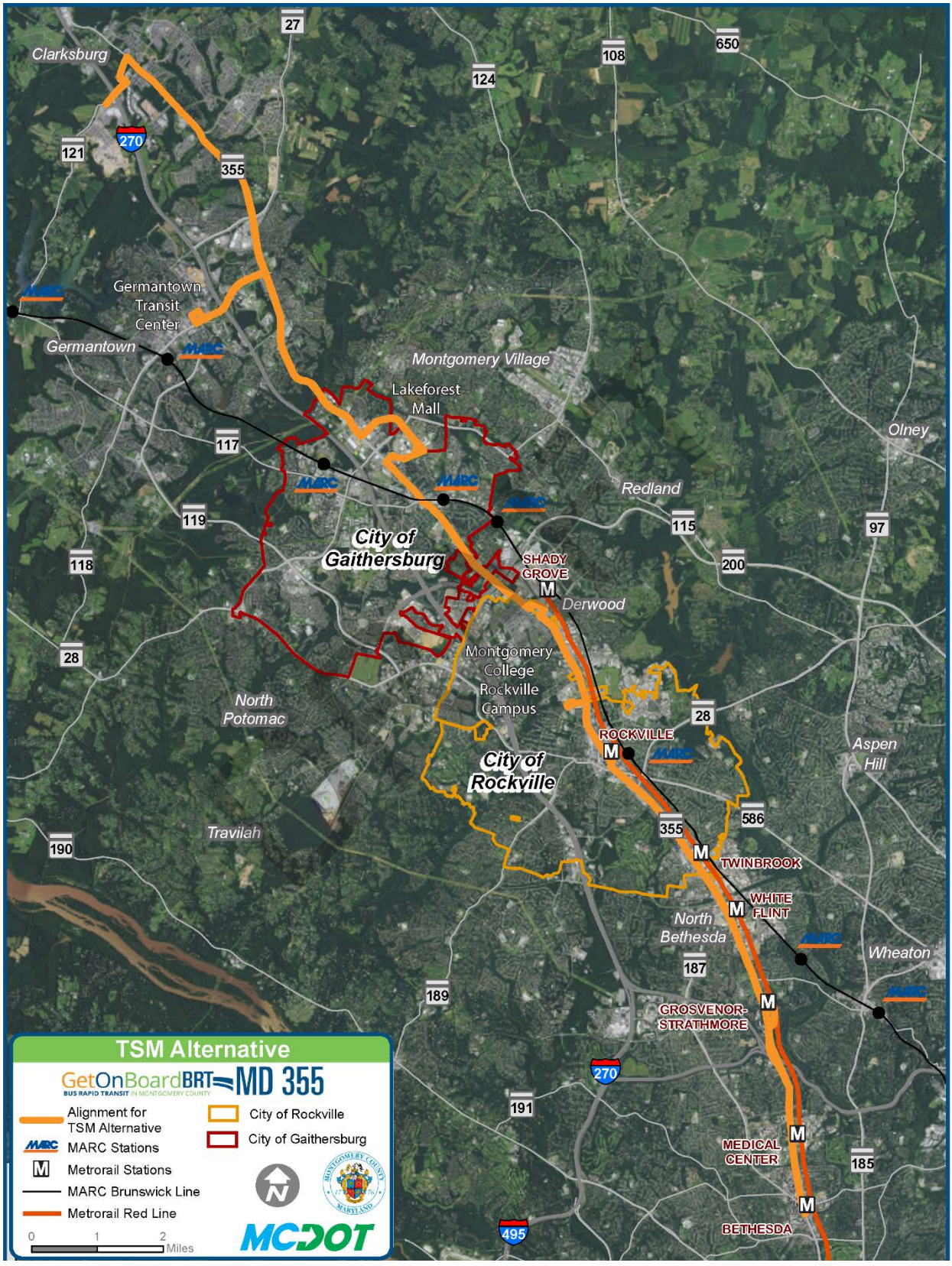
The TSM Alternative would consist of enhanced bus service operating in mixed traffic using existing lanes from the Bethesda Metrorail Station to Clarksburg along MD 355 and along Clarksburg Road to the Clarksburg BRT terminus. The proposed alignment for the TSM Alternative is shown in **Figure 7-2**.

7.4.1 Segments 1 through 6

In Segments 1 through 6, the Ride On extRa would operate in mixed traffic along MD 355. There would be no widening of the roadway.

In Segment 5, the Ride On extRa currently terminates at the Lakeforest Transit Center. The service would be extended from Lost Knife Road onto Christopher Avenue before returning the MD 355. The alignment would remain on MD 355 before reaching the end of Segment 6 at Middlebrook Road.

Figure 7-2: TSM Alternative



7.4.2 Segment 7

In Segment 7, the Ride On extRa would operate in mixed traffic along on MD 355 from Middlebrook Road to the BRT terminus at Clarksburg, via Clarksburg Road, Gateway Center Drive and Stringtown Road.

7.5 Alternative A

Alternative A would enhance elements of the TSM Alternative by including additional elements such as TSP and queue jumps to create a BRT service with limited infrastructure improvements. Alternative A would consist of BRT service, operating in mixed traffic using existing lanes from the Bethesda Metrorail Station near Elm Street to Clarksburg along MD 355. It would also include BRT stations with off-board fare collection and level boarding, articulated buses, and FLASH branding.

There would be no widening of the roadway, with the exception of queue jumps at select intersections. The proposed alignment for Alternative A is shown in **Figure 7-3,** a breakdown by segment is described below and shown in **Figure 7-4** and proposed typical sections for Alternative A are shown in **Figures 7-5 through 7-9**. Detailed Plan Sheets are included in **Appendix A**.

7.5.1 Segments 1 through 6

In Segments 1 through 6, the BRT would operate in mixed traffic along MD 355. There would be no widening of the roadway except at queue jump locations.

In Segment 1, the BRT terminus would be located at Elm Street and MD 355, adjacent to the Bethesda Metrorail south entrance, and the entrance to the Purple Line station, currently under construction. Buses ending southbound service would turn right onto Bethesda Avenue, then right on Woodmont Avenue, and right on Elm Street.

In Segment 2, queue jumps would be located along MD 355 at the intersections of Tuckerman Lane (northbound), Strathmore Avenue (northbound and southbound), Nicholson Lane (northbound), Marinelli Road (northbound), Edmonston Drive (northbound), Wootton Parkway (northbound and southbound), and Monroe Place (northbound).

In Segment 3, BRT service would be provided to Montgomery College - Rockville via Mannakee Street. Queue jumps would be located along MD 355 at the intersection of East Middle Lane (northbound and southbound).

In Segment 4, BRT service would be provided to the Shady Grove Metrorail Station via Redland Road, Somerville Drive, and Metro Station Drive in mixed traffic. Queue jumps would be located along MD 355 at the intersections of Redland Boulevard (northbound), Watkins Pond Boulevard (southbound), Rockville Corporate Center (southbound), and Gude Drive (southbound).

In Segment 5, BRT service would divert from MD 355 at Lakeforest Boulevard to travel in mixed traffic on Lakeforest Boulevard, Russell Avenue, Odendhal Avenue, and Lost Knife Road to the Lakeforest Transit Center on the east side of the Lakeforest Mall. From the Lakeforest Transit Center, the BRT would travel

Figure 7-3: Alternative A

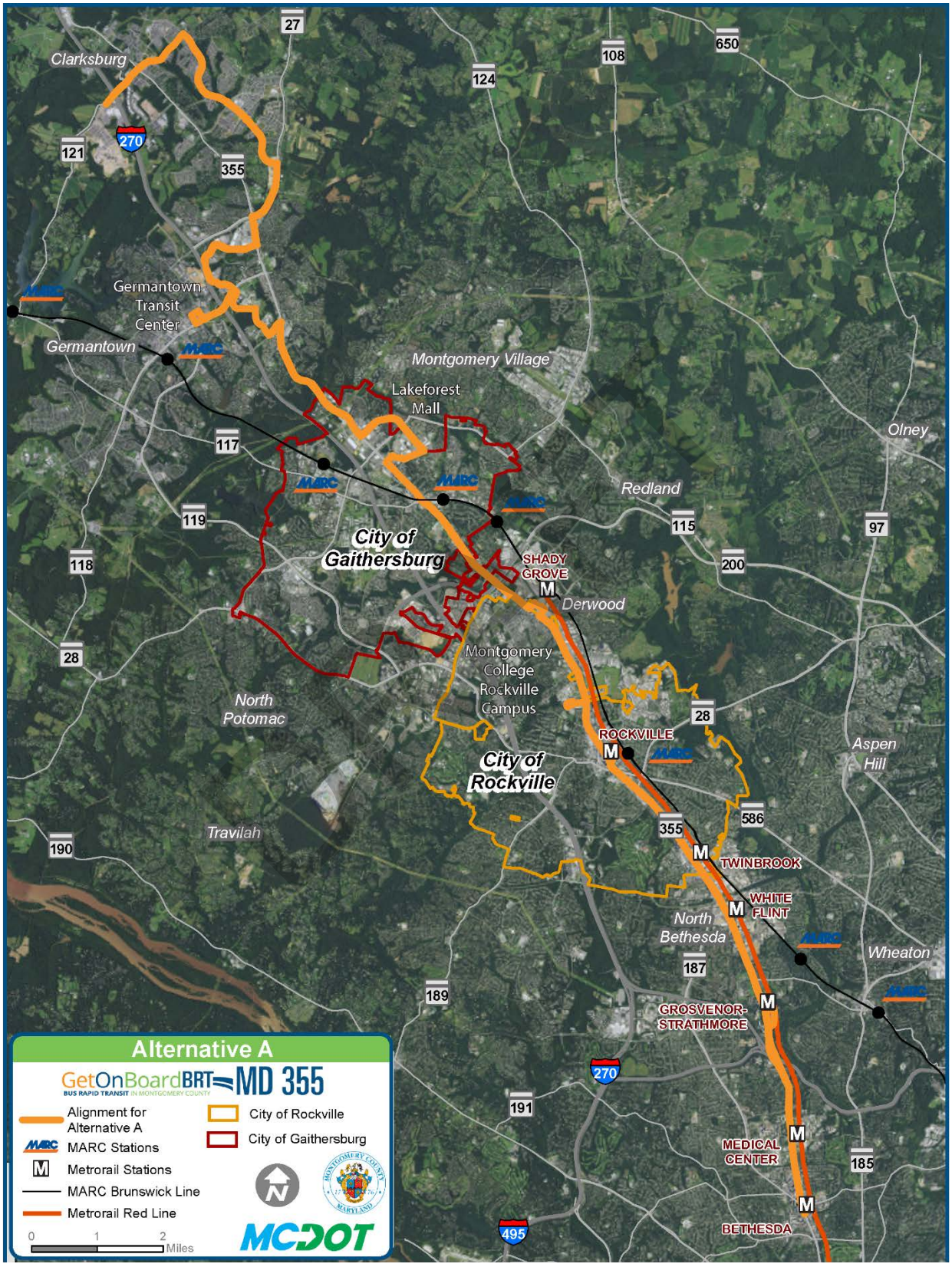


Figure 7-4: Alternative A Segment Features

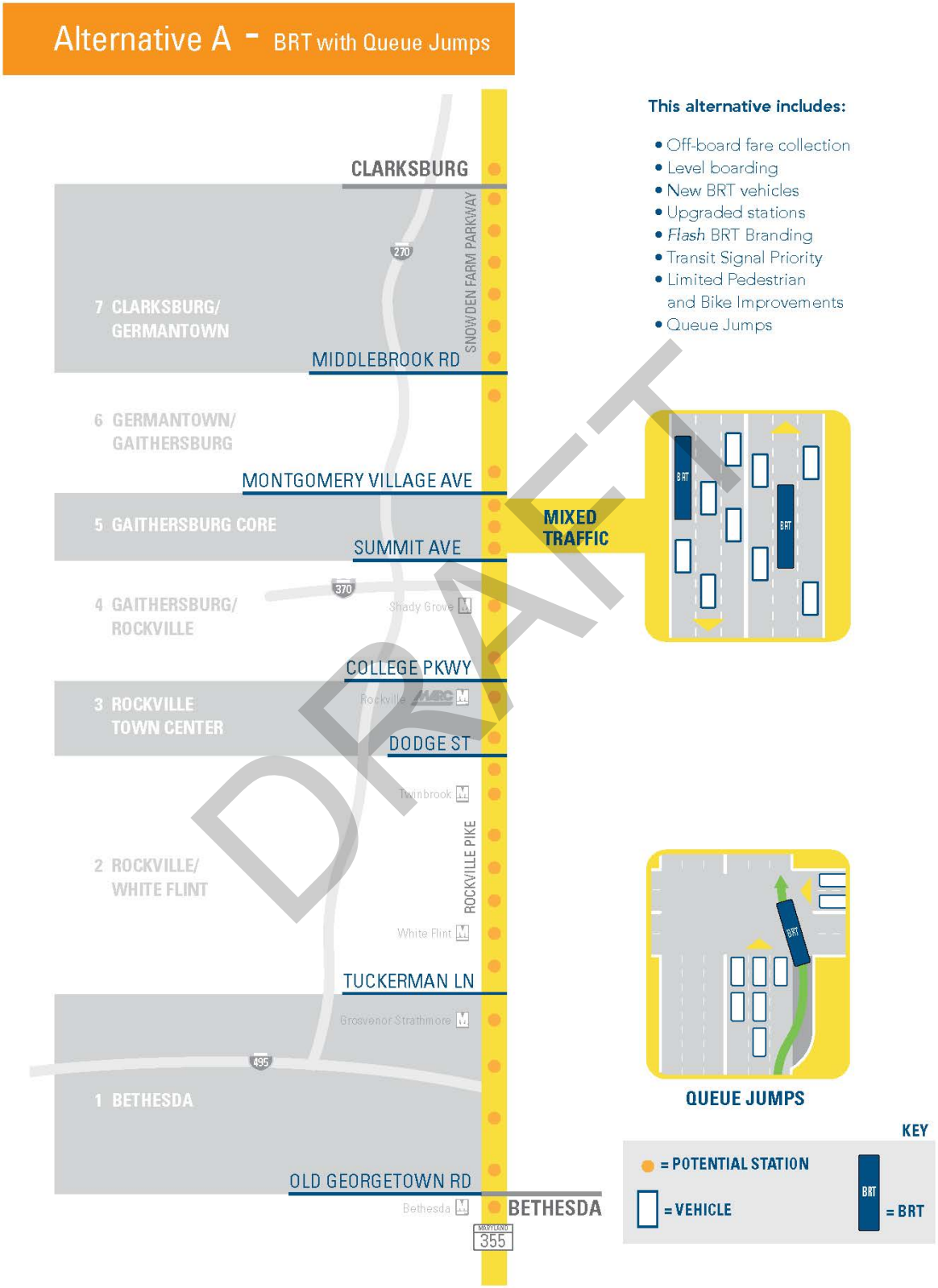


Figure 7-5: Alternative A Typical Sections

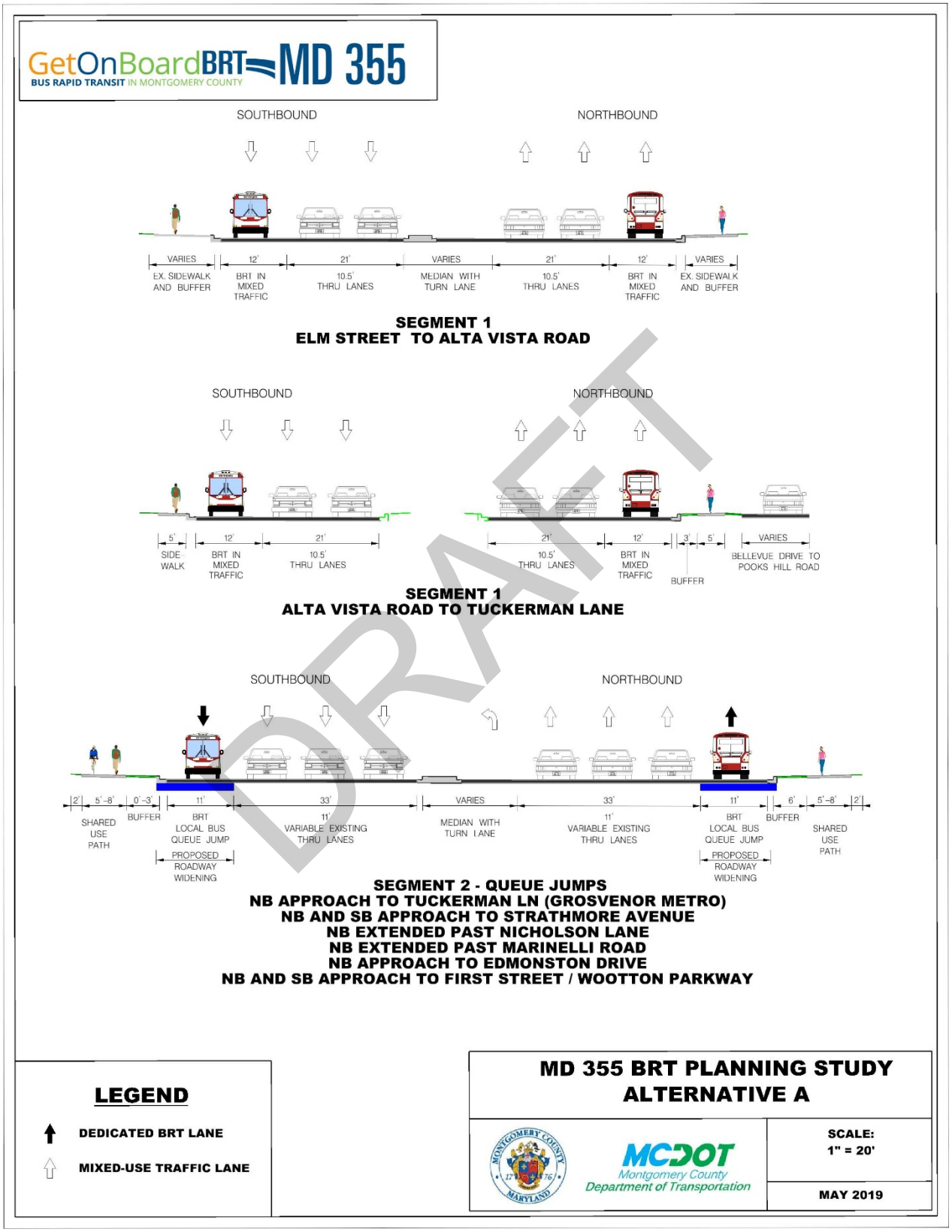


Figure 7-6: Alternative A Typical Sections

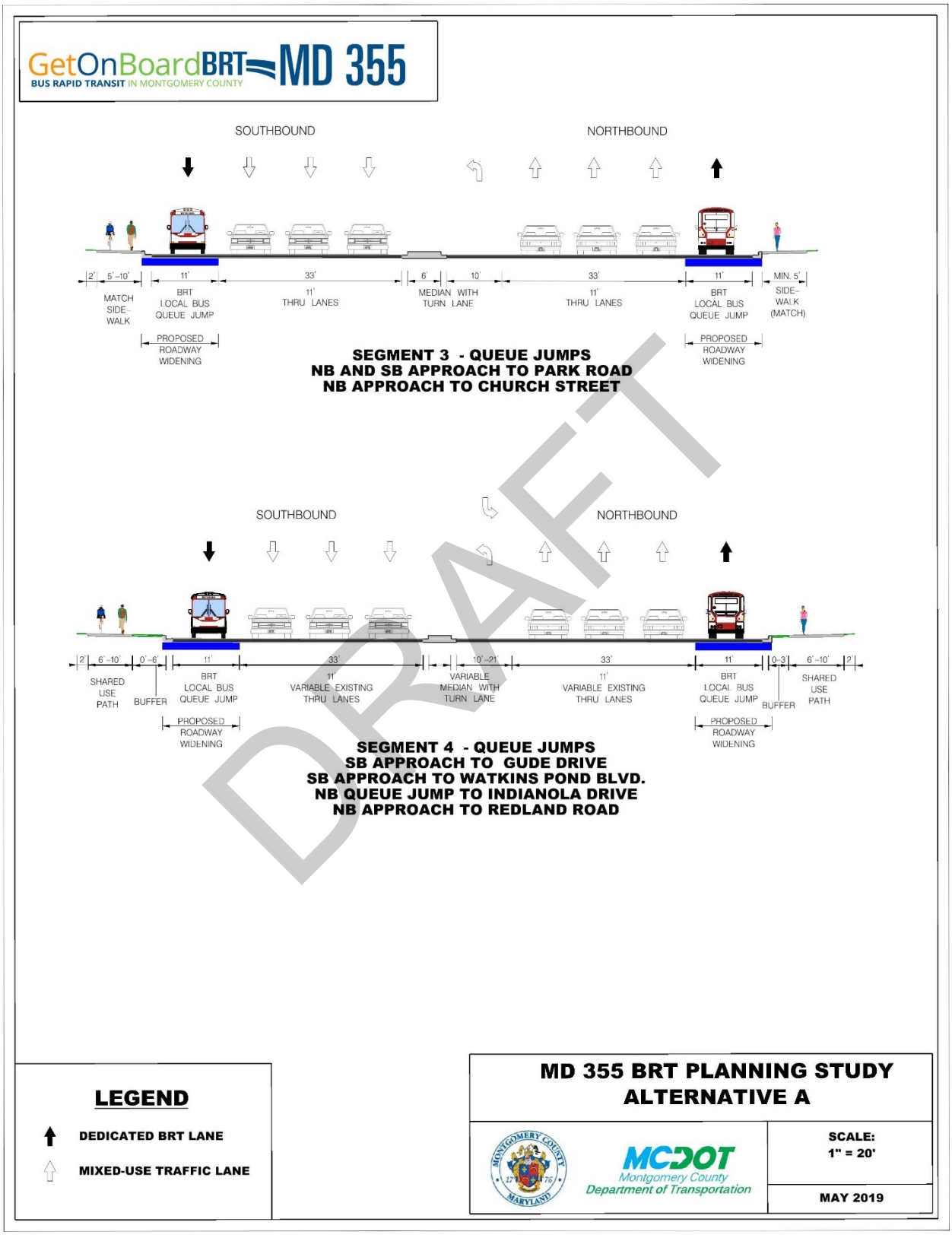


Figure 7-7: Alternative A Typical Sections

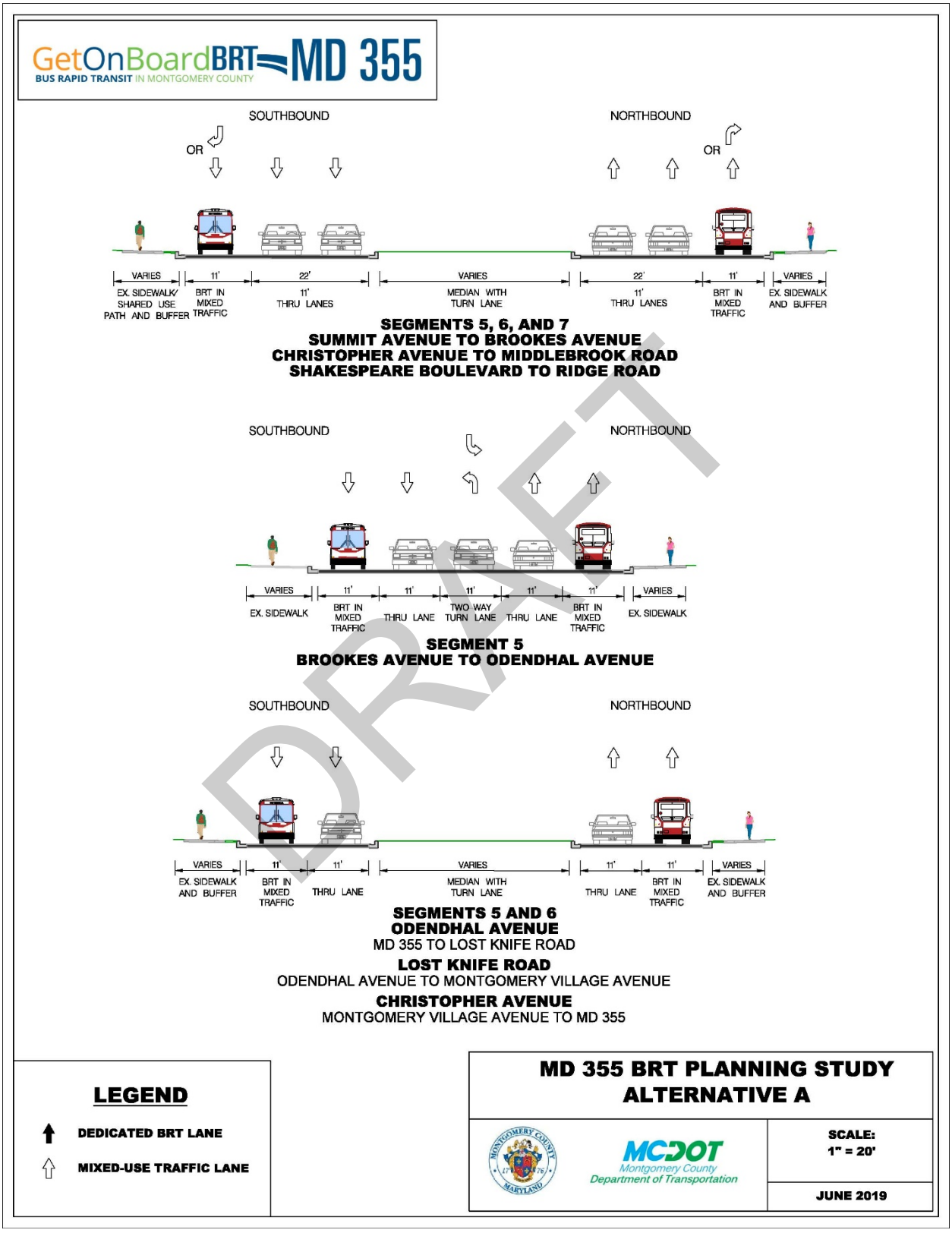


Figure 7-8: Alternative A Typical Sections

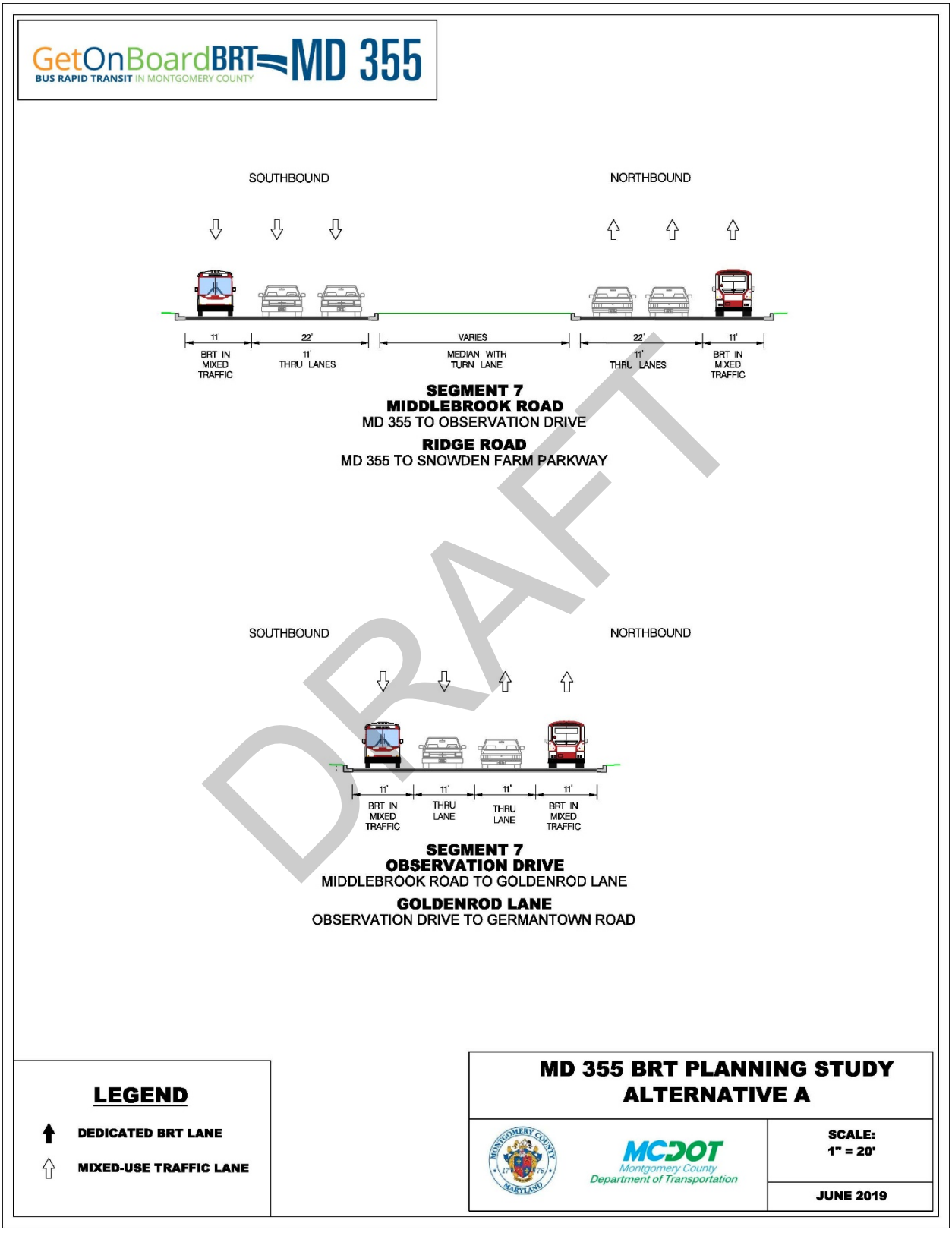
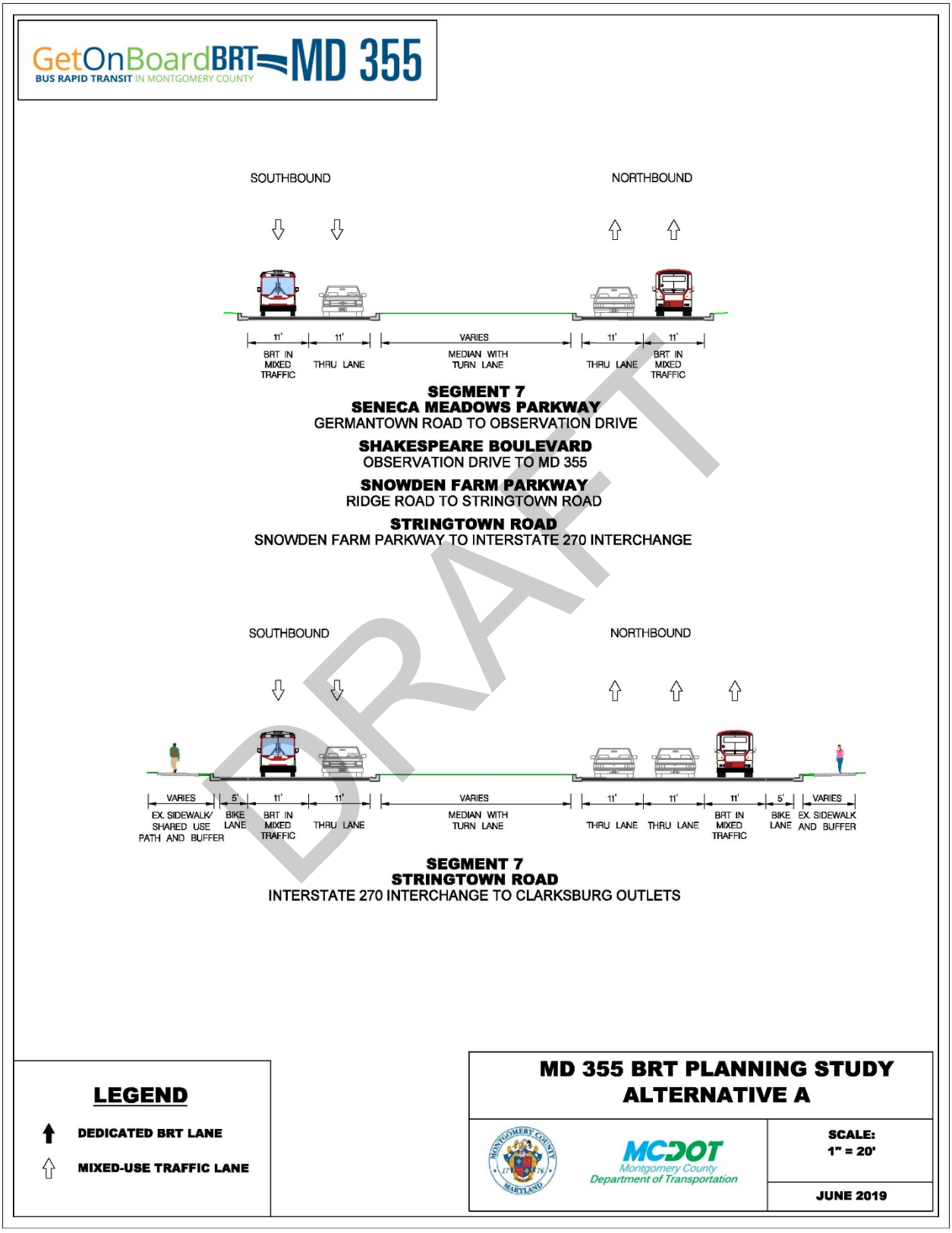
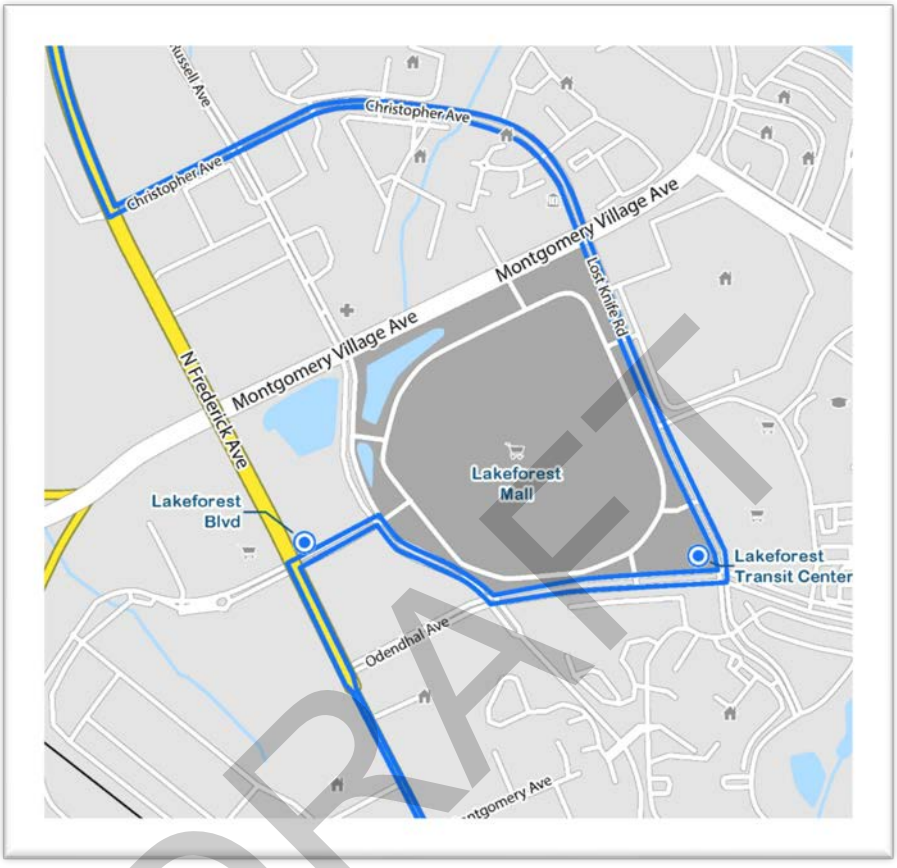


Figure 7-9: Alternative A Typical Sections



in mixed traffic on Lost Knife Road and cross MD 124 (Montgomery Village Avenue) to continue onto Christopher Avenue in Segment 6. See **Figure 7-10** for the service route to Lakeforest Transit Center.

Figure 7-10: Service Route to Lakeforest Transit Center



In Segment 6, BRT service would continue from Lost Knife Road onto Christopher Avenue before returning to MD 355. The alignment would remain on MD 355 before reaching the end of Segment 6 at Middlebrook Road. Queue jumps would be located along MD 355 at the intersections of Foreman Boulevard (northbound and southbound), Little Seneca Parkway (northbound and southbound), Germantown Road (northbound), and Middlebrook Road (northbound).

7.5.2 Segment 7

In Segment 7, the BRT would travel in mixed traffic along Middlebrook Road to Observation Drive, Goldenrod Lane, Seneca Meadows Parkway, Shakespeare Boulevard, then up MD 355 to Ridge Road, Snowden Farm Parkway to Stringtown Road to the BRT terminus at Clarksburg. Some of the service route patterns serve the Germantown Transit Center, so the BRT service would turn on Germantown Road to access the Germantown Transit Center and not continue north to Clarksburg.

7.6 Alternative B

Alternative B would generally operate in dedicated median lanes where feasible or in mixed traffic. The median guideway would be physically separated from the general purpose travel lanes by varying width concrete, grass, or landscaped medians. Because the dedicated BRT lanes would be located in the median, left turns would be restricted to signalized intersections.

Alternative B would also include additional TSP at key locations along the corridor, BRT stations with off-board fare collection and level boarding, articulated buses, and FLASH branding. The proposed alignment for Alternative B is shown in **Figure 7-11,** a breakdown by segment is described below and shown in **Figure 7-12** and proposed typical sections for Alternative B are shown in **Figures 7-13 through 7-19**. Detailed Plan Sheets are included in **Appendix A**.

7.6.1 Segment 1

In Segment 1, Alternative B would be the same as Alternative A. It would operate in mixed traffic and there would be no widening of the roadway. The BRT terminus would be located at Elm Street and MD 355, adjacent to the Bethesda Metrorail south entrance, and the entrance to the Purple Line station, currently under construction. Buses ending southbound service would turn right onto Bethesda Avenue, then right on Woodmont Avenue, and right on Elm Street.

7.6.2 Segment 2

Alternative B would include 11-foot wide dedicated BRT lanes in each direction in the median of MD 355 from Tuckerman Lane to Dodge Street. The median buffer width would vary from a four-foot wide raised concrete median to a 15-foot wide buffer that would accommodate an 11-foot wide left turn lane and a four-foot-wide raised concrete median. Three general purpose travel lanes in each direction would remain but would be narrowed to ten feet wide in order to minimize roadway widening.

Figure 7-11: Alternative B

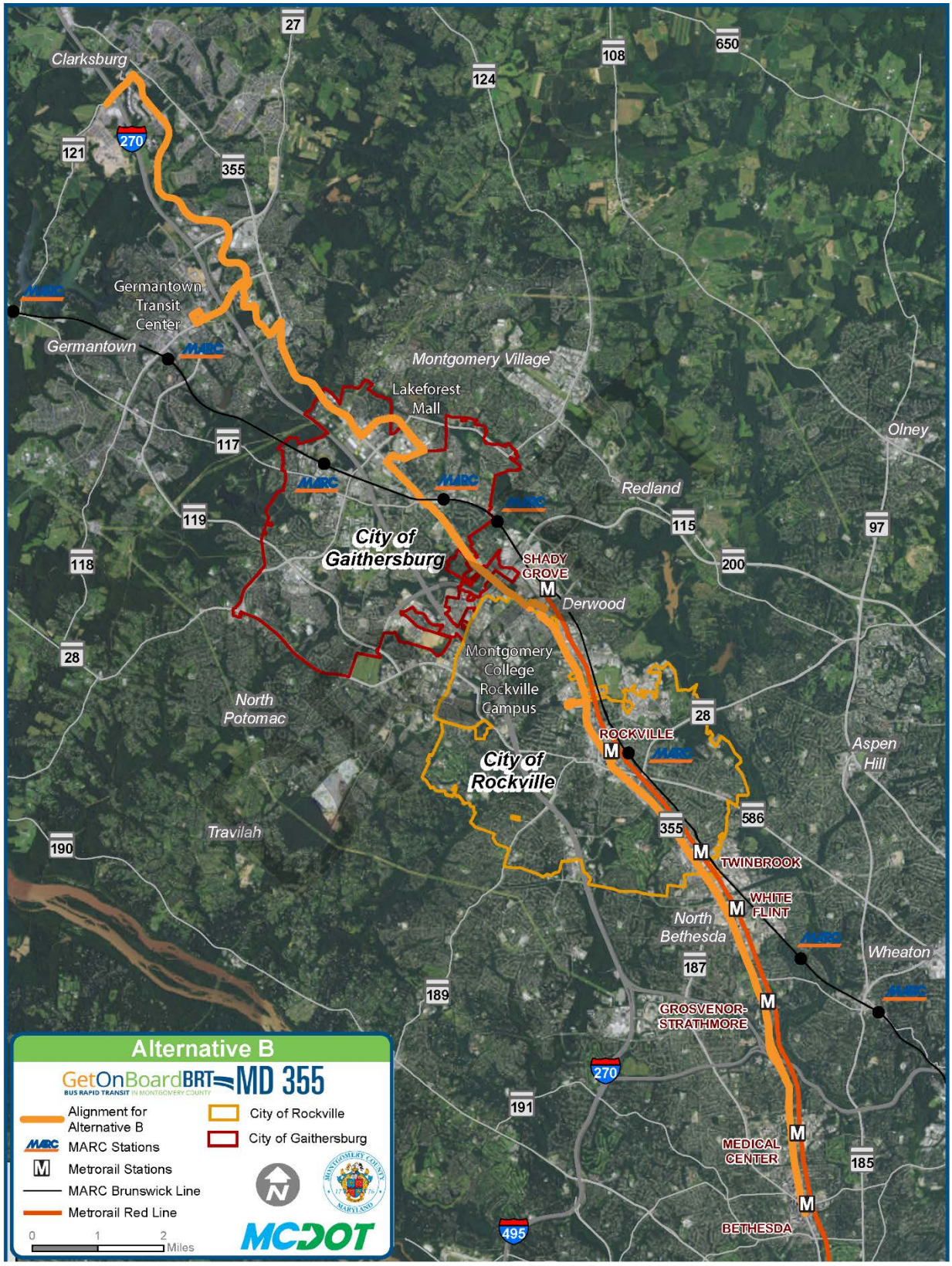


Figure 7-12: Alternative B Segment Features

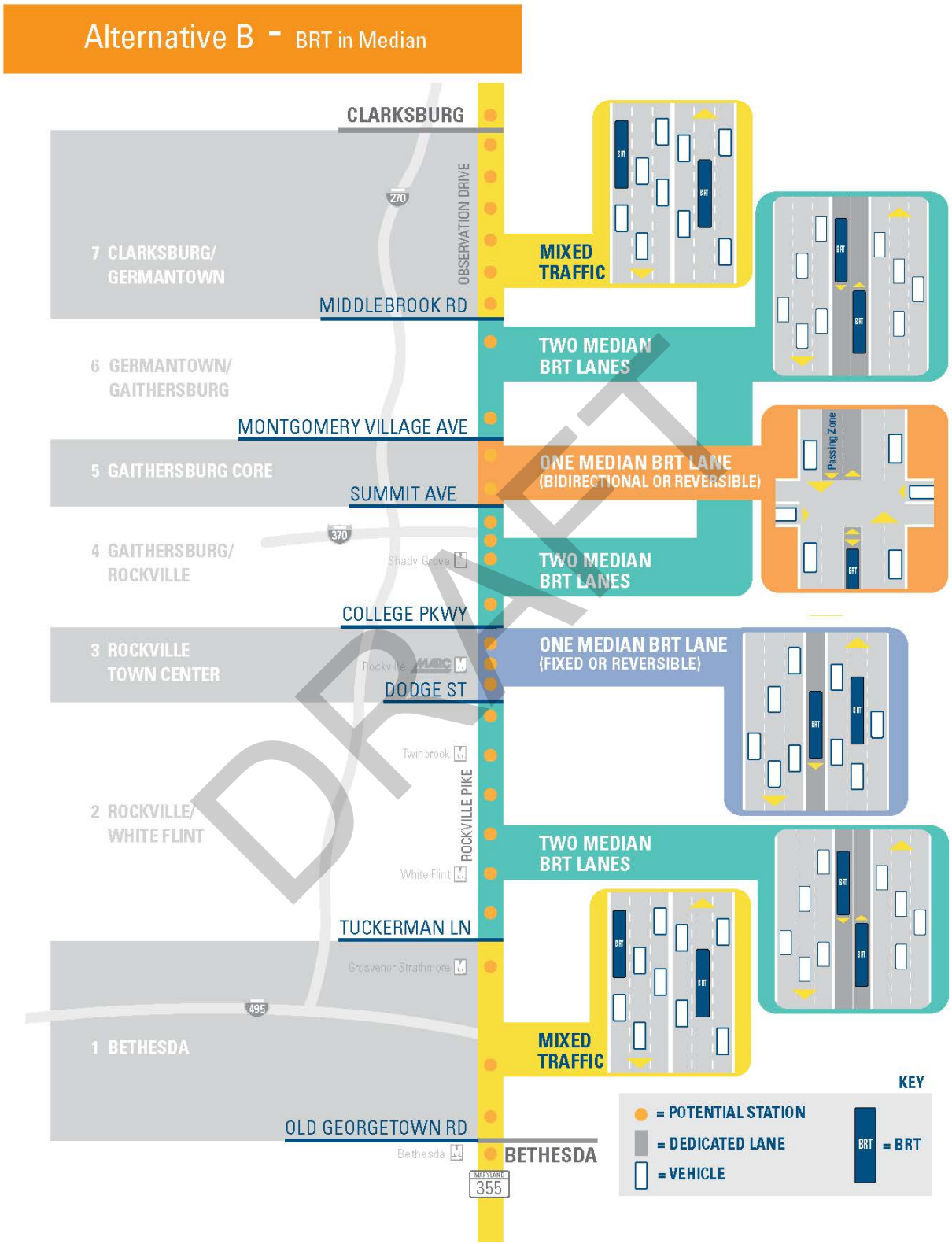


Figure 7-13: Alternative B Typical Sections

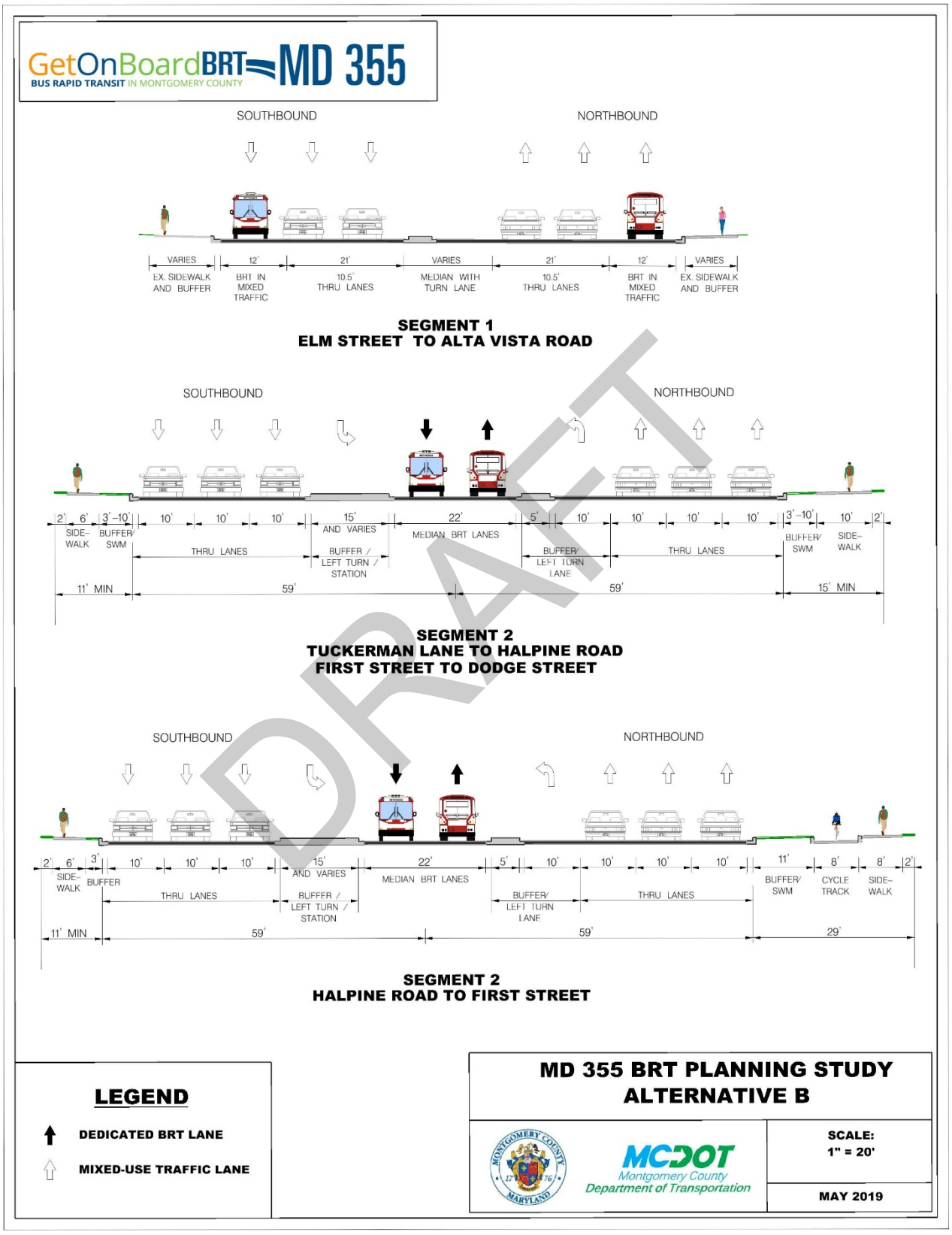


Figure 7-14: Alternative B Typical Sections

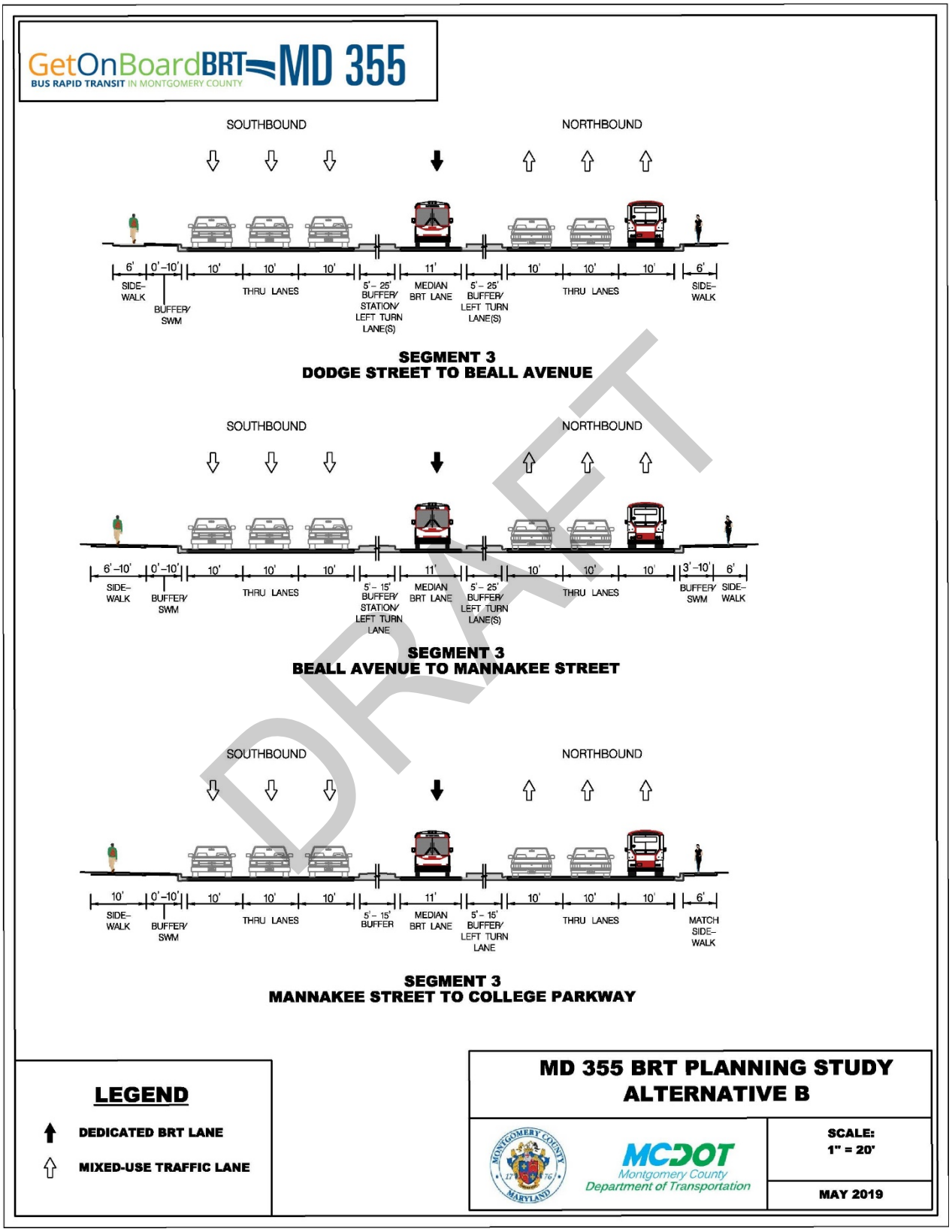


Figure 7-15: Alternative B Typical Sections

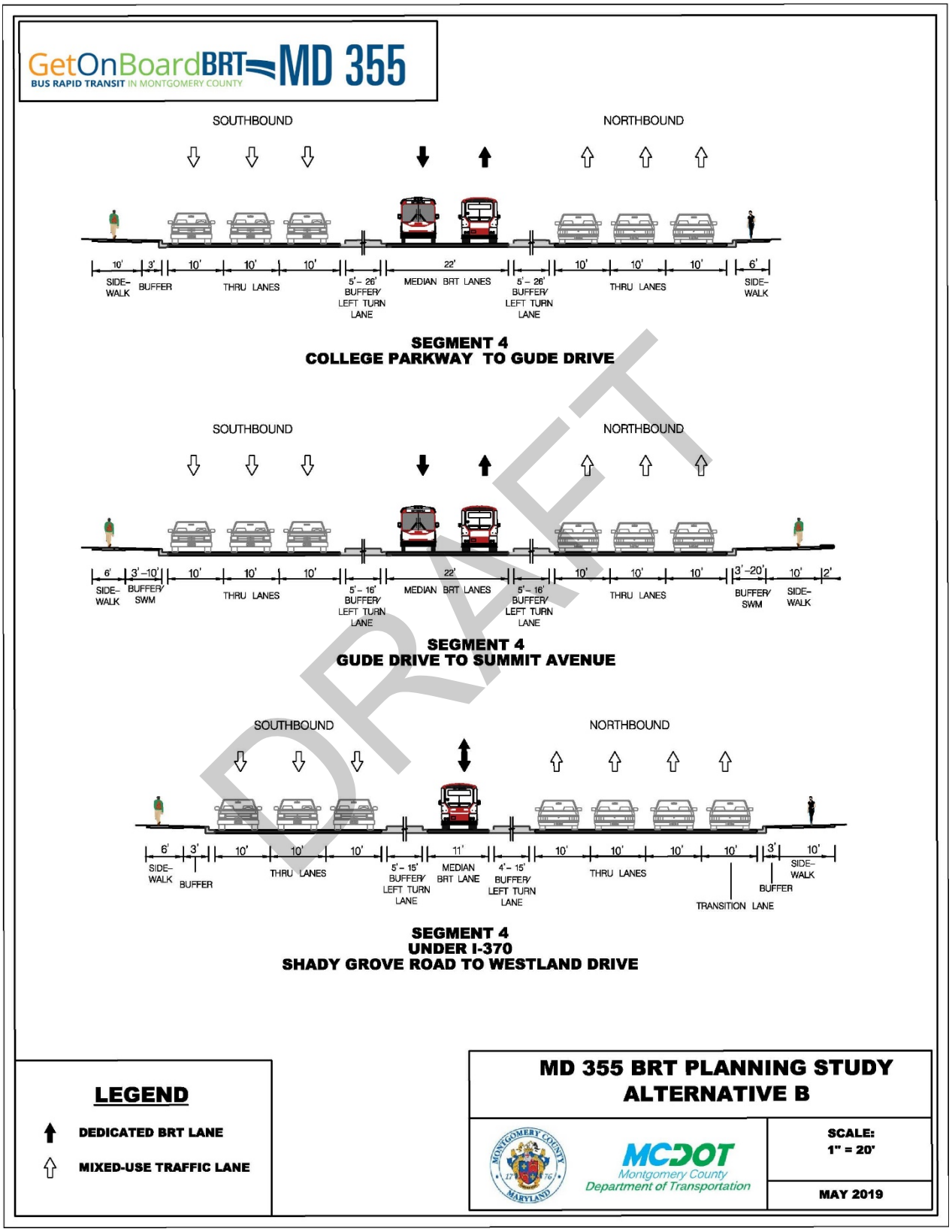


Figure 7-16: Alternative B Typical Sections

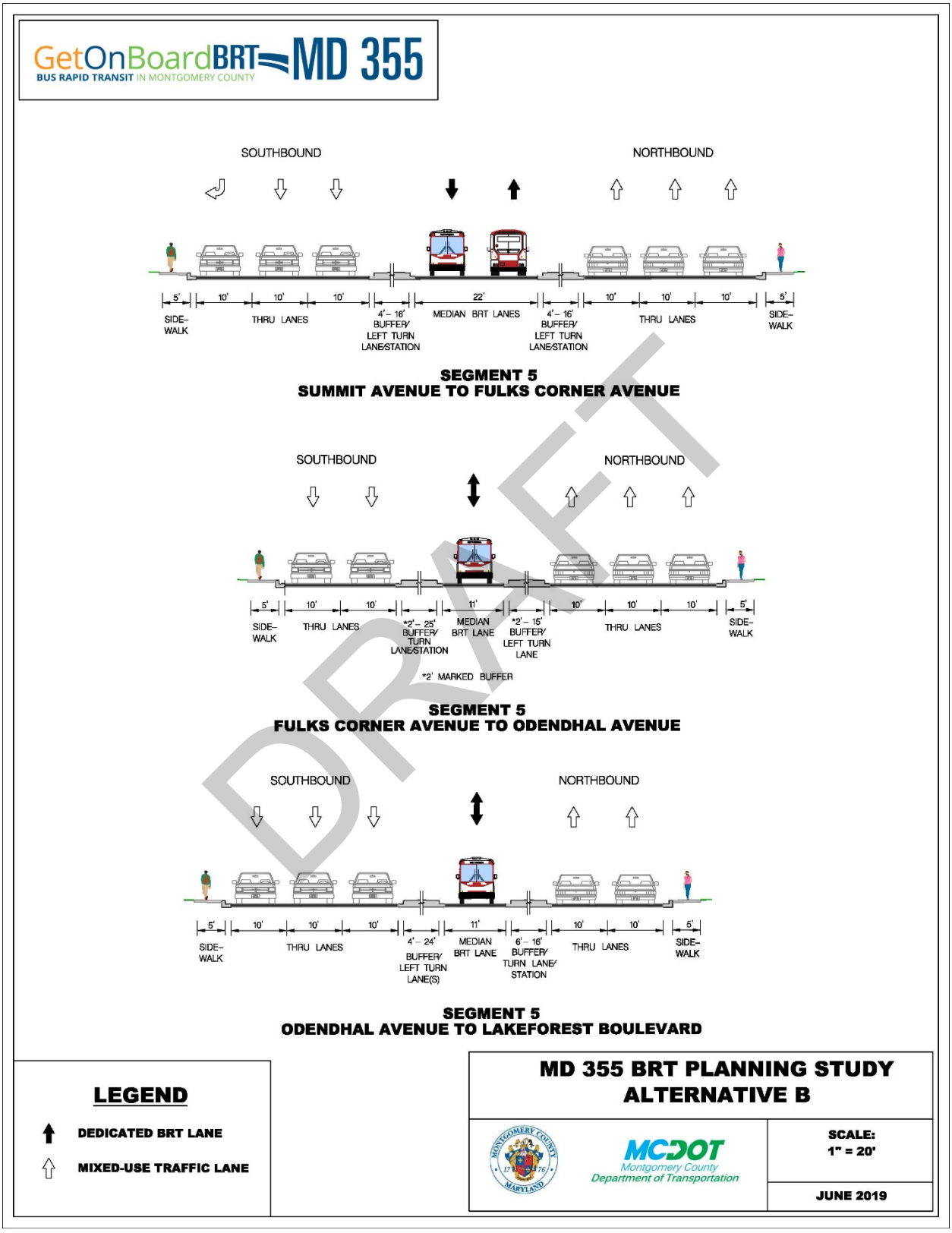
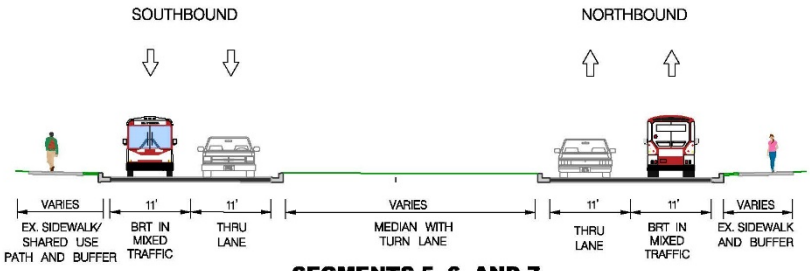
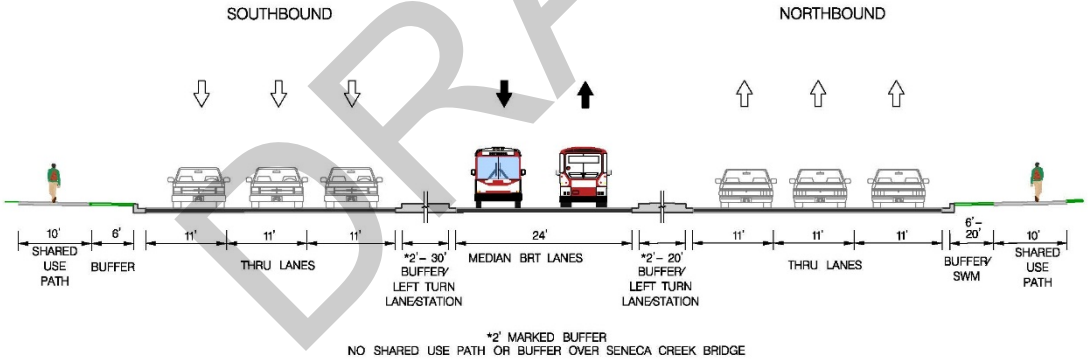


Figure 7-17: Alternative B Typical Sections

GetOnBoardBRT MD 355
BUS RAPID TRANSIT IN MONTGOMERY COUNTY



SEGMENTS 5, 6, AND 7
LAKEFOREST BOULEVARD
MD 355 TO RUSSELL AVENUE
RUSSELL AVENUE
LAKEFOREST BOULEVARD TO ODENDHAL AVENUE
ODENDHAL AVENUE
RUSSELL AVENUE TO LOST KNIFE ROAD
LOST KNIFE ROAD
ODENDHAL AVENUE TO MONTGOMERY VILLAGE AVENUE
CHRISTOPHER AVENUE
MONTGOMERY VILLAGE AVENUE TO MD 355
OBSERVATION DRIVE
GERMANTOWN ROAD TO STRINGTOWN ROAD
STRINGTOWN ROAD
OBSERVATION DRIVE TO INTERSTATE 270 INTERCHANGE



*2' MARKED BUFFER
NO SHARED USE PATH OR BUFFER OVER SENECA CREEK BRIDGE

SEGMENT 6
CHRISTOPHER AVENUE TO GUNNERS BRANCH ROAD

LEGEND

DEDICATED BRT LANE

MIXED-USE TRAFFIC LANE

MD 355 BRT PLANNING STUDY
ALTERNATIVE B

MCDOT Montgomery County Department of Transportation

SCALE:
1" = 20'

JUNE 2019

Figure 7-18: Alternative B Typical Sections

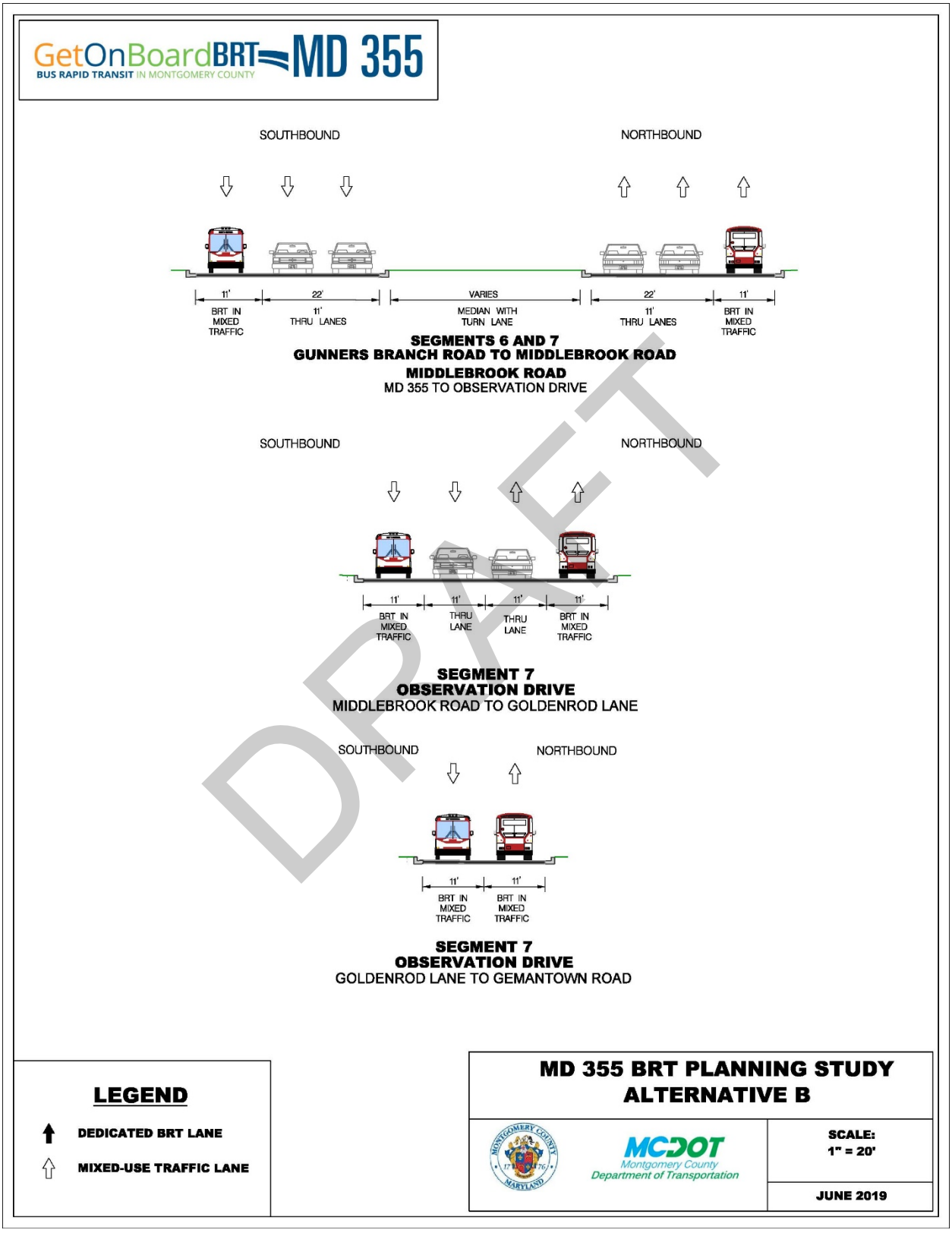
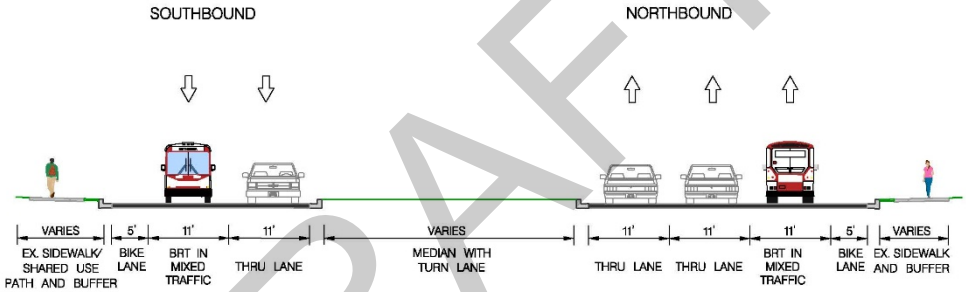


Figure 7-19: Alternative B Typical Sections

GetOnBoardBRT MD 355
BUS RAPID TRANSIT IN MONTGOMERY COUNTY



SEGMENT 7
STRINGTOWN ROAD
INTERSTATE 270 INTERCHANGE TO CLARKSBURG OUTLETS

LEGEND

- **DEDICATED BRT LANE**
- **MIXED-USE TRAFFIC LANE**

MD 355 BRT PLANNING STUDY
ALTERNATIVE B

MCDOT Montgomery County Department of Transportation

SCALE:
1" = 20'

JUNE 2019

In order to accommodate the dedicated lanes, approximately two to 25 feet of outside pavement widening would be required on both sides of the roadway.

Where roadway widening would impact existing pedestrian facilities, they would be reconstructed. Along southbound MD 355, a six-foot wide sidewalk would be included with a minimum three-foot wide varying width grass or landscape buffer. Along northbound MD 355, a ten-foot wide shared use path would be included with a minimum three-foot wide varying width grass or landscape buffer from Tuckerman Lane to Halpine Road. From Halpine Road to First Street, the shared use path would transition to an eight-foot wide cycle track and an eight-foot wide sidewalk with a six-foot wide grass or landscape buffer, then back to a shared use path with a minimum three-foot wide varying width grass or landscape buffer from First Street to Dodge Street.

For all alternatives, where feasible, proposed pedestrian and bicycle amenities would conform to *The Montgomery County Bicycle Master Plan* (2018), the City of Rockville *Bikeway Master Plan* (2017), and other master planned pedestrian and bicycle improvement recommendations. In locations where incorporating master planned recommendations as part of the BRT improvements would be prohibitively impactive to existing parcels, a less impactive pedestrian solution has been proposed. However, design of the BRT would not preclude master planned recommendations as those parcels redevelop.

Retaining walls would be included in some locations to avoid or minimize impacts to properties, buildings, and parking lots.

7.6.3 Segment 3

Due to existing constraints, Alternative B would include an 11-foot wide southbound dedicated BRT lane in the median from Dodge Street to North Campus Drive. In the northbound direction, the BRT would operate in mixed traffic[2].

Northbound BRT vehicles would transition from a dedicated median lane in Segment 2 to mixed traffic in Segment 3. This transition would occur via a slip ramp located between Wootton Parkway and Dodge Street. Once the BRT has merged into mixed traffic, it would further transition to the curb lane to serve the station platform at Middle Lane.

The median buffer width would vary from a four-foot wide raised concrete median to a 15-foot wide buffer that would accommodate an 11-foot wide left turn lane and a four-foot wide raised concrete median. Three general purpose travel lanes in each direction would remain but would be narrowed to ten feet wide in order to minimize roadway widening.

At North Campus Drive, the northbound BRT vehicle would transition from mixed traffic to a dedicated transit lane. 11-foot wide dedicated median BRT lanes in each direction would continue to College Parkway.

[2] During Phase 1 of the study, traffic analysis determined that southbound traffic experiences the heaviest volumes all day in Segment 3.

In order to accommodate the dedicated lanes, approximately two to 40 feet of outside pavement widening would be required on both sides of the roadway. From Church Street to Beall Street, all roadway widening would be to the east due to the proximity of high-rise buildings. South of Mannakee Street to College Parkway, all roadway widening would be to the west due to the proximity of the CSX railroad right-of-way.

BRT service would be provided to Montgomery College - Rockville via Mannakee Street. A station would be located on the college campus near the intersection of Mannakee Street and South Campus Drive.

Along southbound MD 355, a six-foot wide sidewalk would be included with buffers varying in width from zero to seven feet from Dodge Street to Ivy League Lane. At Ivy League Lane, the sidewalk would widen to a ten-foot wide shared use path with a minimum three-foot wide varying width buffer to College Parkway. Along northbound MD 355, a six-foot wide sidewalk would be included with a three-foot wide buffer where feasible.

Retaining walls would be included in some locations to avoid or minimize impacts to properties, buildings, and parking lots.

7.6.4 Segment 4

The BRT would operate in 11-foot wide dedicated lanes in each direction in the median of MD 355 from College Parkway to Redland Road. BRT service would then be provided into the Shady Grove Metrorail Station via Redland Road, Somerville Drive, and Metro Station Drive in mixed traffic. Median dedicated lanes in each direction would start again once the alignment is back on MD 355 to Shady Grove Road. As MD 355 crosses under I-370, a single 11-foot wide bidirectional dedicated median BRT lane would run between Shady Grove Road and South Westland Drive, in order to avoid impacts to the overhead structure. North of Westland Drive the alignment would transition back to 11-foot wide median dedicated lanes in each direction to the end of Segment 4 at Summit Avenue.

The median buffer width would vary from a four-foot wide raised concrete median to a 15-foot wide buffer that would accommodate an 11-foot wide left turn lane and a four-foot-wide raised concrete median. Three general purpose travel lanes in each direction would remain but would be narrowed to ten feet wide in order to minimize roadway widening.

In order to accommodate the dedicated lanes, approximately three to 30 feet of outside pavement widening would be required on both sides of the roadway.

Along southbound MD 355, a ten-foot wide shared use path would be included with a minimum three-foot wide varying width grass or landscape buffer from College Parkway to Gude Drive. It would then transition to a six-foot wide sidewalk with a minimum three-foot wide varying width grass or landscape buffer from Gude Drive to the end of Segment 4 at Summit Avenue. Along northbound MD 355, a six-foot wide sidewalk would be included with a minimum three-foot wide varying width grass or landscape buffer from College Parkway to Gude Drive. It would then transition to a ten-foot wide shared use path with a

minimum three-foot wide varying width grass or landscape buffer from Gude Drive to the end of Segment 4 at Summit Avenue.

Retaining walls would be included in some locations to avoid or minimize impacts to properties, buildings, and parking lots.

7.6.5 Segment 5

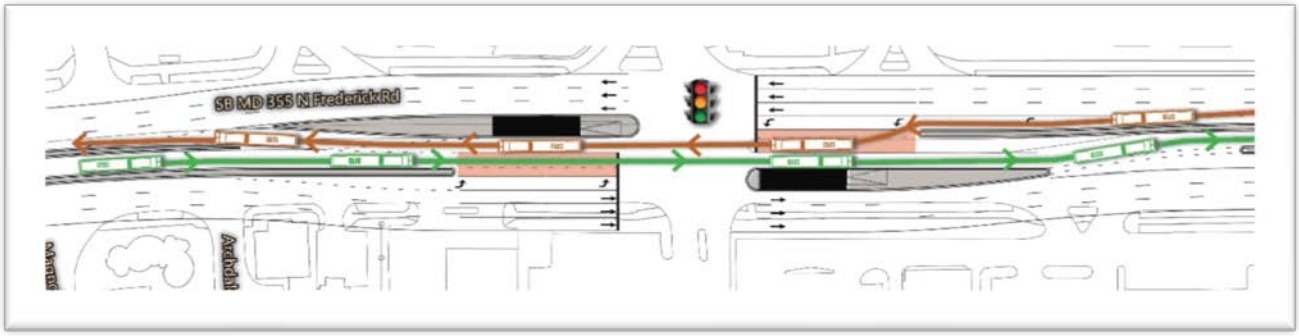
The BRT would operate in 11-foot wide dedicated lanes in each direction for a short distance from Summit Avenue to a proposed BRT station at Fulks Corner Avenue and Cedar Avenue. The intersection of Fulks Corner Avenue and Cedar Avenue is currently unsignalized and would require construction of a new traffic signal to control traffic turning movements and pedestrian access to the station. The guideway would transition to a single 11-foot lane on the north side of the intersection at Fulks Avenue and Cedar Avenue and maintain that configuration to the next proposed station at Lakeforest Boulevard. A single-lane guideway would be necessary in this segment to avoid widening or reconstructing the Father Cuddy Bridge and to minimize impacts to numerous properties with minimal building setbacks along MD 355 north of the Father Cuddy Bridge.

In order to accommodate the dedicated lanes, up to 25 feet of outside pavement widening would be required on both sides of the roadway.

The single-lane guideway would utilize a reversible operation, which would allow for peak direction BRT service in the guideway and would require off-peak BRT service to use the mixed traffic lanes, depending on the time of day. For example, southbound BRT service would use the guideway during the weekday morning peak and northbound BRT service would use the guideway during the weekday afternoon peak, with a switch in service direction for the single-lane guideway during a specified time in the midday.

Depending on the time of day, the guideway design would allow for BRT service operating in each direction to access either the median guideway or mixed traffic lanes. At the intersection of Fulks Corner Avenue and Cedar Avenue, the southbound BRT station would be located on the far side of the intersection and off-peak BRT service could enter the dual-lane guideway segment via a “bus box” (i.e., a short opening in the guideway separator) next to the southbound left turn lane for Fulks Corner Avenue, shown in **Figure 7-18**. Off-peak BRT service would exit the dual-lane guideway via a short exit ramp just north of the station platform that would be operated under coordinated signal control with the traffic signal at Fulks Corner Avenue and Cedar Avenue. Peak BRT service would remain in the median guideway with no need for transitions.

Figure 7-18: Alternative B Bus Box



BRT service would divert from MD 355 at Lakeforest Boulevard to travel in mixed traffic on Lakeforest Boulevard, Russell Avenue, Odendhal Avenue, and Lost Knife Road to the Lakeforest Transit Center on the east side of the Lakeforest Mall. From the Lakeforest Transit Center, the BRT would travel in mixed traffic on Lost Knife Road to the northern limit of Segment 5 at MD 124 (Montgomery Village Avenue). Southbound BRT service would access the median guideway by making a left turn concurrent with the mixed traffic left turn movement from Lakeforest Boulevard. Northbound peak direction BRT service would exit from the single-lane guideway via a long opening in the northbound median separator to provide a merge area, and BRT service at all times of day would operate in mixed traffic north of Odendhal Avenue to make a right turn at Lakeforest Boulevard.

The median buffer width would vary from a four-foot wide raised concrete median to approximately 15 feet wide buffer opposite left turn lanes at signalized intersections. On the Father Cuddy Bridge and on the eastern side of the BRT lane between Chestnut Street and Odendhal Avenue, the raised median buffer would be eliminated and replaced with a two-foot striped buffer. On the bridge, the buffer minimizes the width of the roadway section to avoid bridge widening.

Three general purpose travel lanes in the southbound direction and two general purpose lanes in the northbound direction would be retained. This is generally consistent with existing conditions, where the third (outermost) southbound lane transitions to an exclusive right-turn lane at multiple intersections. Currently, a third northbound mixed traffic lane on MD 355 (marked as a long right-turn lane) is maintained from the boundary of Segment 4 across the Father Cuddy bridge and drops at Brookes Avenue, just north of the bridge. However, to accommodate the BRT guideway without widening the bridge, the third mixed traffic lane would be dropped at the intersection of Fulks Corner Avenue and Cedar Avenue. All travel lanes would be designed as ten feet wide to minimize roadway widening.

Due to existing constraints, a five to six-foot wide sidewalk with a minimum three-foot wide varying width grass or landscape buffer would be provided along both sides of MD 355. From the Father Cuddy Bridge to Lakeforest Boulevard, the buffer would be eliminated to further minimize impacts. Retaining walls would be included in some locations to minimize impacts to properties, buildings, and parking lots.

7.6.6 Segment 6

MD 124 (Montgomery Village Avenue) is the southern boundary of Segment 6, and the BRT would travel in mixed traffic on Christopher Avenue from MD 124 to the MD 355 corridor. Once back on MD 355, the BRT would operate in 11-foot wide dedicated median lanes in each direction, starting at Christopher Avenue. The BRT service in the northbound direction would enter the guideway via a right turn during the Christopher Avenue signal phase but would turn from the through lane on Christopher Avenue instead of using the channelized right turn lane. The southbound BRT service would exit the median guideway by making a left turn during the southbound MD 355 left turn phase. This is feasible because there are two receiving lanes on Christopher Avenue to accommodate both the BRT from the guideway and traffic using the single dedicated left turn lane.

The dual-lane guideway would be provided continuously in Segment 6 from Christopher Avenue to just south of Middlebrook Road. The dual-lane guideway would end between Gunners Branch Road and Middlebrook Road, and no additional median guideway is proposed north of Segment 6. Southbound BRT service entering Segment 6 would merge to the left lane and enter the dual-lane guideway via a slip lane at the end of the southbound left turn lane on MD 355 after Gunners Branch Road. Northbound BRT service would exit the dual-lane guideway via a slip ramp that would extend to the northbound left turn lane onto Middlebrook Road, where the BRT service would turn to continue to Observation Drive.

The median buffer width would vary from a four-foot wide raised concrete median to an approximately 15 feet wide buffer opposite left turn lanes at signalized intersections. Where the guideway crosses Great Seneca Creek, the raised median buffer would be eliminated and replaced with a two-foot striped buffer for approximately 500 feet to minimize the width of the roadway section and avoid bridge widening.

Three general purpose travel lanes would be provided in both directions continuously through Segment 6 but would be narrowed to ten feet wide in order to minimize roadway widening.

A ten-foot wide shared use path would be included with a minimum three-foot wide varying width grass or landscape buffer, which is generally continuous for this segment. Where localized property constraints are a challenge, a six-foot wide sidewalk with a narrower or no grass/landscape buffer is provided. Retaining walls would be included in some locations to minimize impacts to properties, buildings, and parking lots.

7.6.7 Segment 7

In Segment 7, the BRT would operate in mixed traffic for the entire segment. The Segment 7 alignment for Alternative B begins to the south with the BRT turning off MD 355 at Middlebrook Road. The BRT service would travel along Middlebrook Road to Observation Drive. The BRT service would continue up Observation Drive, including service on the as yet unbuilt portion of Observation Drive between Waters Discovery Lane and Roberts Tavern Drive, just south of Stringtown Road, and then turn on Stringtown Road to the BRT Terminus at Clarksburg.

Observation Drive provides four general travel lanes, except within the Montgomery College Germantown campus, where Observation Drive is a two-lane undivided roadway. Between Middlebrook Road and Montgomery College, Observation Drive is a four-lane undivided roadway, while north of MD 118 (Germantown Road) the roadway is four lanes with a wide median separating the northbound and southbound directions. A landscape buffer of variable width, up to 20 feet wide, is provided along both sides of Observation Drive. Between Middlebrook Road and MD 118, an approximately eight-foot-wide trail or six-foot sidewalk is continuously provided along the east side of the street. North of MD 118, an approximately eight-foot-wide paved trail is provided along the west side of the street and a six-foot sidewalk is provided along the east side. The unbuilt portion of Observation Drive is proposed to maintain the same cross-section as the completed portion north of MD 118.

Segment 7 would not include any dedicated BRT guideway, and construction in Segment 7 is localized and limited to station platforms, sidewalks and retaining walls at some stations, and stormwater management facilities. Several stations would be located in Segment 7 and all would be located on the curbside with BRT service operating in mixed traffic. Given the operational function and character of Observation Drive, the station locations would remain unsignalized.

7.7 Alternative C

Alternative C would generally operate in dedicated curb lanes along MD 355 where feasible.

Alternative C would include additional TSP along with queue jumps at key locations along the corridor. The same queue jump locations would be included in Alternative C that are proposed for Alternative A in **Table 7-3.** It would also include BRT stations with off-board fare collection and level boarding, articulated buses, and FLASH branding. The proposed alignment for Alternative C is shown in **Figure 7-20,** a breakdown by segment is described below and shown in **Figure 7-21** and proposed typical sections for Alternative C are shown in **Figures 7-22 through 7-28**. Detailed Plan Sheets are included in **Appendix A**.

7.7.1 Segment 1

Segment 1 would include a dedicated curb lane in the peak direction between the Bethesda Metrorail Station at Elm Street and Alta Vista Road (southbound in the AM peak and northbound in the PM peak). In order to minimize property impacts in this very constrained area, an off-peak direction lane would be repurposed to create a reversible roadway with different AM and PM lane configurations.

The middle general traffic lanes would be reversible requiring removal of the raised concrete median, allowing changes in direction throughout the day to accommodate BRT peak direction dedication, which would be managed by dynamic signals and signage. In the AM peak period, the typical section would include a southbound dedicated BRT lane; three southbound through lanes; and two northbound through lanes, which would accommodate the off-peak northbound BRT in mixed traffic. In the PM peak period, the roadway configuration would change to include two southbound through lanes, which would accommodate the off-peak southbound BRT in mixed traffic; three northbound through lanes; and a northbound dedicated BRT lane.

Figure 7-20: Alternative C

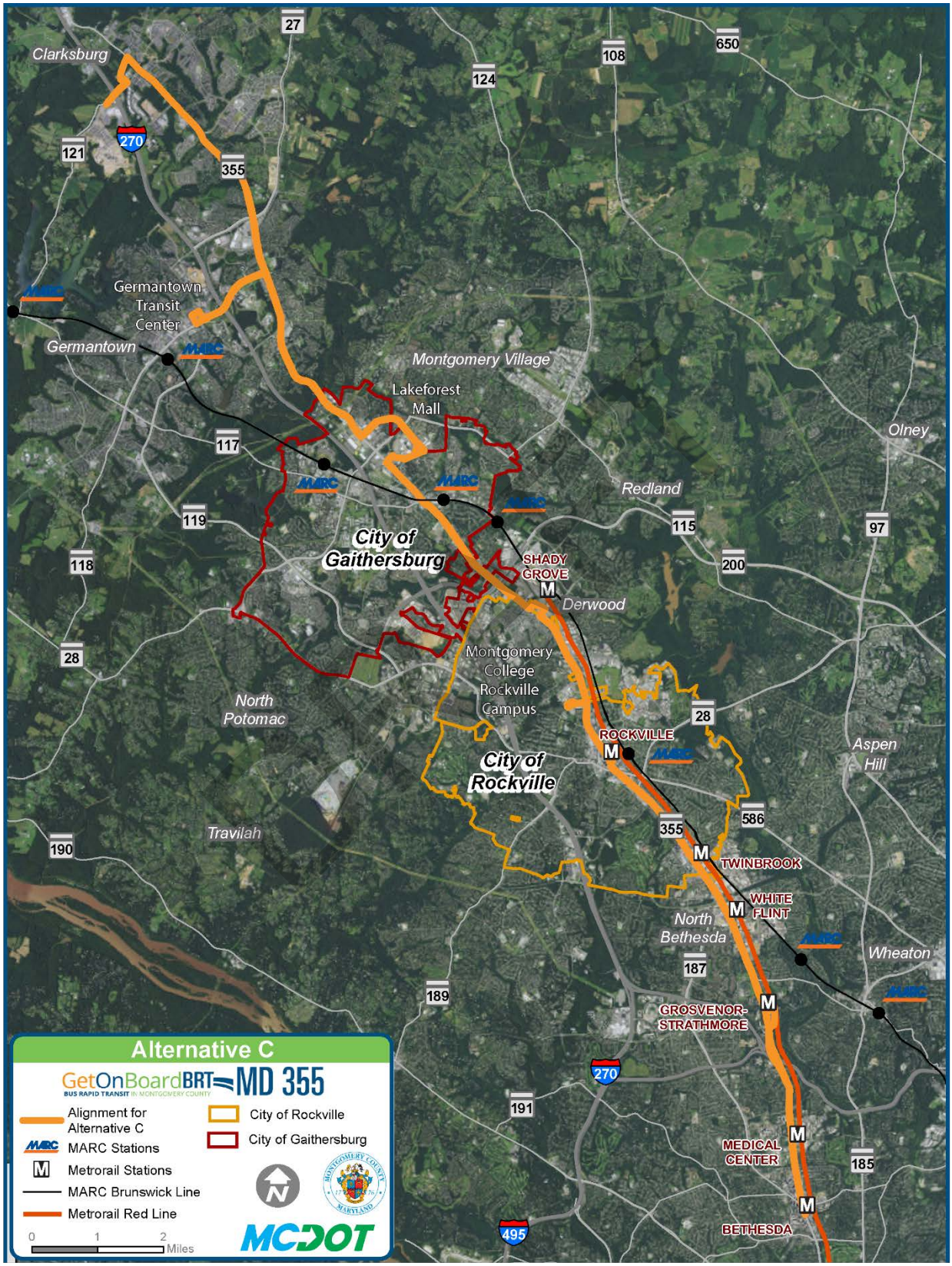


Figure 7-21: Alternative C Segment Features

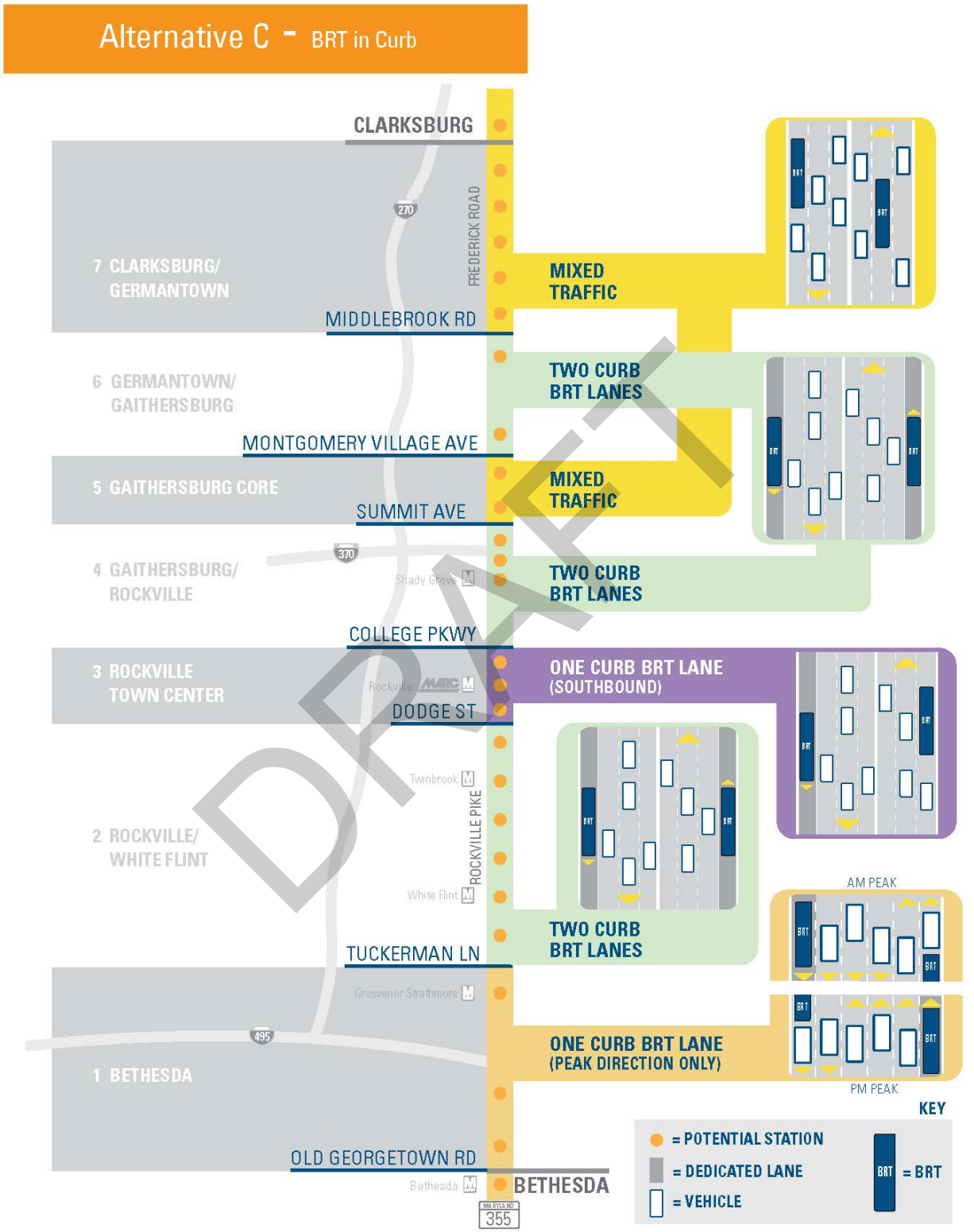


Figure 7-22: Alternative C Typical Sections

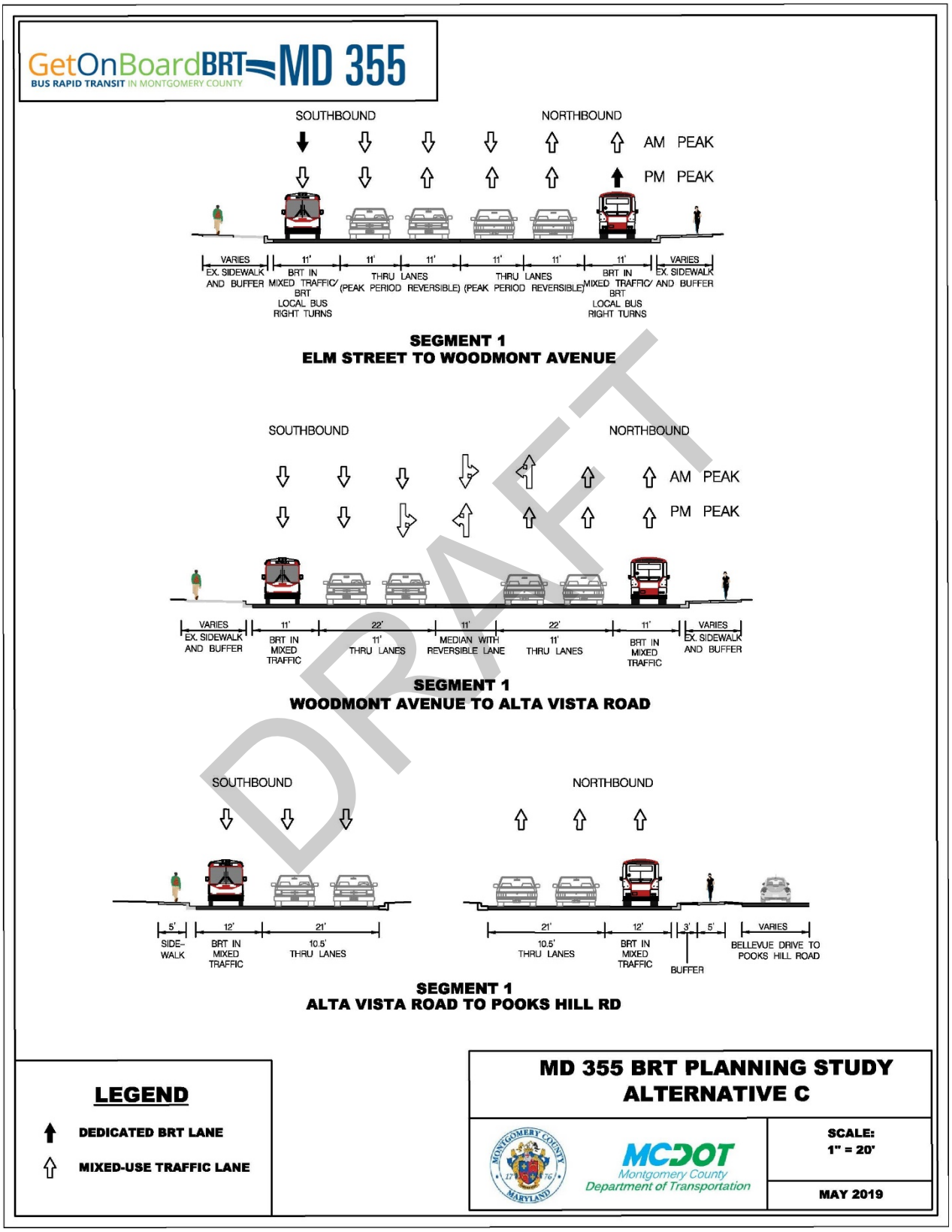


Figure 7-23: Alternative C Typical Sections

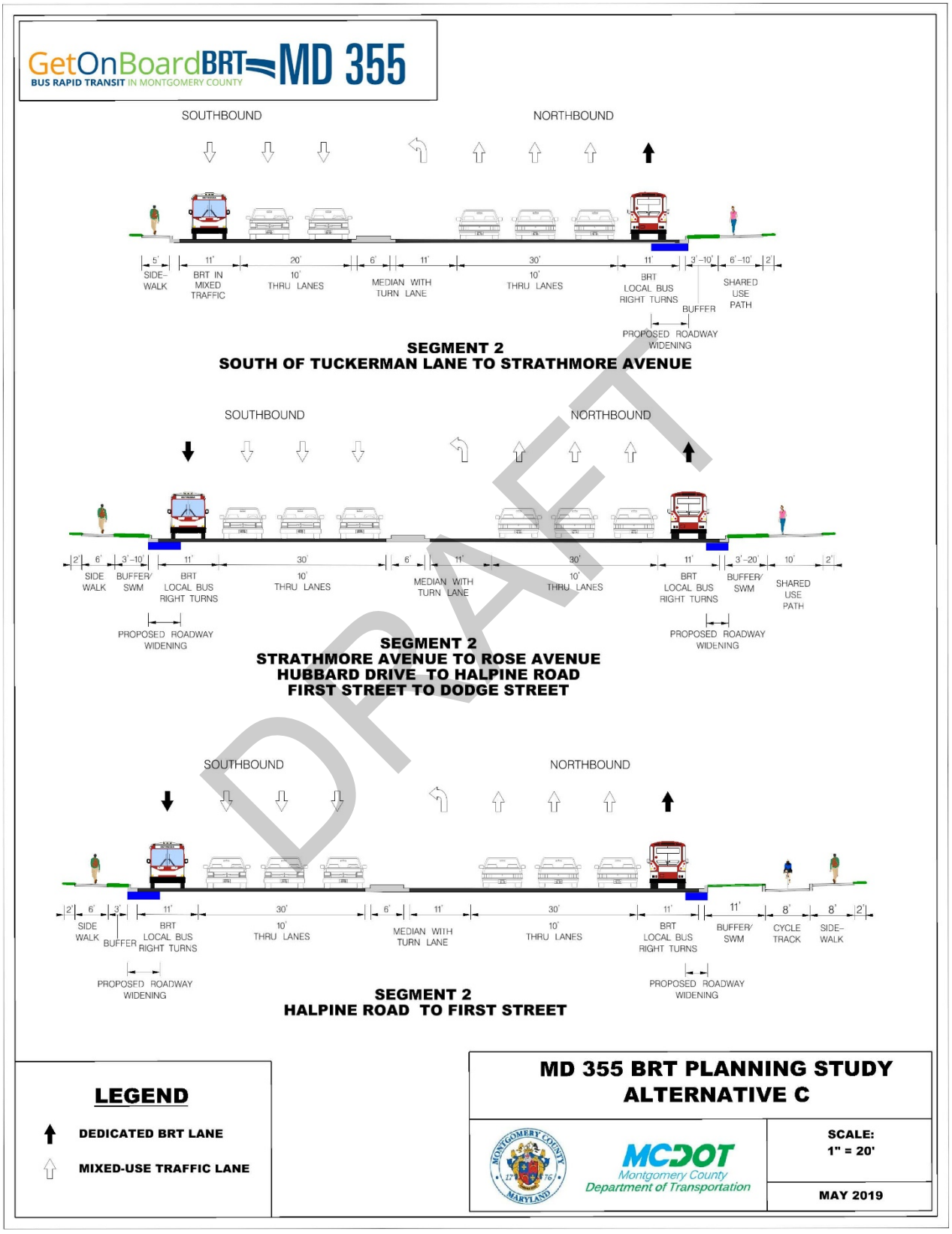


Figure 7-24: Alternative C Typical Sections

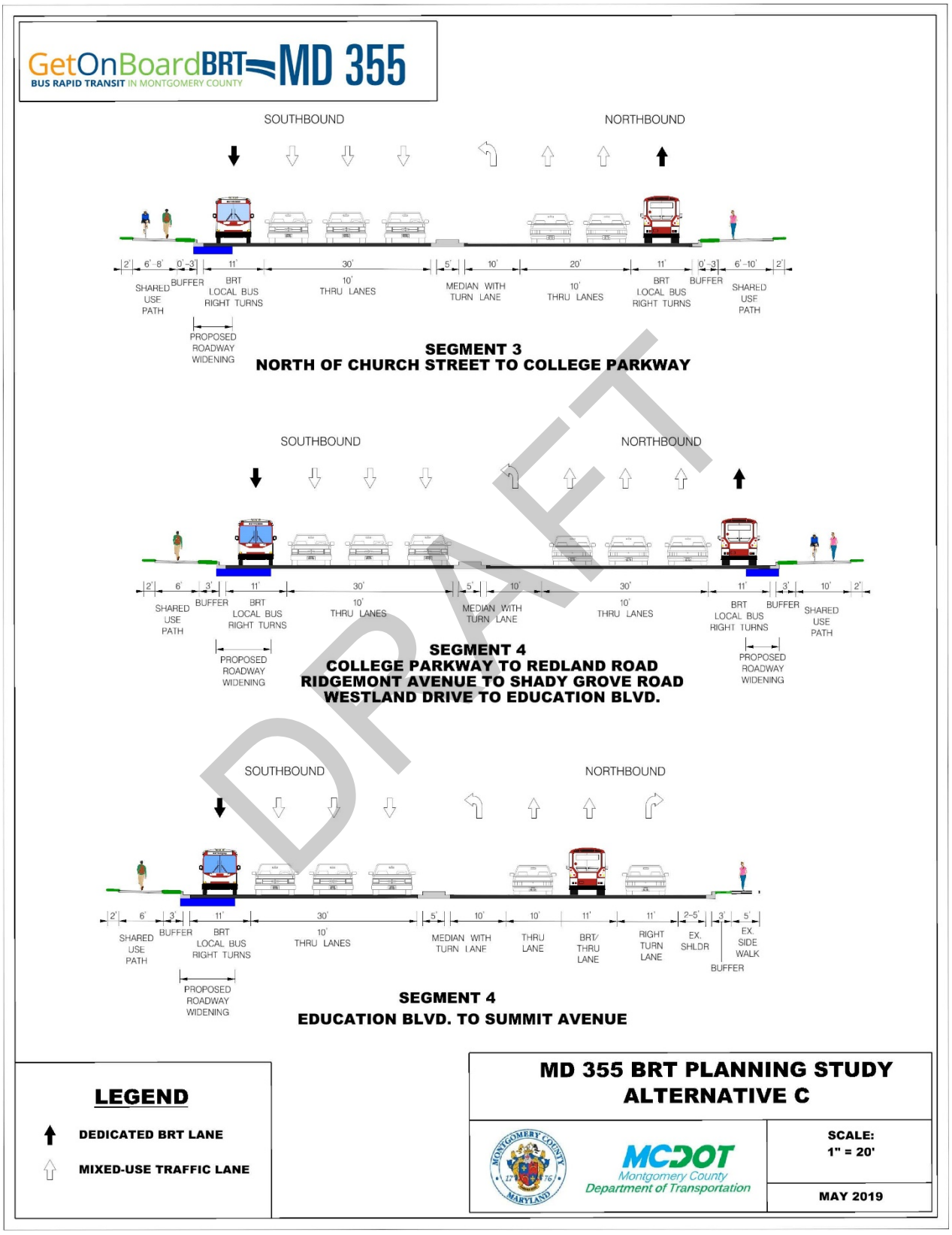


Figure 7-25: Alternative C Typical Sections

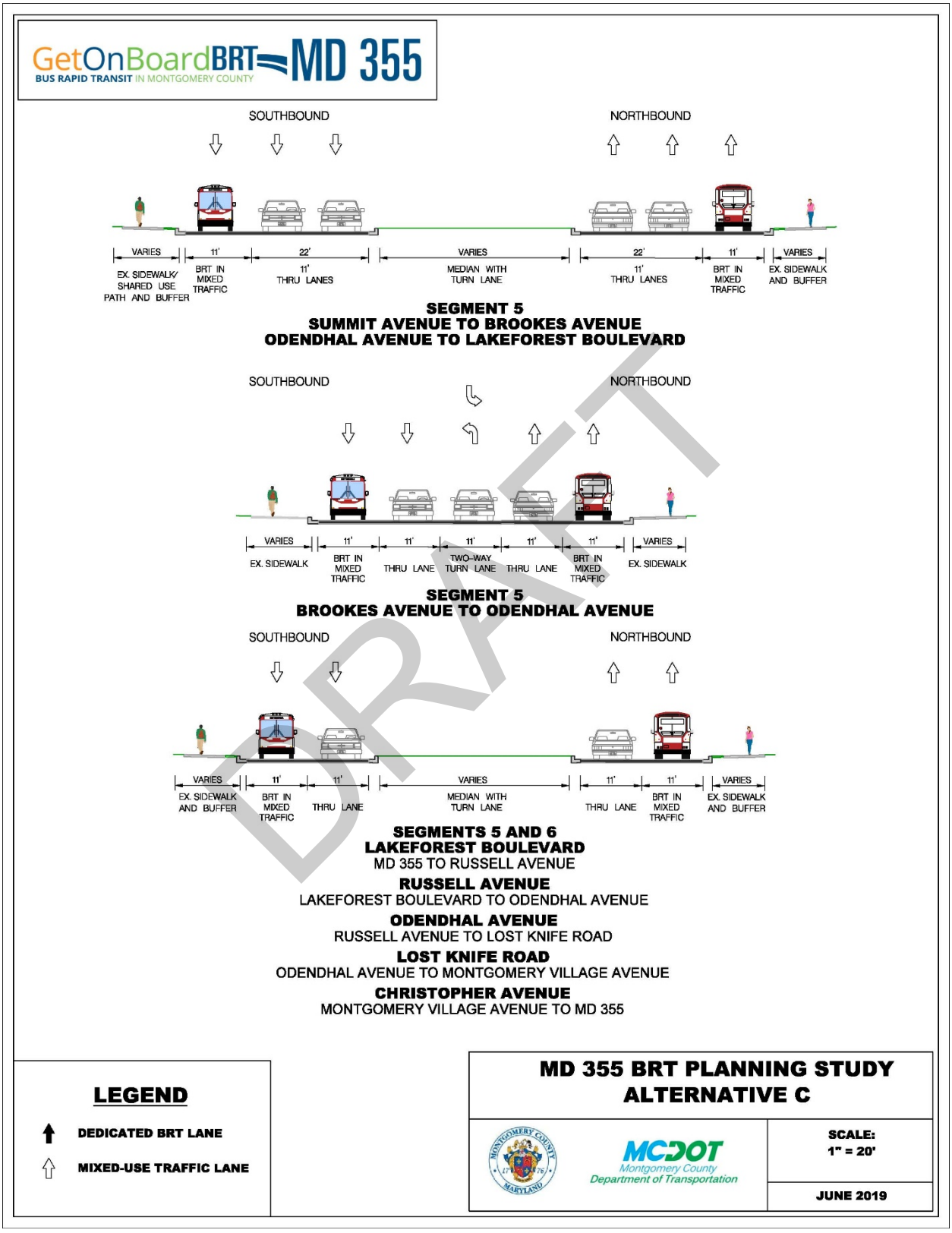


Figure 7-26: Alternative C Typical Sections

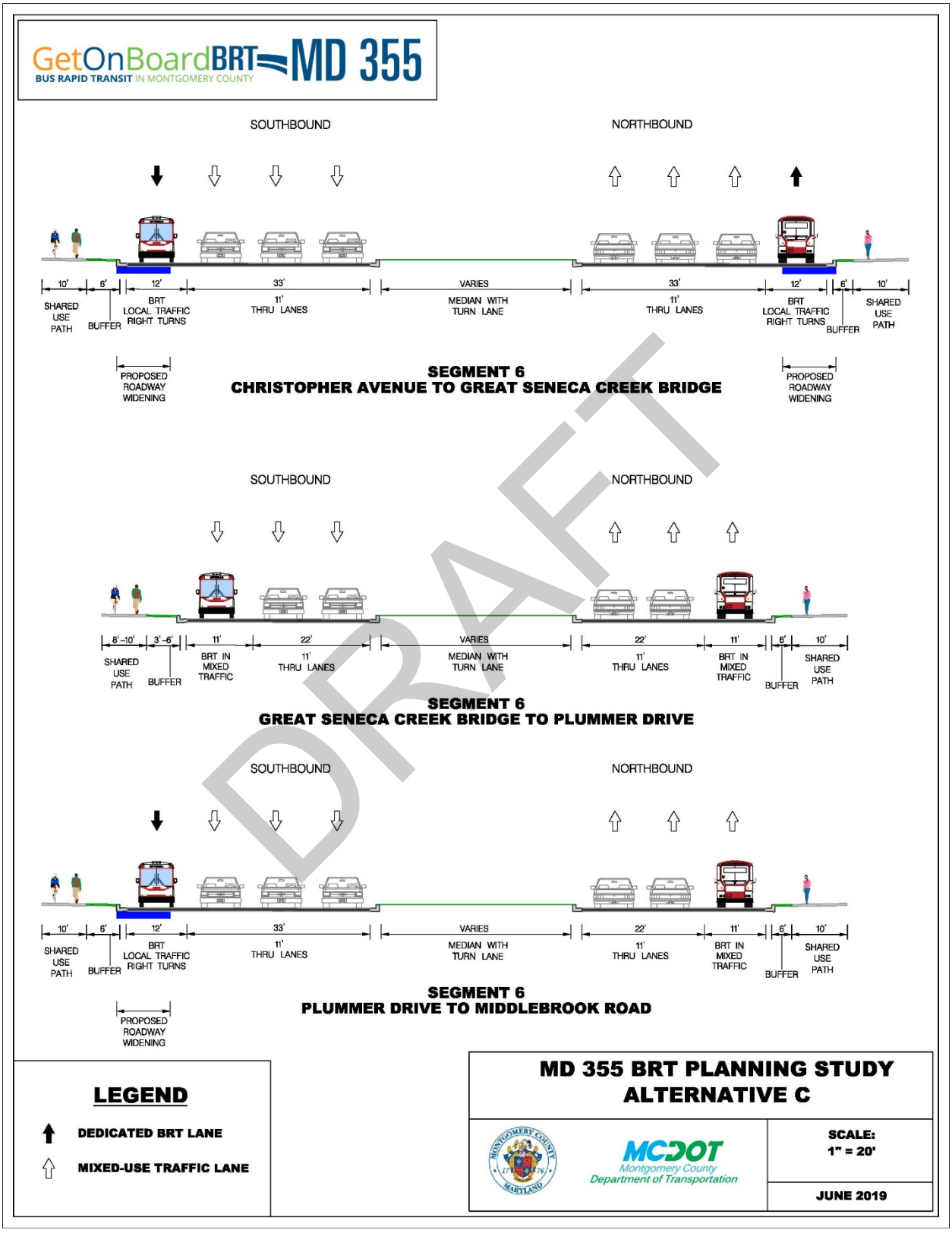


Figure 7-27: Alternative C Typical Sections

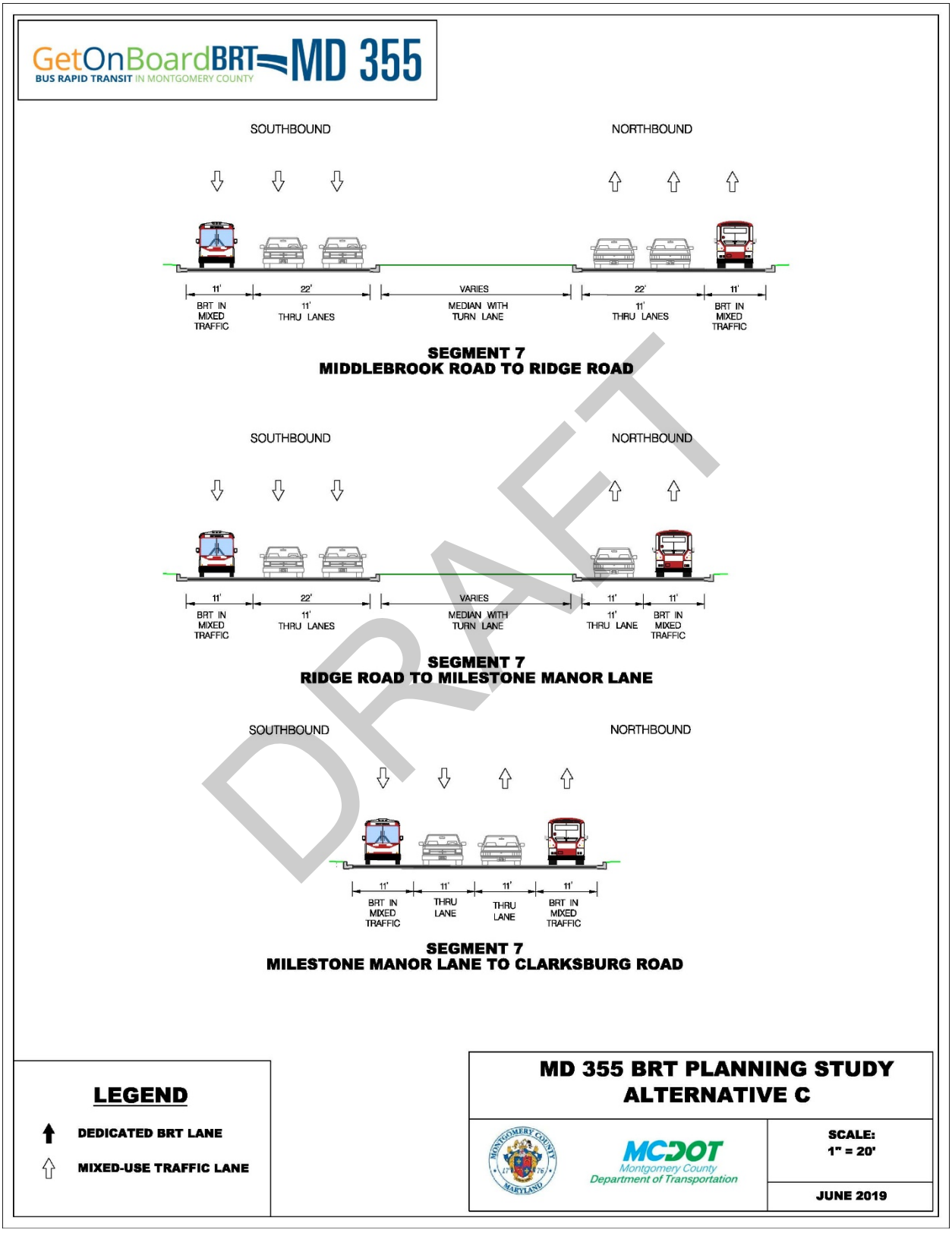
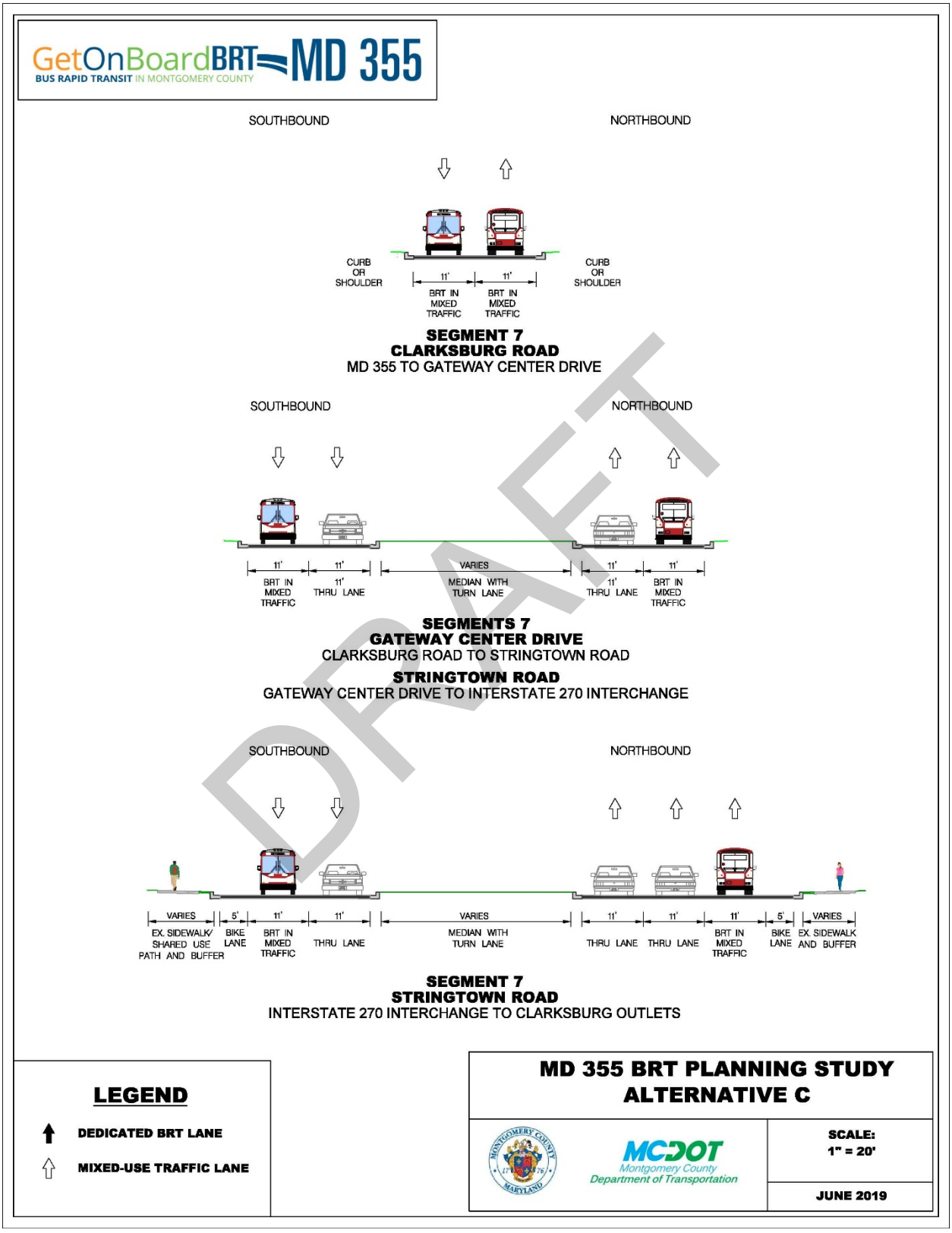


Figure 7-28: Alternative C Typical Sections



The BRT would run in mixed traffic between Alta Vista Road and Tuckerman Lane over the bridges of the Capital Beltway and under the Metrorail tracks. Given the right-of-way constraints in Segment 1, there would be no widening of the roadway. Alternative C would include three 11 to 12-foot wide travel lanes in each direction plus turn lanes at key intersections.

7.7.2 Segment 2

Segment 2 would include a dedicated curb lane in each direction, which would be shared with local transit service and right turning vehicles. The BRT would run in mixed traffic in the vicinity of the Montrose Parkway interchange in order to avoid impacts to the structure. Three general purpose travel lanes in each direction would remain but would be narrowed to ten feet wide in order to minimize roadway widening.

In order to accommodate the dedicated lanes, approximately two to 25 feet of outside pavement widening would be required on both sides of the roadway.

Similar to Segment 2 in Alternative B, along southbound MD 355, a six-foot wide sidewalk would be included with a minimum three-foot wide varying width grass or landscape buffer. Along northbound MD 355, a ten-foot wide shared use path would be included with a minimum three-foot wide varying width grass or landscape buffer from Tuckerman Lane to Halpine Road. From Halpine Road to First Street, the shared use path would transition to an eight-foot wide cycle track and an eight-foot wide sidewalk with a six-foot wide grass or landscape buffer, then back to a shared use path with a minimum three-foot wide varying width grass or landscape buffer from First Street to Dodge Street.

Retaining walls would be included in some locations to avoid or minimize impacts to properties, buildings, and parking lots.

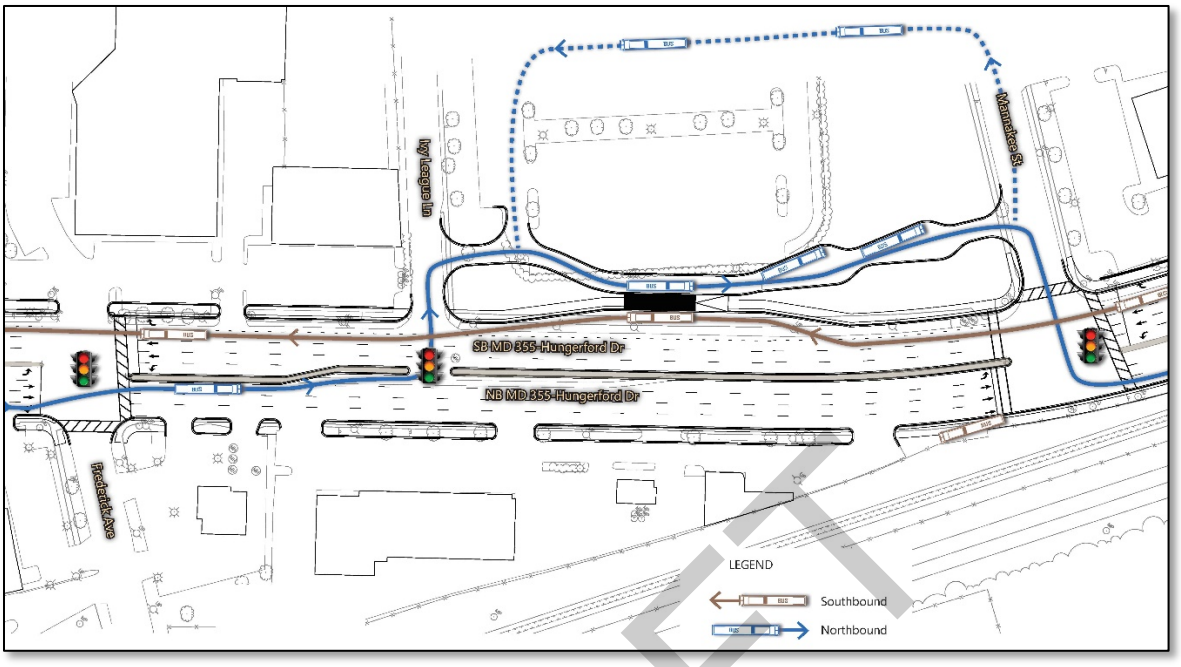
7.7.3 Segment 3

The BRT would run in mixed traffic in both directions of MD 355 from Dodge Street to Beall Avenue in order to minimize impacts. From Beall Avenue to College Parkway an 11-foot wide southbound dedicated curb lane would be added, and the northbound BRT would continue to operate in mixed traffic.

In order to accommodate the dedicated lane, approximately four to ten feet of outside pavement widening would be required, mostly on the east side of the roadway.

Access to Montgomery College - Rockville would be provided through construction of a BRT station, loop, and layover area between Ivy League Lane and Mannakee Street. Both southbound and northbound buses would enter on Ivy League lane and exit on Mannakee Street. **Figure 7-29** shows the BRT station, loop, and layover area.

Figure 7-29: BRT Station and Loop at Montgomery College – Rockville



Similar to Segment 3 in Alternative B, along southbound MD 355, a six-foot wide sidewalk would be included with buffers varying in width from zero to seven feet from Dodge Street to Ivy League Lane. At Ivy League Lane, the sidewalk would widen to a ten-foot wide shared use path with a minimum three-foot wide varying width buffer to College Parkway. Along northbound MD 355, a six-foot wide sidewalk would be included with a three-foot wide buffer where feasible.

Retaining walls would be included in some locations to avoid or minimize impacts to properties, buildings, and parking lots.

7.7.4 Segment 4

The BRT would operate in 11-foot wide dedicated curb lanes in each direction of MD 355 from College Parkway to Redland Road. BRT Service would then be provided into the Shady Grove Metrorail Station via Redland Road, Sommerville Drive, and Metro Station Drive in mixed traffic. Dedicated curb lanes in each direction start again once the alignment is back on MD 355 to Shady Grove Road. As MD 355 crosses under I-370, the BRT would transition to mixed traffic operations in order to avoid impacts to the structure. North of South Westland Drive the alignment transitions back to 11-foot wide dedicated curb lanes in each direction to the end of Segment 4 at Summit Avenue.

Three general purpose travel lanes in each direction would remain but would be narrowed to ten feet wide in order to minimize roadway widening. In order to accommodate the dedicated lanes, approximately four to eight feet of outside pavement widening would be required on both sides of the roadway.

Along southbound MD 355 a six-foot wide sidewalk with a minimum three-foot wide varying width grass or landscape buffer would be included from Gude Drive to Redland Road, from Ridgemont Avenue to Shady Grove Road, and from O'Neill Drive to the end of Segment 4 at Summit Avenue. Along northbound MD 355, a ten-foot wide shared use path would be included with a minimum three-foot wide varying width grass or landscape buffer from Gude Drive to Redland Road, from King Farm Boulevard to Shady Grove Road, and from Westland Drive to the end of Segment 4 at Summit Avenue.

Retaining walls would be included in some locations to avoid or minimize impacts to properties, buildings, and parking lots.

7.7.5 Segment 5

BRT service would operate in mixed traffic in both directions along MD 355 from Summit Avenue to Lakeforest Boulevard. To serve the Lakeforest Transit Center, the BRT service would turn off MD 355 onto Lakeforest Boulevard, Russell Avenue, Odendhal Avenue, Lost Knife Road and continue north through the intersection with Montgomery Village Avenue. Due to the constrained corridor through Gaithersburg along MD 355, no new pedestrian or bicycle improvements would accompany this alternative.

7.7.6 Segment 6

The southern end of Segment 6 BRT service would be the intersection of Montgomery Village Avenue intersection with Lost Knife Road and Christopher Avenue. The BRT would travel along Christopher Avenue in mixed traffic. Along MD 355, between Christopher Avenue and Watkins Mill Road, a dedicated curb lane would be provided in the northbound direction. The southbound dedicated curb lane would terminate at the middle commercial entrance to allow the BRT to merge over to the left-turn lane at Christopher Avenue.

The BRT would operate in 11-foot wide dedicated curb lanes in each direction of MD 355 from Watkins Mill Road up to Professional Drive. Due to the width of the existing bridge over Great Seneca Creek, the BRT would operate in mixed traffic in both directions on and near the bridge, between Professional Drive and Plummer Drive. As recommended in the MDOT Phase 1 *MD 355 BRT Corridor Study*, between Plummer Drive and Middlebrook Road, a dedicated 11-foot wide curb lane would be provided in only the southern travel direction. The northbound BRT would continue to operate in mixed traffic.

As part of this alternative, a shared use path would be installed on both sides of the road throughout the segment. Existing pedestrian facilities are currently provided across the Great Seneca Creek bridge and would remain unmodified.

Retaining walls would be included in some locations to avoid or minimize impacts to properties, buildings, and parking lots.

7.7.7 Segment 7

In Segment 7, the BRT would operate in mixed traffic along MD 355 from Middlebrook Road to the BRT terminus at Clarksburg, via Clarksburg Road, Gateway Center Drive and Stringtown Road. MD 355 would

be widened to six general travel lanes north of Middlebrook Road and four lanes north of MD 27 (Ridge Road) as part of a separate MDOT SHA project prior to the construction of stations and operation of the BRT on MD 355 north of Middlebrook Road. To support efficient BRT operations in Segment 7, the widening project should be completed prior to constructing BRT stations or operating the BRT service on MD 355, north of Ridge Road.

The capital and maintenance costs associated with the MDOT SHA widening project will be borne by other agencies or projects and are not included in cost estimates for this project. The BRT project would only be responsible for the design, construction, and costs of the stations along MD 355 and any associated stormwater management facilities.

7.8 Station Locations

As part of Phase 2, MCDOT performed a comprehensive assessment of potential station locations. The Countywide Transit Corridors Functional Master Plan (CTCFMP) identified an initial set of stations along MD 355 when that study was approved by the Montgomery County Council in 2013. The CTCFMP envisioned that future studies would modify these recommendations. Subsequently, the Cities of Rockville and Gaithersburg identified potential station locations in their respective studies. Phase 1 of the MD 355 BRT study, conducted by the MDOT MTA, evaluated the stations proposed by these previous studies and eliminated or modified twelve station locations. These station recommendations were carried forward for further evaluation in this phase of study. Public and CAC comments also informed the evaluation of stations.

MCDOT conducted two levels of station screening to evaluate the station options. In the first level of screening, intersections/activity centers were identified at a planning level to determine if they appeared to be suitable for BRT service. Criteria considered were ridership, land use, pedestrian and bicycle connections, transit connections, street network, and roadway characteristics. At the conclusion of the Level 1 Screening, a determination was made for each proposed station location. Station locations were either retained, retained with their location under evaluation,[3] identified as a future in-fill station, or eliminated.

The Level 2 Screening further assessed the station locations identified to be retained or considered as future in-fill stations in Level 1. On the basis of engineering considerations, service planning, and ridership analysis, the station locations were refined or eliminated. At the conclusion of the Level 2 analysis, a set of recommended stations were identified to be carried forward in the Alternatives. Other stations were eliminated or recommended to be considered as future in-fill stations. These in-fill stations are not suitable for BRT service in the near-term but may become more attractive as development along the corridor continues and the BRT service matures.

Based on those recommendations, each Alternative has a common set of 22 station locations in Segments 1 through 6. In Segment 7, each Alternative has a different number and set of locations based on the

[3] These stations typically included existing transit centers or major activity centers where BRT service is warranted but a precise siting location will require more analysis in subsequent design phases.

specific alignment in that segment. Alternative A, Segment 7 includes eight stations along Observation Drive, Seneca Meadows Parkway, Shakespeare Boulevard, MD 355, Snowden Farm Parkway, and Stringtown Road. Alternative B, Segment 7 includes six stations along Observation. Alternative C, Segment 7 includes five stations along MD 355. In Segment 7, each Alternative terminates at the Clarksburg Outlets.

The *Station Screening Report* describes the full two-level screening process and provides a list of the in-fill stations. The stations included in the TSM Alternative and Alternatives A, B, and C are shown in **Table 7-4**.

Table 7-4: TSM Alternative and Alternatives A, B, and C Stations

Segment	Location	TSM Alternative[4]	Alternative A	Alternative B	Alternative C
1	Bethesda Metrorail Station (Future second entrance)	✓	✓	✓	✓
1	MD 355 and Cordell Avenue	✓	✓	✓	✓
1	Medical Center Metrorail Station	✓	✓	✓	✓
2	Grosvenor-Strathmore Metrorail Station	✓	✓	✓	✓
2	MD 355 and Security Lane	✓	✓	✓	✓
2	White Flint Metrorail Station	✓	✓	✓	✓
2	MD 355 and Bou Avenue		✓	✓	✓
2	MD 355 and Halpine Road	✓	✓	✓	✓
2	MD 355 and Edmonston Drive	✓	✓	✓	✓
2	MD 355 and Mount Vernon Place		✓	✓	✓
3	MD 355 and East Middle Lane (Rockville Metrorail Station)	✓	✓	✓	✓
3	MD 355 and Mannakee Street		✓	✓	✓
3	Montgomery College - Rockville[5]	✓	✓	✓	
4	Shady Grove Metrorail Station	✓	✓	✓	✓
4	MD 355 and South Westland Drive	✓	✓	✓	✓
4	MD 355 and Education Boulevard		✓	✓	✓
5	MD 355 and South Summit Avenue	✓			
5	MD 355 and Cedar/Fulks Corner Avenue		✓	✓	✓
5	MD 355 and Lakeforest Boulevard		✓	✓	✓
5	Lakeforest Transit Center	✓	✓	✓	✓
6	MD 355 and Watkins Mill Boulevard	✓	✓	✓	✓
6	MD 355 and Gunner's Branch Road	✓	✓	✓	✓
7	Holy Cross Hospital		✓	✓	
7	Montgomery College Germantown		✓	✓	

[4] Stations that are already served by the Ride On extRa Route 101 are noted with a blue checkmark.
[5] Depending on the service pattern, Alternatives would serve the Montgomery College Rockville area via MD 355 and Mannakee Street or a station at Montgomery College Rockville's existing transit center. No service pattern would stop at both locations.

Segment	Location	TSM Alternative[4]	Alternative A	Alternative B	Alternative C
7	MD 355 and Oxbridge Drive	✓			✓
7	Germantown Transit Center	✓	✓	✓	✓
7	Seneca Meadows Office Park		✓		
7	Shakespeare Boulevard and Amber Ridge Drive		✓		
7	Observation Drive and Shakespeare Boulevard			✓	
7	MD 355 and Shakespeare Boulevard	✓			✓
7	MD 355 and Milestone Center Entrance		✓		
7	Snowden Farm Parkway and Newcut Road		✓		
7	Stringtown Road and Rainbow Arch Drive		✓		
7	Observation Drive and Milestone Center Drive			✓	
7	Observation Drive and Shawnee Lane			✓	
7	MD 355 and Foreman Boulevard	✓			✓
7	MD 355 and Redgrave Place	✓			✓
7	Clarksburg Outlets	✓	✓	✓	✓

A more detailed description of each station location along the BRT route for each alternative is identified in **Tables 7-5 through 7-8.**

Table 7-5: TSM Alternative Stop Locations[6]

Segment	Location	Northbound	Southbound
1	Bethesda Metrorail Station	Far side of Waverly Street	Far side of Elm Street
1	MD 355 and Cordell Avenue	Far side of West Virginia Avenue	Far side of Cordell Avenue
1	*Medical Center Metrorail Station*	*Near side of South Drive*	*Far side of South Drive*
1	*Grosvenor-Strathmore Metrorail Station*		
2	*MD 355 and Security Lane*	*Far side of Security Lane*	*Far side of Security Lane*
2	*White Flint Metrorail Station*	*Far side of Marinelli Road*	*Near side of Marinelli Road*
2	*MD 355 and Halpine Road*	*Far side of Halpine Road*	*Far side of Halpine Road*
2	*MD 355 and Edmonston Drive*	*Far side of Edmonston Drive*	*Far side of Edmonston Drive*
3	*Rockville Metrorail Station*	*Station bus bays*	*Station bus bays*
3	*Montgomery College - Rockville[7]*	*College bus bays*	*College bus bays*
4	*Shady Grove Metrorail Station*	*Station bus bays*	*Station bus bays*

[6] Stations already served by the Ride On extRa Route 101 service are italicized.
[7] Depending on the service pattern, Alternatives would serve the Montgomery College Rockville area via MD 355 and Mannakee Street or a station at Montgomery College Rockville's existing transit center. No service pattern would stop at both locations.

Segment	Location	Northbound	Southbound
4	*MD 355 and South Westland Drive*	*Far side of South Westland Drive*	*Near side of South Westland Drive*
5	*MD 355 and South Summit Avenue*	*Far side of South Summit Avenue*	*Far side of South Summit Avenue*
5	*Lakeforest Transit Center*	Far side of Odendhal Avenue on Lost Knife Road	Near side of Odendhal Avenue on Lost Knife Road at existing Transit Center
6	MD 355 and Watkins Mill Boulevard	Near side of Watkins Mill Road	Far side of Watkins Mill Road
6	MD 355 and Gunners Branch Road	Near side of Gunners Branch Road	Far side of Gunners Branch Road
7	MD 355 and Oxbridge Drive	Near side of Oxbridge Drive	Far side of Oxbridge Drive
7	Germantown Transit Center	Within transit center	Within transit center
7	MD 355 and Shakespeare Boulevard	Near side of Shakespeare Boulevard	Far side of Shakespeare Boulevard
7	MD 355 and Foreman Boulevard	Far side of Foreman Boulevard	Far side of Foreman Boulevard
7	MD 355 and Redgrave Place	Near side of Redgrave Place	Far side of Redgrave Place
7	Clarksburg Outlets	Location in Outlets to be determined	Location in Outlets to be determined

Table 7-6: Alternative A Station Locations

Segment	Location	Northbound	Southbound
1	Bethesda Metrorail Station	Far side of Waverly Street	Far side of Elm Street
1	MD 355 and Cordell Avenue	Far side of West Virginia Avenue	Far side of Cordell Avenue
1	Medical Center Metrorail Station	Near side of South Drive	Far side of South Drive
2	Grosvenor-Strathmore Metrorail Station	Near side in existing bus pullout	Far side of Tuckerman Lane (north segment)
2	MD 355 and Security Lane	Far side of Security Lane	Far side of Security Lane
2	White Flint Metrorail Station	Far side of Marinelli Rd	Near side of Marinelli Rd
2	MD 355 and Bou Avenue	Near side of Bou Avenue	Far side of Bou Avenue
2	MD 355 and Halpine Road	Far side of Halpine Road	Far side of Halpine Road
2	MD 355 and Edmonston Drive	Near side of Edmonston Drive	Far side of Edmonston Drive
2	MD 355 and Mount Vernon Place	Near side of Mount Vernon Place	Near side of Mount Vernon Place
3	MD 355 and East Middle Lane (Rockville Metrorail Station)	Near side of E. Middle Lane	Near side of E. Middle Lane
3	MD 355 and Mannakee Street	Near side of Mannakee Street	Near side of Ivy League Lane
3	Montgomery College - Rockville	College bus bays	College bus bays
4	Shady Grove Metrorail Station	Far side of Redland Road on Somerville Drive	Near side of Redland Road on Somerville Drive
4	MD 355 and South Westland Drive	Far side of South Westland Drive	Near side of South Westland Drive

Segment	Location	Northbound	Southbound
4	MD 355 and Education Boulevard	Near side of Education Boulevard	Far side of Education Boulevard
5	MD 355 and Cedar/Fulks Corner Avenue	Far side of Cedar Avenue/Fulks Corner Avenue	Near side of Cedar Avenue/Fulks Corner Avenue
5	MD 355 and Lakeforest Boulevard	Far side of MD 355 on Lakeforest Boulevard	Far side of Lakeforest Boulevard
5	Lakeforest Transit Center	Far side of Odendhal Avenue on Lost Knife Road	Near side of Odendhal Avenue on Lost Knife Road at existing Transit Center
6	MD 355 and Watkins Mill Boulevard	Near side of Watkins Mill Road	Far side of Watkins Mill Road
6	MD 355 and Gunner's Branch Road	Near side of Gunners Branch Road	Far side of Gunners Branch Road
7	Holy Cross Hospital	Far side of south hospital Entrance	Near side of south hospital Entrance
7	Montgomery College Germantown	Near side of Innovation Center driveway on Goldenrod Lane	Far side of Innovation Center driveway on Goldenrod Lane
7	Germantown Transit Center	West side of Aircraft Drive in existing transit center	West side of Aircraft Drive in existing transit center
7	Seneca Meadows Office Park	Near side of south Office Park entrance	Far side of south Office Park entrance
7	Shakespeare Boulevard and Amber Ridge Drive	Far side of Amber Ridge Drive	Near side of Amber Ridge Drive
7	MD 355 and Milestone Center Entrance	Near side of entrance	Far side of entrance
7	Snowden Farm Parkway and Newcut Road	Near side of Newcut Road	Far side of Newcut Road
7	Stringtown Road and Rainbow Arch Drive	Far side of Rainbow Arch Drive	Far side of Rainbow Arch Drive
7	Clarksburg Outlets	Location in Outlets to be determined	Location in Outlets to be determined

Table 7-7: Alternative B Station Locations

Segment	Location	Northbound	Southbound
1	Bethesda Metrorail Station	Far side of Waverly Street	Far side of Elm Street
1	MD 355 and Cordell Avenue	Far side of West Virginia Avenue	Far side of Cordell Avenue
1	Medical Center Metrorail Station	Near side of South Drive	Far side of South Drive
2	Grosvenor-Strathmore Metrorail Station	Near side in existing bus pullout	Far side of Tuckerman Lane (north segment)
2	MD 355 and Security Lane	Far side of Security Lane	Far side of Security Lane
2	White Flint Metrorail Station	Far side of Marinelli Rd	Near side of Marinelli Rd
2	MD 355 and Bou Avenue	Near side of Bou Avenue	Far side of Bou Avenue
2	MD 355 and Halpine Road	Far side of Halpine Road	Far side of Halpine Road

Segment	Location	Northbound	Southbound
2	MD 355 and Edmonston Drive	Near side of Edmonston Drive	Far side of Edmonston Drive
2	MD 355 and Mount Vernon Place	Near side of Mount Vernon Place	Near side of Mount Vernon Place
3	MD 355 and East Middle Lane (Rockville Metrorail Station)	Near side of E. Middle Lane	Near side of E. Middle Lane
3	MD 355 and Mannakee Street	Near side of Mannakee Street	Near side of Ivy League Lane
3	Montgomery College - Rockville	College bus bays	College bus bays
4	Shady Grove Metrorail Station	Far side of Redland Road on Somerville Drive	Near side of Redland Road on Somerville Drive
4	MD 355 and South Westland Drive	Far side of South Westland Drive	Near side of South Westland Drive
4	MD 355 and Education Boulevard	Near side of Education Boulevard	Far side of Education Boulevard
5	MD 355 and Cedar/Fulks Corner Avenue	Far side of Cedar Avenue/Fulks Corner Avenue	Far side of Cedar Avenue/Fulks Corner Avenue
5	MD 355 and Lakeforest Boulevard	Far side of MD 355 on Lakeforest Boulevard	Far side of Lakeforest Boulevard
5	Lakeforest Transit Center	Far side of Odendhal Avenue on Lost Knife Road	Near side of Odendhal Avenue on Lost Knife Road at existing Transit Center
6	MD 355 and Watkins Mill Boulevard	Far side of Watkins Mill Road	Far side of Watkins Mill Road
6	MD 355 and Gunner's Branch Road	Far side of Gunners Branch Road	Far side of Gunners Branch Road
7	Holy Cross Hospital	Far side of south hospital Entrance	Far side of south hospital Entrance
7	Montgomery College Germantown	West of Observation Drive in redesigned transit center	West of Observation Drive in redesigned transit center
7	Germantown Transit Center	West side of Aircraft Drive in existing transit center	West side of Aircraft Drive in existing transit center
7	Observation Drive and Shakespeare Boulevard	Far side of Shakespeare Boulevard	Near side of Shakespeare Boulevard
7	Observation Drive and Milestone Center Drive	Far side of Milestone Center Drive	Near side of Milestone Center Drive
7	Observation Drive and Shawnee Lane	Far side of Shawnee Lane	Far side of Shawnee Lane
7	Clarksburg Outlets	Location in Outlets to be determined	Location in Outlets to be determined

Table 7-8: Alternative C Station Locations

Segment	Location	Northbound	Southbound
1	Bethesda Metrorail Station	Far side of Waverly Street	Far side of Elm Street
1	MD 355 and Cordell Avenue	Far side of West Virginia Avenue	Far side of Cordell Avenue

Segment	Location	Northbound	Southbound
1	Medical Center Metrorail Station	Near side of South Drive	Far side of South Drive
2	Grosvenor-Strathmore Metrorail Station	Near side in existing bus pullout	Far side of Tuckerman Lane (north segment)
2	MD 355 and Security Lane	Far side of Security Lane	Far side of Security Lane
2	White Flint Metrorail Station	Far side of Marinelli Rd	Near side of Marinelli Rd
2	MD 355 and Bou Avenue	Near side of Bou Avenue	Far side of Bou Avenue
2	MD 355 and Halpine Road	Far side of Halpine Road	Far side of Halpine Road
2	MD 355 and Edmonston Drive	Near side of Edmonston Drive	Far side of Edmonston Drive
2	MD 355 and Mount Vernon Place	Near side of Mount Vernon Place	Near side of Mount Vernon Place
3	MD 355 and East Middle Lane (Rockville Metrorail Station)	Near side of E. Middle Lane	Near side of E. Middle Lane
3	MD 355 and Mannakee Street	Near side of Mannakee Street	Near side of Ivy League Lane
3	Montgomery College - Rockville	College bus bays	College bus bays
4	Shady Grove Metrorail Station	Far side of Redland Road on Somerville Drive	Near side of Redland Road on Somerville Drive
4	MD 355 and South Westland Drive	Far side of South Westland Drive	Near side of South Westland Drive
4	MD 355 and Education Boulevard	Near side of Education Boulevard	Far side of Education Boulevard
5	MD 355 and Cedar/Fulks Corner Avenue	Far side of Cedar Avenue/Fulks Corner Avenue	Near side of Cedar Avenue/Fulks Corner Avenue
5	MD 355 and Lakeforest Boulevard	Far side of MD 355 on Lakeforest Boulevard	Far side of Lakeforest Boulevard
5	Lakeforest Transit Center	Far side of Odendhal Avenue on Lost Knife Road	Near side of Odendhal Avenue on Lost Knife Road at existing Transit Center
6	MD 355 and Watkins Mill Boulevard	Near side of Watkins Mill Road	Far side of Watkins Mill Road
6	MD 355 and Gunner's Branch Road	Near side of Gunners Branch Road	Far side of Gunners Branch Road
7	MD 355 and Oxbridge Drive	Near side of Oxbridge Drive	Far side of Oxbridge Drive
7	Germantown Transit Center	West side of Aircraft Drive in existing transit center	West side of Aircraft Drive in existing transit center
7	MD 355 and Shakespeare Boulevard	Near side of Shakespeare Boulevard	Far side of Shakespeare Boulevard
7	MD 355 and Foreman Boulevard	Far side of Foreman Boulevard	Far side of Foreman Boulevard
7	MD 355 and Redgrave Place	Near side of Redgrave Place	Far side of Redgrave Place
7	Clarksburg Outlets	Location in outlets to be determined	Location in outlets to be determined

8 Travel Modeling, Ridership Forecasting, Service and Operations Planning

8.1 Traffic Modeling and Ridership Forecasting

Provided below is a summary of results from the ridership and traffic modeling efforts. Significant detail on the ridership and traffic modeling methodology and results are provided in the *Traffic and Ridership Forecasting Analysis Summaries*.

8.1.1 BRT Boardings and Daily Transit Ridership

Alternative B would result in the highest weekday daily BRT boardings at 30,000 per day. Alternative C is next at 27,900, followed by Alternative A at 25,000.

Segment 2 would experience the highest boardings under each of the Build Alternatives, followed by Segment 4, and then Segment 5.

Total daily weekday transit boardings would be the highest in Alternative B, at 91,900. This is approximately 16,000 more boardings per day than in the No-Build Alternative. The next highest would be Alternative C, at 89,400 total boardings, followed by Alternative A at 87,400. Each of the Build Alternatives would attract a large number of local bus riders.

Alternative B would result in the highest number of new transit riders, at 9,400, followed by both Alternative A and C, at 8,900.

Transit Mode share for trips originating in the corridor would improve to 9 percent for each of the three Build Alternatives, when compared to the No-Build Alternative mode share of 8.3 percent. Transit mode share for trips destined to the corridor would improve to 7.2 percent to 7.3 percent (depending on Alternative) when compared to the No-Build Alternative mode share of 6.6 percent. Finally, mode share for trips originating in all of Montgomery County would improve to 8.6 percent to 8.8 percent (depending on Alternative) when compared to the No-Build Alternative mode share of 8.3 percent.

Person throughput, which is a measure of how productively the MD 355 corridor roadway is being utilized, would increase for each Build Alternatives when compared to the No-Build Alternative. These throughput increases are relatively small, however, reflecting the fact that the majority of trips in the corridor would continue to be made by automobile even with the increase in corridor transit ridership.

8.1.2 Accessibility to Jobs and Activity Centers

This set of MOEs measured the change in accessibility to jobs and key activity centers between the No-Build Alternative and the three Build Alternatives under certain travel time scenarios: 30 minutes, 45 minutes, and 60 minutes. The concept is that improved service frequencies and travel times under the BRT alternatives would expand the number of jobs or activity centers that can be reached within a reasonable amount of time, therefore expanding the transit market. In most of the accessibility MOEs evaluated, the transit market did expand, meaning more jobs or activity centers would be accessible under each transit travel time scenario.

8.1.3 Transit Travel Times between Key Origin Destination Pairs

This MOE evaluated the transit travel time between key origin-destination pairs within the corridor as well as one pair with an origin in the corridor and the destination outside the corridor. In nearly all instances, transit travel times would be improved based on the combination of improved BRT frequencies and improved trip times, and Alternatives B and C would perform better than Alternative A.

8.1.4 Transit Reliability

Transit reliability is measured by how effectively buses are separated from each other at a key location along the MD 355 corridor relative to scheduled separation. Maintaining scheduled separation is important because when buses bunch closer together than scheduled, longer gaps in service occur after the bunching, which in turn results in longer wait times for passengers. These gaps also often result in crowding because the first bus after the bunch is forced to carry passengers who would have been more evenly distributed across multiple buses if the buses had been correctly separated.

Reliability was measured by the percentage of BRT vehicles that arrived at Cedar Avenue in Gaithersburg separated from the bus in front of it within a range of seven to 13 minutes during the AM and PM peak (this range represents three minutes on either side of the scheduled bus separation of ten minutes, meaning a BRT vehicle is scheduled to arrive every ten minutes at a stop).

One additional factor that may have an impact on BRT reliability is a phenomenon known as non-recurring congestion. Non-recurring congestion is congestion that occurs because of incidents such as traffic accidents, vehicle breakdowns, or road work that occurs on a variable basis and thus cannot be planned for.

To understand the impact non-recurring congestion has on the MD 355 corridor and the approximate magnitude of the variability it creates in travel time, INRIX traffic data was analyzed. Travel time data for the MD 355 corridor was reviewed for 2018 over a 24-hour period for two segments: Clarksburg to Rockville and Rockville to Bethesda. This data shows how travel time can vary along the corridor by time of day. During the peak commuting periods (AM and PM), the travel time can vary as much as 20 minutes; meaning drivers need to factor this additional time into their commute in order to arrive on time. This variability in travel time manifests itself as unreliable corridor conditions that frustrate travelers.

Non-recurring congestion events would have a greater impact on reliability under Alternatives A and C because they are more impacted by general traffic conditions. The impacts would be greatest for Alternative A, which runs in mixed traffic. The dedicated transit lanes completely separated from general traffic under Alternative B would be the most effective in mitigating the impacts of non-recurring congestion.

8.1.5 Balance the mobility needs of automobiles, trucks, and transit users

A number of MOEs that were developed and evaluated the impact of the provision of transit priority on general traffic operations. These include Change in Number of Miles of LOS E or F by Alternative, Change

in Average Person Travel Time Delay by Alternative, and Change in Intersection Level of Service by Alternative.

The data for the first two metrics, Number of Miles of LOS E or F and Change in Person Travel Time Delay show marginal impacts to general traffic operations due to small increases in miles of LOS E or F and small increases in travel delay. The intersection LOS data also shows a relatively small number of intersections that would decline to LOS E or F when compared to the No-Build Alternative, with more intersections that would decline in the PM peak than in the AM peak.

8.1.6 BRT Travel Times Compared to Local Bus Travel Times

BRT and local bus travel times were generated as outputs of the project VISSIM models and a comparison of the two was an important MOE used in comparing alternatives. The data, which was evaluated for both peak periods and both directions, shows, with few exceptions, two key patterns:

- BRT travel times would be lower than local bus travel times in each BRT alternative and would also be lower when compared to the No-Build Alternative local bus travel times. In addition, BRT would have lower travel times than Ride On extRa under the No-Build Alternative and TSM Alternatives in all but a few instances which are associated with the different alignment alternatives in Segment 7. The data shows that BRT meets the goal of providing a travel time premium relative to local bus as well as Ride On extRa service.

- In most instances local bus travel times under BRT Alternatives A and B would increase relative to local bus travel times under the No-Build Alternative. This increase in travel time under Alternative A is likely the result of more transit vehicles running in the curb lane under mixed traffic operations, thus impacting local bus operations. Under Alternative B, the increase in local bus travel times is most likely the result of the impacts of BRT priority on general traffic operations, which also impact local buses running in mixed traffic. In the case of Alternative C, local bus travel times would actually decrease relative to the No-Build Alternative, most likely as a result of the dedicated transit lane provided in Alternative C, which benefits local bus in addition to BRT.

8.1.7 BRT Travel Times Compared to Automobile Travel Times

Auto travel times were also generated as outputs of the project VISSIM models and a comparison of auto travel times to BRT travel times was an important MOE used in comparing alternatives. The data show two key patterns:

Auto travel times would be lower, in almost all instances, than BRT travel times. This means that even with transit priority treatments, the auto would still provide a more time-competitive trip than BRT.

Auto travel times would increase under Alternatives B and C relative to the No-Build Alternative by approximately six percent and three percent, respectively. This increase reflects the fact that the exclusive transit phases installed as part of the BRT alternatives and road widening do, as noted above, have negative impacts on corridor traffic operations.

8.2 Service and Operations Planning

8.2.1 BRT Service Plan

After assessing the existing conditions and analyzing the market demand for transit, the Project Team developed service plans for the proposed MD 355 BRT service, which included hours of operation, alignment recommendations, and frequency of service. A variety of data sources were used to inform this service plan: U.S. Census demographic and employment data, regional travel demand models, projected development and growth patterns, existing transit ridership data, and community input.

The Project Team recommends four partially overlapping BRT routes, all of which would operate primarily on MD 355:

- FLASH 1C: Clarksburg to Montgomery College - Rockville Campus;
- FLASH 1G: Germantown Transit Center to Montgomery College - Rockville Campus;
- FLASH 2: Lakeforest Transit Center to Grosvenor Metrorail Station; and
- FLASH 3: Montgomery College - Rockville Campus to Bethesda Metrorail Station.

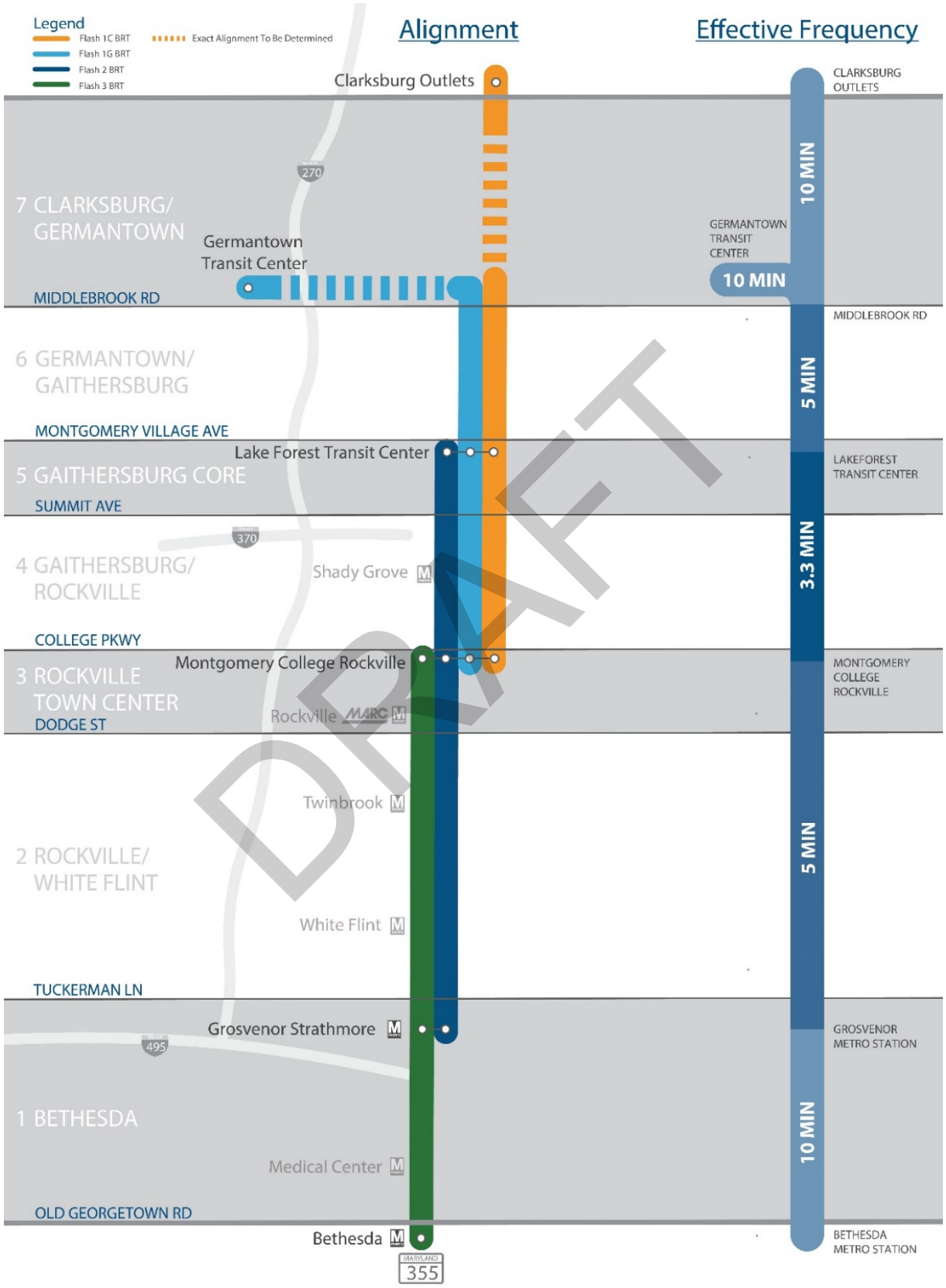
The frequency and span of service for each BRT route is listed in **Table 8-1**. or BRT Flash service, the peak period is defined as between 6:00 AM – 9:00 PM. Off-peak is considered anytime outside of these hours.

Table 8-1: BRT FLASH Route Span of Service

Route	Weekday Frequency	Weekday Span	Weekend Frequency	Saturday Span	Sunday Span
FLASH 1C	10 mins peak 15 mins off-peak	4:15 AM - 12:00 AM	15 mins	5:00 AM - 12:00 AM	5:00 AM - 12:00 AM
FLASH 1G	10 mins peak 15 mins off-peak	4:15 AM - 1:45 AM	15 mins	5:00 AM - 1:45 AM	5:00 AM - 1:30 AM
FLASH 2	10 mins peak 15 mins off-peak	4:15 AM - 1:45 AM	15 mins	5:00 AM - 1:45 AM	5:00 AM - 1:30 AM
FLASH 3	10 mins peak 15 mins off-peak	5:00 AM - 1:45 AM	15 mins	5:00 AM - 1:00 AM	5:00 AM - 1:00 AM

Figure 8-1 shows a schematic map of BRT service showing origins, destinations, and major destinations served. The effective headway of the combined BRT routes during peak periods is also shown to give a better sense of how BRT service overlaps to provide high quality, frequent, and reliable transit service on the MD 355 corridor. More information can be found in the *Service Planning Technical Report*.

Figure 8-1: BRT FLASH Route Levels of Service



9 Preliminary Cost Estimates

Right-of-way cost estimates were developed based on City and County land use and zoning and are based on the area of right-of-way required on each property. A summary of right-of-way needs for each Build Alternative is included in **Tables 9-1 through 9-4**. For property displacements, the right-of-way cost included the cost of purchasing the entire property and relocation costs. At this phase in the MD 355 BRT Planning Study, right-of-way needs are preliminary. As the study progresses, further avoidance and minimization to reduce property impacts will be investigated.

Table 9-1: TSM Alternative Right-of-Way Needs

Segment	Acres Impacted	Number of Displacements
1	0.02	0
2	0.01	0
3	0.01	0
4	0.03	0
5	0.02	0
6	0.18	0
7	0.08	0
Total	0.35	0

Table 9-2: Alternative A Right-of-Way Needs

Segment	Acres Impacted	Number of Displacements
1	1.11	0
2	2.64	0
3	1.33	0
4	3.65	0
5	1.06	0
6	1.60	0
7	1.00	0
Total	12.39	0

Table 9-3: Alternative B Right-of-Way Needs

Segment	Acres Impacted	Number of Displacements
1	1.11	0
2	21.33	8
3	8.02	2
4	15.22	7
5	5.13	6
6	8.58	5

Segment	Acres Impacted	Number of Displacements
7	1.43	0
Total	60.83	28

Table 9-4: Alternative C Right-of-Way Needs

Segment	Acres Impacted	Number of Displacements
1	1.08	0
2	13.32	4
3	6.00	2
4	12.22	5
5	1.45	0
6	3.54	1
7	0.94	0
Total	38.55	12

Preliminary Cost Estimates were prepared for each Build Alternative by alignment segment. The *Cost Estimate Methodology* is included in **Appendix B** and detailed construction cost estimates for each Build Alternative can be found in **Appendix C**. Preliminary Cost Estimates are in 2018 dollars and include a 40 percent contingency to account for the conceptual nature of the design, a 15.3 percent overhead contingency, and 10 percent final design costs. Detailed Preliminary Cost Estimates for each alternative alignment segment are summarized in **Tables 9-5 through 9-8**.

Table 9-5: TSM Alternative Preliminary Cost Estimate

Segment	Construction	Right-of-Way	Total
1	$358,379	$372,983	$731,362
2	$793,373	$69,152	$861,524
3	$206,610	$10,122	$216,733
4	$209,041	$51,796	$260,837
5	$452,800	$19,570	$472,371
6	$829,945	$263,901	$1,093,847
7	$1,463,213	$146,521	$1,609,734
Cost of Buses			*$9,630,000*
Total			$15M

Table 9-6: Alternative A Preliminary Cost Estimate

Segment	Construction	Right-of-Way	Total
1	$13,702,948	$4,565,963	$17,220,006
2	$39,674,553	$9,889,347	$46,805,132
3	$7,737,066	$3,196,429	$10,290,842

Segment	Construction	Right-of-Way	Total
4	$19,709,962	$5,997,235	$24,187,754
5	$7,722,637	$1,464,567	$8,690,078
6	$5,750,280	$3,134,513	$8,509,553
7	$18,277,712	$593,740	$17,549,427
Cost of BRT Vehicles			*$42,875,000*
Total			$185M

Table 9-7: Alternative B Preliminary Cost Estimate

Segment	Construction	Right-of-Way	Total
1	$14,181,908	$4,565,963	$18,747,871
2	$162,247,971	$184,070,161	$346,318,132
3	$62,790,036	$29,618,352	$92,408,388
4	$113,540,314	$56,288,329	$169,828,642
5	$54,277,876	$31,632,130	$85,910,006
6	$96,390,151	$24,607,016	$120,997,167
7	$13,487,119	$1,201,980	$14,689,099
Cost of BRT Vehicles			*$36,750,000*
Total			$886M

Table 9-8: Alternative C Preliminary Cost Estimate

Segment	Construction	Right-of-Way	Total
1	$32,722,518	$3,987,066	$36,709,584
2	$90,548,979	$99,371,050	$189,920,030
3	$32,450,587	$32,499,431	$64,950,018
4	$60,454,046	$62,687,376	$123,141,422
5	$8,248,079	$1,750,452	$9,998,532
6	$53,170,182	$6,045,035	$59,215,217
7	$11,930,621	$829,683	$12,760,304
Cost of BRT Vehicles			*$36,750,000*
Total			$534M

The annual operating cost for the TSM Alternative and Alternatives A, B, and C are summarized in **Table 9-9**.

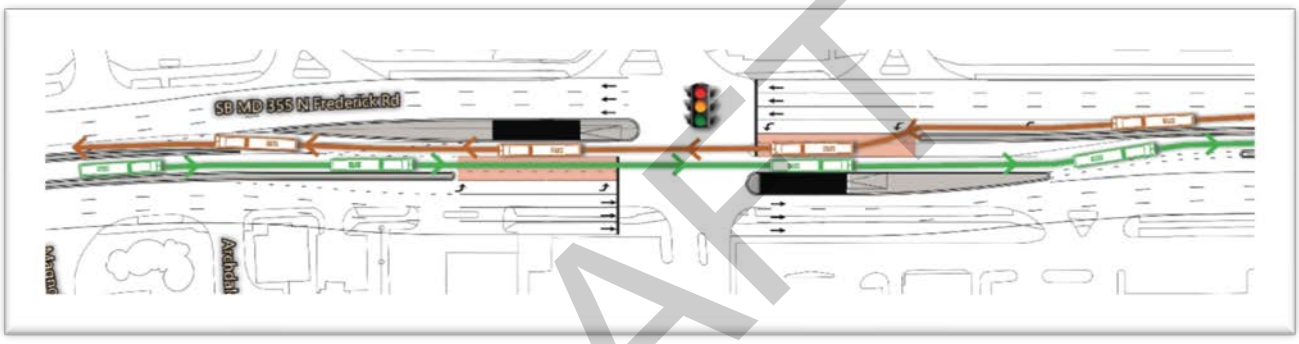
Table 9-9: Annual Operating Cost Estimates

	TSM Alternative	Alternative A	Alternative B	Alternative C
Operating Cost (2018 USD)	$11,309,143	$31,899,339	$28,041,063	$28,019,725

10 Additional Alternative Development

Following the completion of the Build Alternatives Development, design modifications were developed for Alternative B in Segments 4 through 6 in an attempt to reduce costs and property impacts. This Alternative, called Alternative B Modified, would include a one-way peak direction guideway in the median of MD 355. The BRT service would operate in the single-lane guideway in the peak direction, and off-peak direction service would operate in mixed traffic. The off-peak BRT service would enter into short segments of dual-lane guideway to access the station platforms via a "bus box" (i.e., a short opening in the guideway separator) next to the left turn lane, shown in **Figure 10-1**. The off-peak BRT service would exit from the station area into mixed traffic via a short exit lane operating under coordinated signal control with the traffic signal at the station intersection.

Figure 10-1: Alternative B Modified Bus Box



Proposed typical sections for Alternative B Modified are shown in **Figure 10-2** and detailed Plan Sheets are included in **Appendix A**.

10.1 Segment 4

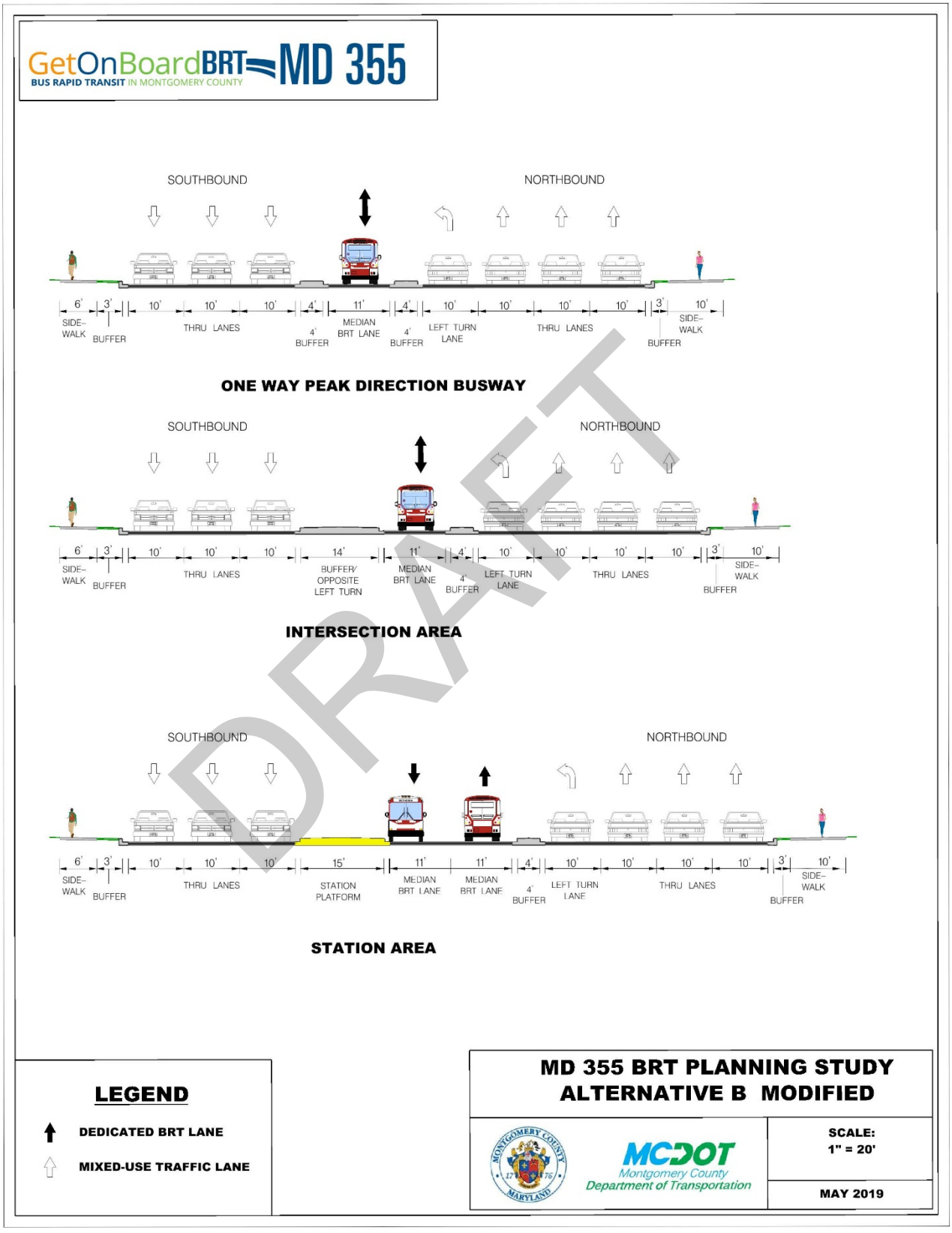
The BRT would operate in one 11-foot wide dedicated lane in peak direction in the median of MD 355 from College Parkway to Redland Road. Similar to Alternative B, BRT Service would then be provided into the Shady Grove Metrorail Station via Redland Road, Sommerville Drive, and Metro Station Drive in mixed traffic. The median dedicated lane would then start in each direction again once the alignment is back on MD 355 to Summit Avenue.

The median buffer width would vary from a four-foot wide raised concrete median to a 15-foot wide buffer that would accommodate an 11-foot wide left turn lane and a four-foot-wide raised concrete median. Three general purpose travel lanes in each direction would remain but would be narrowed to ten feet wide in order to minimize roadway widening.

In order to accommodate the dedicated lane, approximately 0 to 30 feet of outside pavement widening would be required on both sides of the roadway.

Similar to Alternative B, along southbound MD 355, a ten-foot wide shared use path would be included with a minimum three-foot wide varying width grass or landscape buffer from College Parkway to Gude

Figure 10-2: Alternative B Modified Typical Sections



Drive. It would then transition to a six-foot wide sidewalk with a minimum three-foot wide varying width grass or landscape buffer from Gude Drive to the end of Segment 4 at Summit Avenue. Along northbound MD 355, a six-foot wide sidewalk would be included with a minimum three-foot wide varying width grass or landscape buffer from College Parkway to Gude Drive. It would then transition to a ten-foot wide shared use path would be included with a minimum three-foot wide varying width grass or landscape buffer from Gude Drive to the end of Segment 4 at Summit Avenue. Retaining walls would be included in some locations to avoid or minimize impacts to properties, buildings, and parking lots.

10.2 Segment 5

Segment 5 in Alternative B Modified closely mirrors Alternative B. The alignment was modified between the Summit Avenue to the Father Cuddy Bridge to avoid impacts to specific properties based on MCDOT and City of Gaithersburg feedback. North of the Father Cuddy Bridge, there would be no changes to the Segment 5 alignment or engineering because Alternative B Segment 5 is already designed as a single-lane guideway. All Segment 5 guideway features, station locations, BRT transitions to and from mixed traffic, pedestrian facilities, and property encroachments would remain consistent with Alternative B north of the Father Cuddy Bridge. The BRT service route would still divert from MD 355 to serve the Lakeforest Transit Center, including connected to Segment 6 via Lost Knife Road and Christopher Avenue.

10.3 Segment 6

The BRT would operate in a single-lane median guideway on MD 355, with one 11-foot wide dedicated lane, starting at Christopher Avenue and continuing to just north of Gunners Branch Road.

The median buffer width would vary from a four-foot wide raised concrete median to an approximately 15 feet wide buffer opposite left turn lanes at signalized intersections. Three general purpose travel lanes would be provided in both directions continuously through Segment 6 but would be narrowed to ten feet wide to minimize roadway widening.

A ten-foot wide shared use path would be included with a minimum three-foot wide varying width grass or landscape buffer, on both sides of MD 355. This curbside design is generally continuous for this segment. Where localized property constraints are a challenge, a six-foot wide sidewalk with a narrower or no grass or landscape buffer is provided. The existing curbside features are maintained on the bridge over the Great Seneca Creek, including a ten-foot wide trail on the west side of the bridge and six-foot wide sidewalk on the east side of the bridge.

Retaining walls would be included in some locations to minimize impacts to properties, buildings, and parking lots.

10.4 Traffic Modeling and Ridership Forecasting

In order to evaluate the effectiveness of Alternative B modified, an assessment was conducted to determine whether running BRT service in mixed traffic in the off-peak direction would have a significant impact on BRT travel times such that there would be a potential impact on ridership relative to Alternative

B. This assessment to evaluate potential impacts to travel time and ridership compared Alternative B off-peak direction travel times to off-peak direction travel times for Alternatives A and C.

While the Alternative B off-peak direction travel times are not directly comparable to off-peak direction BRT travel times for Alternatives A and C, they are sufficiently close such that the Project Team determined that new model runs for Alternative B Modified were not required. Alternative B travel time and ridership numbers were used for Alternative B Modified when comparing the alternatives.

10.5 Cost

Construction and right-of-way cost estimates were developed for Alternative B Modified using the same methodology described in **Chapter 9**. A summary of right-of-way needs for each Alternative B Modified in included in **Table 10-1**. When compared with Alternative B, Alternative B Modified would reduce the number of acres impacted by 7.12, and the number of displacements by 3.

Table 10-1: Alternative B Modified Right-of-Way Needs

Segment	Acres Impacted	Number of Displacements
1	1.11	0
2	21.33	8
3	8.02	2
4	11.30	6
5	3.85	6
6	6.57	4
7	1.43	0
Total	53.61	**26**

*Segments 1 through 3 and 7 are the same as Alternative B

Table 10-2 includes the preliminary cost estimate by alignment segment for Alternative B Modified. When compared with Alternative B, Alternative B Modified would reduce the overall project cost by $65,319,033.

Table 10-2: Alternative B Modified Preliminary Cost Estimate

Segment	Construction	Right-of-Way	Total
1	$14,181,908	$4,565,963	$18,747,871
2	$162,247,971	$184,070,161	$346,318,132
3	$62,790,036	$29,618,352	$92,408,388
4	$96,111,380	$44,792,803	$140,904,183
5	$49,429,942	$30,228,292	$79,658,234
6	$76,604,694	$14,249,672	$90,854,366
7	$13,487,119	$1,201,980	$14,689,099
Cost of BRT Vehicles			*$36,750,000*
Total			$821M

*Segments 1 through 3 and 7 are the same as Alternative B

11 Potential Hybrid Alternative and Phased Implementation

A Recommended Alternative could be pieced together from segments of different alternatives to form a "hybrid" Recommended Alternative. In addition, given the length of the corridor and varying characteristics of the existing conditions, it is anticipated that a Recommended Alternative would be implemented in stages. These strategies are described below.

11.1 Potential Hybrid Alternative

The alternative alignment segments described in **Section 7.2** could ultimately be combined to form a "hybrid" alternative. This hybrid alternative would include alignment segments pieced together from the different Build Alternatives that could reduce impacts and costs while achieving the Purpose and Need. However, if a hybrid alternative is developed, special attention would need to be paid to ensure transitions between guideway types are minimized; as these transitions are where some of the greatest delays to the BRT would occur. For example, it may be beneficial to group several segments into one type of guideway to maximize travel time.

If a hybrid alternative is identified as Recommended Alternative, it would be presented to the public and fully documented during the next phase of the project.

11.2 Phased Implementation Approach

The Recommended Alternative could include a proposed order of implementation. This will document the order in which MCDOT anticipates moving the Recommended Alternative through final design and construction. The implementation of the Recommended Alternative could occur via the construction of the alignment segments or smaller portions of the Recommended Alternative. The order in which the segments are implemented will be informed by engineering and traffic analysis, and public, agency, and stakeholder comments.