CORRIDOR FORWARD

I-270 Transit Plan

Public Hearing Draft

Appendices

January 2022

APPENDICES

APPENDIX 1: GLOSSARY

TERM	DEFINITION
Active Zone	Includes roadway elements between the curb and the property line. It contains all active transportation uses (pedestrians and usually bicyclists) and includes a maintenance buffer, a frontage zone, sidewalks or sidepaths, separated bike lanes, and several types of buffers. For more information, see the County's Complete Streets Design Guidelines.
Activity Centers	Communities that function as employment centers or are anticipated for future growth. Defined by the Metropolitan Washington Council of Governments, activity centers include existing urban centers, priority growth areas, traditional towns, and transit hubs.
Alternatives Analysis (AA)	A consideration of a reasonable range of alternatives that can accomplish the purpose and need of a proposed project, as required by the National Environmental Policy Act (NEPA).
Business as Usual	An analysis that illustrates forecasted outcomes without targeted interventions. It provides a baseline comparison for analysis. Also known as "baseline" and "no-build" scenarios.
Consolidated Transportation Program (CTP)	The state of Maryland's six-year capital budget for transportation projects, which contains projects and programs across the Maryland Department of Transportation.
Corridor Cities Transitway (CCT)	A 15-mile Bus Rapid Transit (BRT) project in Montgomery County, Maryland from the COMSAT facility near Clarksburg, Maryland to the Shady Grove Metrorail Station.
Dedicated Bus Lanes	Lanes that are for the exclusive use of a transit vehicle, which may include local or express buses, bus rapid transit vehicles, or paratransit vehicles.
Draft Environmental Impact Statement (DEIS)	A detailed statement, required for federal actions pursuant to the National Environmental Policy Act of 1969 (NEPA), which assesses the environmental considerations of an action, and alternatives to the action, and is published for public review and comment, prior to release of the Final Environmental Impact Statement.
Equity Focus Areas	Parts of Montgomery County that are characterized by high concentrations of lower-income people of color, who may also speak English less than very well.
Life Sciences	The term Life Sciences is broadly used to describe an industry that studies living organisms and life processes. The industry focuses on advancements in human health, with specific sectors of the industry focused on personalized medicine, cell and gene therapy, vaccine development, medical diagnostics, biopharmaceuticals, medical devices, and health services and suppliers. These sectors include research and development, manufacturing, and sales.
Modes	Forms of transportation, which typically includes driving, transit, walking, bicycling and other micromobility. Transit modes include—but are not limited to—heavy rail, local bus, bus rapid transit, light rail, and paratransit

Monorail Feasibility Study	A study completed by the Maryland Department of Transportation to assess the viability to construct, operate, and maintain a monorail system between Shady Grove Metrorail Station and Frederick, Maryland.
National Environmental Policy Act (NEPA)	Federal law, enacted in 1969, which requires government agencies to consider the environment prior to undertaking any major federal action that significantly affects the environment.
Off-model	An evaluation tool, which uses Geographic Information Systems, spreadsheets, or other tools rather than the Travel Demand Model or the Regional Dynamic Model for analysis.
Peak Hour Headways	Frequency of service during the busiest hour within the morning and evening peak periods using transit.
Peak Hour Trips	Trips made during the busiest hour within the morning and evening peak periods using any transportation mode.
Pre-Screening	Process of completing an initial evaluation on options, prior to proceeding with detailed analysis. This process may result in the removal of some options from further consideration. Pre-screening is typically applied in projects to ensure limited modeling resources are used effectively.
Public-Private Partnership (P3)	Public-Private Partnerships (P3s) are contractual agreements between a public agency and a private entity that allow for greater private participation in the innovative delivery of projects. (From MCDOT)
Scenario-planning	An analysis of various alternative policies, plans, and/or programs on the future of a community or region. In the context of Corridor Forward, the scenarios tested explore how each studied option and various networks support accessibility within the region as well as further Montgomery County's economic, environmental, and equity values.
Service Patterns	Planning for transit routes, including origins, destinations, routing, frequency, and duration of transit.
Staging Provisions	Typically applied in master plans or redevelopment projects that will significantly transform land use, address the timing of development and the provision of key public facilities and amenities within the lifetime of the plan or project. Through staging provisions, incremental development is paired with infrastructure, public facilities, services, or specific milestones to ensure that development advances at a pace consistent with the delivery of infrastructure and services necessary to support the development and minimize negative impacts.
Thrive Montgomery 2050	Thrive Montgomery 2050 is the update to Montgomery County's General Plan, its long-range policy framework for guiding future land use and growth for the next 30 years. Thrive Montgomery 2050 will help guide future land use planning; countywide policies and future initiatives affecting community quality of life; the provision of infrastructure and community amenities; and private development.
Travel Demand	The number of trips between two points, including all modes. The region's travel demand model is a forecasting tool used to understand when, where, and what mode people will choose to travel under specific conditions, accounting for factors such cost and travel times.

APPENDIX 2. OPTIONS DEVELOPMENT & PRE-SCREENING ANALYSIS

This provides additional detail about the options development process and pre-screening analysis. The summary provided on the following pages is accompanied by a technical report developed by the project consultant, Steer.

OPTIONS DEVELOPMENT

Per the Plan purpose, staff and the consultant team focused on compiling options that exist either as master-planned transitways, studied concepts, or frequently requested concepts, into a package of conceptual alternatives for analysis. As previously stated, the conceptual options are distinct in scale, geography, and type of service. Table 1 organizes each conceptual option by mode, corridor, and type of service.

Table 1 – Conceptual Option Summary

Option Number	Option Name	Mode	General Corridor Alignment	Service Type	To	From
1*	MD 355 BRT	Bus Rapid Transit	MD 355	Local	Clarksburg	Bethesda
2A	MARC Commuter Rail – Station Revision	Commuter Rail	CSX Rail Corridor	Regional	Frederick/ Martinsburg	Union Station
2B	MARC Commuter Rail – Additional Mainline Track	Commuter Rail	CSX Rail Corridor	Regional	Frederick/ Martinsburg	Union Station
3A	Red Line Extension Segment 1	Metrorail	CSX Rail Corridor	Limited Stop Local Service	Shady Grove	Downtown Gaithersburg
3B	Red Line Extension Segment 1	Metrorail	MD 355	Limited Stop Local Service	Shady Grove	Downtown Gaithersburg
4A	Red Line Extension Segment 2	Metrorail	CSX Rail Corridor	Limited Stop Local Service	Downtown Gaithersburg	Germantown
4B	Red Line Extension Segment 2	Metrorail	MD 355	Limited Stop Local Service	Downtown Gaithersburg	Germantown

Option Number	Option Name	Mode	General Corridor Alignment	Service Type	To	From
5	Corridor Cities Transitway Phase 1	Bus Rapid Transit	Great Seneca Science Corridor	Local	Existing: Shady Grove, additional variants TBD	Existing: Metropolitan Grove, additional variants TBD
6	Purple Line Extension	Light Rail Transit	I-495/ American Legion Bridge	Regional	Bethesda Station	Tysons Corner or Dunn Loring (VA)
7	North Bethesda Transitway Extension	Bus Rapid Transit	Old Georgetown Road & I-495 /American Legion Bridge	Hybrid Local-Regional	White Flint	Tysons Corner or Dunn Loring (VA)
8	I-270 Monorail	Monorail	I-270	Regional	Downtown Frederick Vicinity	Shady Grove
9	Managed Lanes Enhanced Commuter Bus – County Tech Corridor Extended	Commuter Bus	I-270 & I-495	Regional	Clarksburg	Downtown Bethesda
10	I-270 Light Rail – County Tech Corridor	Light Rail Transit	I-270 & I-495	Regional	Gaithersburg Vicinity	Downtown Bethesda
11	I-270 Bus Rapid Transit – County Tech Corridor	Bus Rapid Transit	I-270 & I-495	Regional	Gaithersburg Vicinity	Downtown Bethesda
12	I-270/I-495 Bus Rapid Transit: NoVa	Bus Rapid Transit	I-270 & I-495 /American Legion Bridge	Regional	Downtown Frederick Vicinity	Tysons Corner or Dunn Loring (VA)
13	I-270/I-495 Bus Rapid Transit: Silver Spring	Bus Rapid Transit	I-270 & I-495	Regional	Downtown Frederick Vicinity	Downtown Silver Spring

* To be excluded from further study and assumed as a future service given the resources invested in the project to date.

PRE-SCREENING EVALUATION

The pre-screening analysis evaluated these 13 options in four steps, which are described in greater detail below:

1. **Organize options by cost and geography:** Projects were sorted into preliminary categories based on their cost and coverage.

2. **Performance analysis:** A simplified list of high-level indicators was developed to consider the options based on measures that 'predict' conventional transit outcomes, such as ridership, travel time savings, and mode shift.
3. **Performance evaluation:** The scores for each indicator are normalized on a 1-5 scale and added together to provide an overall understanding of the option's performance.
4. **Rank by cost and geography:** One or two projects have been selected from each of the categories in step 1 and are proposed to be carried forward for refinement, bundling, and detailed assessment.

1. ORGANIZE PROJECTS BY COST AND GEOGRAPHY

First, the 13 options were sorted into preliminary categories based on their cost and coverage (Table 2). Cost refers to the expected capital and operational costs of the option. Bus and BRT generally have lower capital costs than light rail and heavy rail. Coverage refers to how many neighborhoods and employment centers are served by the transit option. As a result, coverage generally relates to the length of the transit option.

This categorization approach allowed staff to ensure that the advanced projects are well-rounded and present a range of options.

Table 2 – Options by Cost and Geography

	Lower Coverage	Higher Coverage
Higher Cost	3A/B – Red Line Extension 1 4A/B – Red Line Extension 2 6 – Purple Line Extension	2A/B – MARC Commuter Rail 8 – I-270 Monorail
Lower Cost	5 – Corridor Cities Transitway 7 – North Bethesda Transitway Extension 10 – I-270 Light Rail on County Tech Corridor 11 – I-270 BRT on County Tech Corridor	9 – Managed Lanes Enhanced Bus 12 – I-270 BRT to NoVA 13 – I-270 BRT to Silver Spring

2. PERFORMANCE ANALYSIS

Five indicators were used to evaluate the transit options: travel time, population access, job access, accommodating growth, and equitable access. These indicators broadly align with the Plan's values:

- **Strategic Connections:** Serve high-demand origin and destination pairs, balancing costs of implementation with projected benefits.
- **Economic Health**: Enable existing development and master-planned communities to realize their potential as livable and economically vibrant places.
- **Community Equity:** Align with the county's social equity goals and principles.
- **Environmental Resilience:** Operate sustainably and reduce negative environmental impacts.

While environmental resilience is not explicitly identified in the indicators, they generally align with the Plan's air quality and climate goals by prioritizing options that reduce reliance on automobiles and promote transit-oriented development.

Each indicator is summarized in more detail below:

1. **Travel Time:** This indicator measures the travel time between key destinations on the corridor and captures the extent to which each transit option provides competitive travel times with other modes and existing transit on the corridor.
2. **Population Access:** This indicator is concerned with how many people can access rapid transit serving the I-270 corridor, relative to the existing transit system. It estimates the planned (2045) population within 15-minute walking, transit, and driving access of assumed station locations[1] with service to the I-270 corridor.
3. **Job Access:** This indicator considers how many jobs are accessible by a proposed rapid transit option serving the I-270 corridor, relative to the existing transit system, by estimating the planned (2045) jobs within 15-minute walking and transit access of assumed station locations with service to the I-270 corridor.
4. **Accommodating Growth:** This indicator measures the amount of projected growth (2045 relative to 2015) in population and employment located within a 15-minute walk or transit ride from the proposed rapid transit system.
5. **Equitable Access:** This indicator is concerned with increased access to the proposed rapid transit system from Montgomery County's Equity Focus Areas (EFAs) and people of color, relative to the existing system. Access is defined as being within a 15-minute walk, transit ride, or drive of an assumed station location serving the I-270 corridor.

For indicators 2 through 5, only new service areas (falling outside the 15-minute catchment of existing rapid transit stations) are counted to indicate the potential net benefits from a given project.

3. PERFORMANCE EVALUATION

Each indicator has a different unit of analysis. In order to provide a more apples-to-apples comparison across the indicators, the consultant team normalized values using a 1 to 5 scale. For indicator 1, travel time, the score from 1 to 5 is based on how competitive transit travel time is relative to automobile travel time and existing transit service. No improvement in transit travel time results in a score of 1, while a transit travel time equal to or faster than automobile travel receives a 5. For indicators 2 through 5, the results were scaled to a score out of 5 by comparing each option to the highest performing option.

Indicators are summarized below:

1. **Travel Time:** Most options are competitive with automobile for the key destinations considered. Only MARC (Option 2) offers travel times that are consistently equal to or faster than automobile travel times. Options that operate in mixed traffic environments and for longer distances tend to perform more poorly in comparison to automobile travel times (particularly for options that serve locations farther from typically more congested areas).

[1] Station locations evaluated in pre-screening are approximate and are assumed based on key destination points along the route. The stop locations may be revised in the next phase of analysis.

2. **Population Access:** Almost all options offer increased accessibility to rapid transit. Greatest benefits are offered by longer routes with stations not currently served by the region's rapid transit network (Option 12 and 13). MARC (Option 2) has same catchment area as today, but existing peak-direction service is not considered all day rapid transit. Extensions of the Red Line (Option 3 and 4) achieve lower performance due to relatively short lengths of service and the proximity to existing rapid transit stations.
3. **Job Access:** All options offer increased accessibility to jobs from the rapid transit network by walking and transit. Longer routes with more stations that are located beyond existing 15-minute walking and transit catchment areas offer the greatest net benefits (Options 12 and 13). MARC (Option 2) has same catchment area as today, but existing peak-direction service is not considered all day rapid transit. Extensions of the Red Line (Options 3 and 4) achieve lower performance due to relatively short lengths of service and the proximity of existing rapid transit stations.
4. **Accommodating Growth:** Most options provide modest support for projected urban development. Projected population growth in Montgomery County is generally more dispersed throughout the region, while projected employment growth within Montgomery County is generally more tightly clustered along the I-270 corridor. The greatest benefits are offered by longer routes running through areas of expected rapid growth. This preliminary evaluation does not consider the potential impact of options in stimulated unplanned development.
5. **Equitable Access:** All options offer increased accessibility to activity centers from the rapid transit network by walking and transit. Options with longer routes and more stations beyond existing walking and transit catchment areas offer the greatest net benefits.

4. RANK BY COST AND GEOGRAPHY

After the performance evaluation, the options were reviewed through the cost and coverage categories developed in the first step. Final total scaled scores are shown in Table 3.

Table 3 – Performance Evaluation Results

Conceptual Option	Mode	Total Score
HIGH COST/HIGH COVERAGE OPTIONS		
2. Upgrade MARC Service	**Heavy Rail**	**16.5**
8. Monorail	**Monorail**	**14.5**
6. Purple Line Extension	**LRT**	**12.0**
HIGH COST/LOW COVERAGE OPTIONS		
4A. Red Line Extension 2 (Germantown)	**Metro**	**12.0**
4B. Red Line Extension 2 (Germantown) via MD 355	**Metro**	**12.0**
3B. Red Line Extension 1 (Gaithersburg) via MD 355	Metro	12.0
3A. Red Line Extension 1 (Gaithersburg)	Metro	10.5
LOW COST/HIGH COVERAGE OPTIONS		
12. I-270 BRT to NoVa	**BRT**	**21.0**
13. I-270 BRT to Silver Spring	BRT	15.0
9. Managed Lanes Enhanced Bus	Bus	13.0
LOW COST/LOW COVERAGE OPTIONS		
5. Corridor Cities Transitway	**BRT**	**14.0**
7. North Bethesda Transitway Extension	BRT	11.5
10. I-270 LRT County Tech Corridor	LRT	10.5
11. I-270 BRT County Tech Corridor	BRT	10.0

Bold indicates that the option is recommended for detailed study.

RECOMMENDED OPTIONS FOR DETAILED STUDY

Based on the results of the pre-screening analysis and a review of recent planning efforts along the I-270 corridor, six options emerged as the best candidates for Corridor Forward's more detailed evaluation:

- MARC station and service upgrades along the Brunswick Line (Option 2A/B)
- Red Line Extension to Germantown (Option 4A/B)
- Corridor Cities Transitway with current alignment (Option 5)
- Purple Line Extension to Tysons (Option 6)
- Monorail (Option 8) or Light Rail along I-270 from Shady Grove to Frederick
- I-270 BRT from Frederick to Northern Virginia (Option 12) plus Corridor Cities Transitway supplemental concept

Some modifications to the conceptual options were made during the pre-screening process, and these options were refined further as part of the modeling and evaluation process:

- The two MARC options were combined as one project, as the proposed improvements for each option – additional capacity and station location modifications – are complementary.
- The determination of whether the Red Line will run on the CSX corridor or local roadways such as MD 355 was made as part of route refinement.
- The monorail option along I-270 was generalized as a rail corridor, either carrying light rail or monorail vehicles.

- The I-270 BRT was combined with a new option, a supplemental concept for the Corridor Cities Transitway.

Together, these options cover each of the four cost and coverage categories and provide geographic breadth. Some options are more regional in nature, emphasizing connections to Montgomery County's neighboring jurisdictions (MARC, the Purple Line Extension, I-270 BRT), while others focus on strengthening connections within Montgomery County (Red Line Extension, Corridor Cities Transitway, and Monorail or Light Rail). Through another lens, some options extend or improve existing services (MARC, Purple Line Extension, Red Line Extension), while others envision new services (Corridor Cities Transitway, Monorail or Light Rail, and I-270 BRT.

Report #2

July 2021

Corridor Forward Transit Plan Report 2
Retained Alternatives

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1 Report Overview

Steer has been retained by the Maryland-National Capital Park and Planning Commission (MNCPPC) to assist with the development of a transit plan for the I-270 Corridor, between the City of Frederick (Maryland) and Tysons in Fairfax, Virginia. The purpose of the work is to strategically evaluate and prioritize opportunities serving the Corridor, using criteria based on the four values of strategic connections, economic health, community equity, and environmental resilience. The scope of work includes the following five tasks:

- Task 1: Project Management and Engagement
- Task 2: Develop/Refine Projects to be Evaluated
- Task 3: Develop Evaluation Methodology and Metrics
- Task 4: Evaluate Alternatives
- Task 5: Develop Recommendations

The previous report (Report 1) outlined the development of a long list of transit alternatives for the I-270 corridor, drawing on existing proposals and new alternatives. This report describes the process of pre-screening and refinement to create a short-list of retained alternatives for detailed modeling and evaluation.

Specifically, the report documents the following:

Task 4A: Pre-screening assessment, including:

- General route alignment and mode of operation for the long list of project alternatives
- Preliminary stop locations
- Alternatives organization (cost/coverage)
- Performance assessment and evaluation
- Results and identification of the short list

Task 2C: Summary of the refined short list options brought forward from the pre-screening assessment, including:

- Refined route alignment and station locations
- Station amenities (e.g. exiting/planned parking facilities)
- Service assumptions
  - Service patterns
  - Peak/off-peak service headway
  - Average operating speeds and runtime

The alternatives pre-screening and short list development process is summarized below in Figure 1.

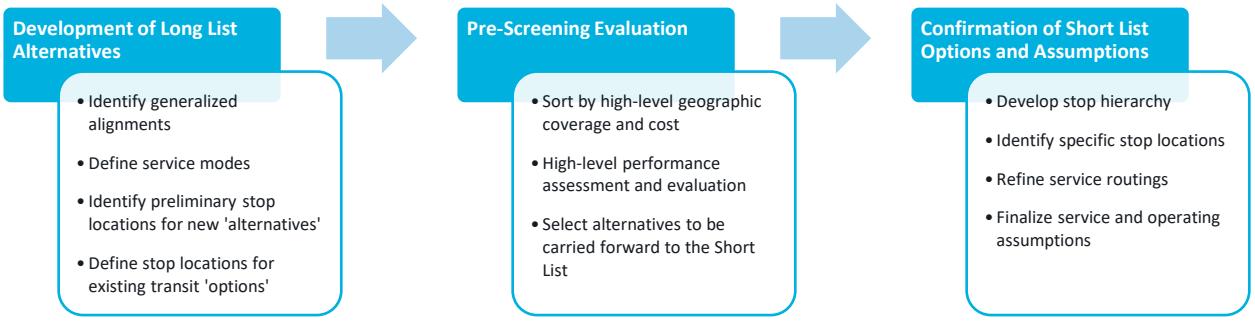


Figure 1: Stops and Pre-screening Process

The identification of preliminary stop locations was used to facilitate and inform the performance assessment. This allowed more specific identification of catchment areas around station locations for use in the pre-screening assessment.

The pre-screening provides an initial evaluation of the long-list alternatives to gauge high-level performance across metrics related to the project objectives to identify the most promising alternatives to be carried forward for refinement, modeling, and detailed evaluation.

Following the pre-screening, the alternatives carried forward were reviewed in detail to refine stop locations, alignment, service assumptions for the Short List Options. This assessment also and defined the facilities and amenities for the stations associated with each short list option, based on the application of a station/stop typology.

2 Project Alternatives Long List

This section of the report includes a recap of the long list of alternatives and describes the preliminary stop locations used for the purposes of the pre-screening assessment.

Alternatives Long List Overview

The development of the alternatives long list was described fully in Report 1. The Alternatives Long List was developed via two streams. First, there are several projects, previously considered or proposed by other groups, that were deemed to be important enough to include in the initial screening process. These were included based on the proposals as they exist now to take advantage of existing data and assessments already completed. Additional alternatives were included from the combination of 'new' alignment-mode pairs that were not previously considered.

Long List of Alternatives: Existing Transit Options

The options are listed below and are illustrated in Figure 2 below.

1. **MD 355 Flash BRT:** This option is the proposed alignment for the MD 355 Flash Bus Rapid Transit (BRT) service between Clarksburg and Bethesda, via MD 355. Following input from the Montgomery County Department of Transportation (MCDOT), direction was given to include the MD 355 Flash BRT as part of the baseline future network and was thus not considered further.
2. **Enhanced MARC Service:** Increased or modified service for Maryland Regional Commuter (MARC) Brunswick Line service. Two potential avenues for enhancing the service were considered:
   a) Maintain existing track; minor service improvements; no new stations but potential relocations
   b) Introduce third track to allow increased service frequency and operational flexibility
3. **Red Line Metro Extension 1 to Gaithersburg:** An extension of the Washington Metropolitan Area Transit Authority (WMATA) Red Line north from the current terminus at Shady Grove Metrorail station. Two potential alignments for the extension were considered:
   a) Extension to Gaithersburg via the CSX right-of-way
   b) Extension to Gaithersburg via the MD 355 right-of-way
4. **Red Line Metro Extension 2 to Germantown:** A further extension of the WMATA Red Line from Gaithersburg to Germantown (includes Red Line Metro Extension 1). Two potential alignments were considered:
   a) Extension to Germantown via the CSX right-of-way
   b) Extension to Germantown via the MD 355 right-of-way
5. **Corridor Cities Transitway Stage 1 + 2:** The proposed Corridor Cities Transitway (CCT) project includes Stage 1 serving the Gaithersburg area and Stage 2 from Metropolitan Grove to Clarksburg
6. **Purple Line LRT Extension:** A westward extension of the Purple Line LRT (currently under construction) from the planned terminus at Bethesda Station, to Tysons in Northern Virginia.

7. **Extended North Bethesda Transitway (NBTW):** An extended version of the proposed NBTW, with the western terminus in Tysons, Northern Virginia
8. **Monorail to Frederick:** The High Road Foundation's proposal for monorail between Frederick and Shady Grove Metrorail Station

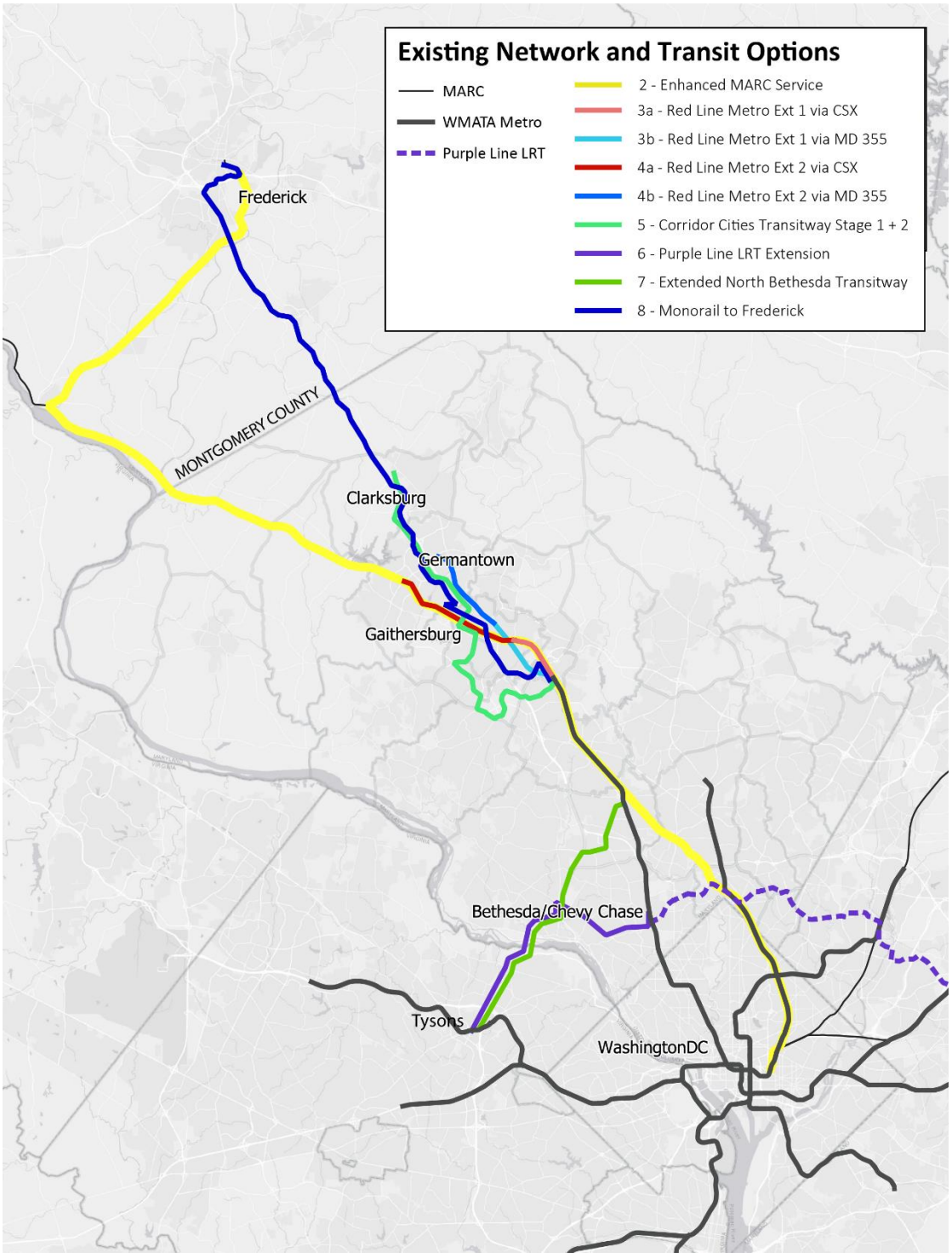


Figure 2: Long List of Project Alternatives – Existing Transit Options

Long List of Alternatives – New Transit Alternatives

In addition to the alternatives that were included based on existing proposals, new alternatives were developed based on the demographic and travel pattern analysis completed (documented in Report 1) and the overall criteria established for the evaluation process. These alternatives are listed below and illustrated in Figure 3:

9. **I-270 Managed Lanes BRT:** BRT service using managed / priority lanes within the I-270 right-of-way.
10. **I-270 Corridor LRT:** LRT service along the I-270 corridor from Bethesda Metrorail Station to Gaithersburg.
11. **I-270 Corridor BRT:** BRT service along the I-270 corridor from Bethesda Metrorail Station to Gaithersburg.
12. **Frederick to Tysons BRT:** A long distance BRT service connecting key destinations along the I-270 and I-495 corridors from the City of Frederick to Tysons Corner via the American Legion Bridge.
13. **Frederick to Silver Spring BRT:** A long distance BRT service connecting key destinations along the I-270 and I-495 corridors from the City of Frederick to Silver Spring.

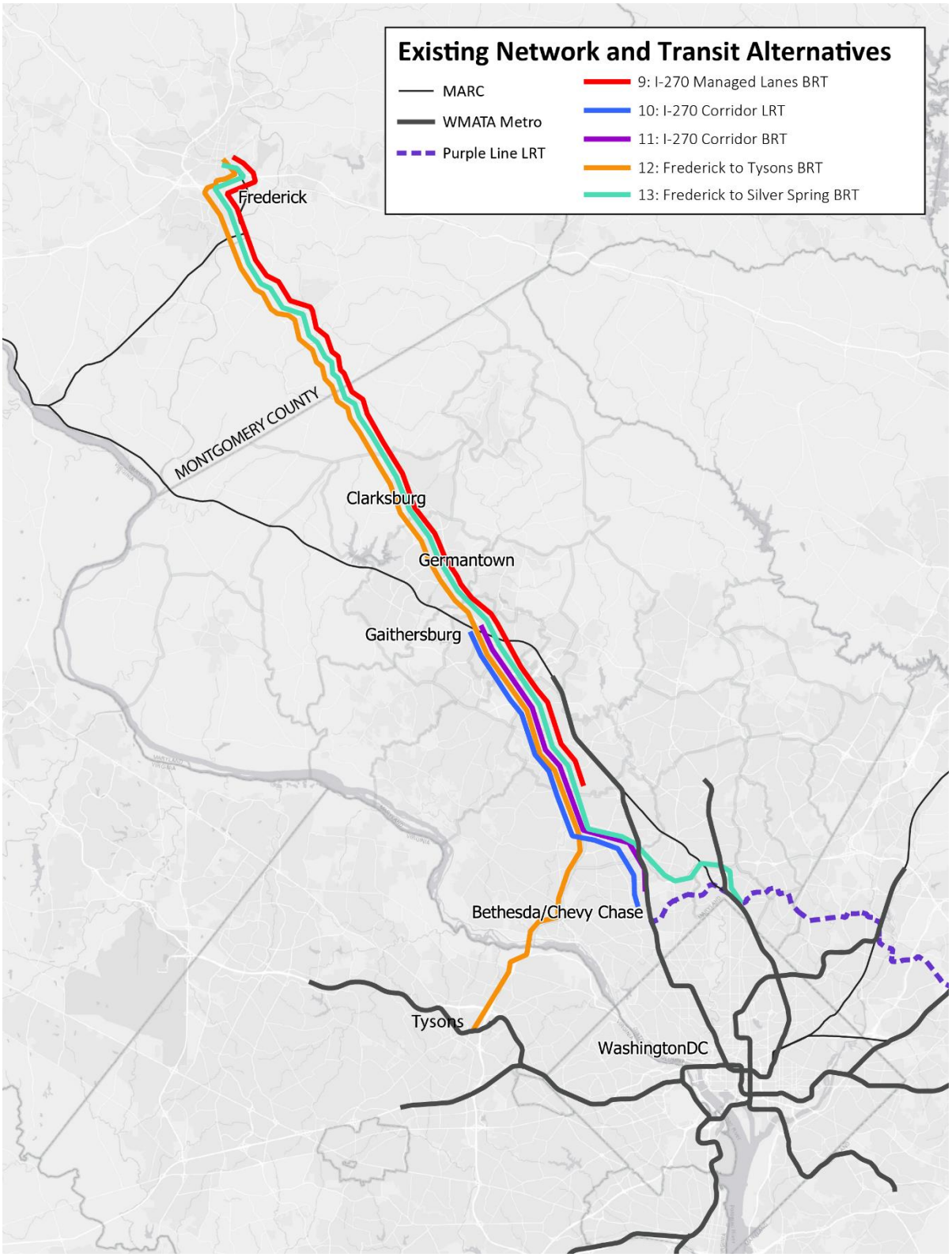


Figure 3: Long List of Project Alternatives – New Transit Alternatives

Stop Locations

Preliminary Stop Locations for Long List Pre-Screening Assessment

During the initial analysis documented in Report 1, catchment areas conservatively included the entirety of all planning areas through which each alternative traversed. For the pre-screening assessment, preliminary stop locations were identified and the catchment areas were refined to allow a more nuanced assessment of each alternative (detailed further in Section 3, beginning on page 24).

For the pre-screening assessment, existing stop location information was incorporated for the alternatives based on existing proposals where data was available. For the new alternatives developed through the study process, and for existing transit options where stops locations data was not available, a set of preliminary stop locations was developed for the pre-screening assessment. Informed by the demographic, land use, and travel analysis conducted in Task 2B (see Report 1), preliminary stops were identified as key nodes along each alignment, including major town centers, educational campuses, existing transit stations, areas with high multi-modal access, major urban developments (existing or potential), and other significant trip generators.

Specific parcels for the preliminary stops were not identified for the pre-screening process. Instead, a general location was selected to represent the node, typically at the intersection of major transportation routes, to allow assessment of the maximum potential of the location. For example, a key node identified for Germantown identified a preliminary stop location centered at I-270 and the intersection with MD 124.

The preliminary stop locations are shown for each of the long list alternatives beginning on the next page.

Refined Stop Locations for Short List

Following the pre-screening process, the preliminary stops were reviewed for the alternatives carried forward to the short list. Based on this review and through collaboration with M-NCPPC staff, the stop locations were refined and developed further in terms of the assumptions for functionality and associated facilities, such as vehicle parking. The short list options and refined stops are presented in Section 4.

Alternative 2a/b: Enhanced MARC Service

For Alternative 2, there are no additional stations proposed for the MARC Brunswick Line service from Union Station in Downtown Washington DC to the City of Frederick. Relocations of stations at Garrett Park and/or Washington Grove were flagged for future consideration, but to simplify the pre-screening analysis the existing locations were used since the catchment area assessment is high level and the relocations would have little effect at this stage. The preliminary station locations are shown in Figure 4.

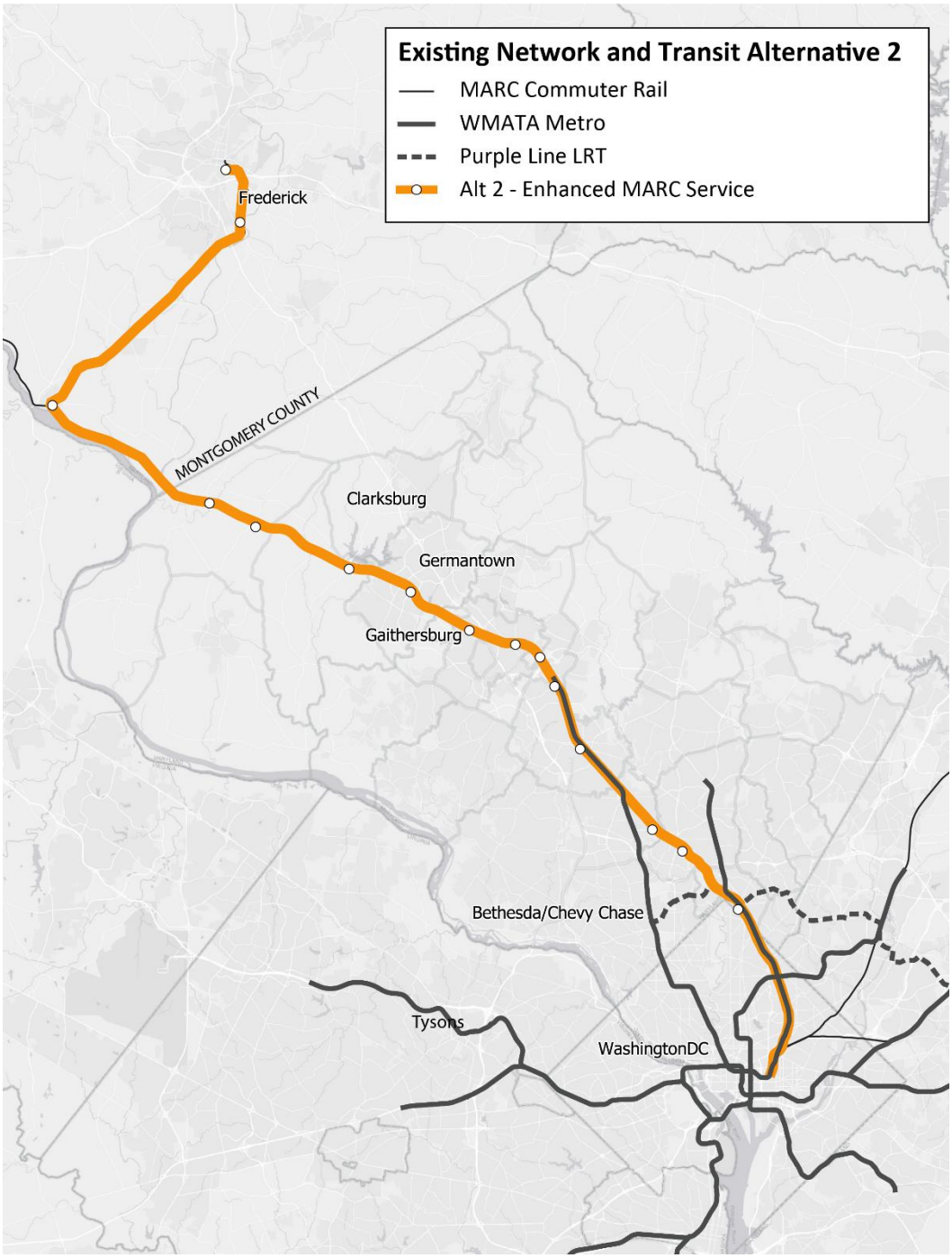
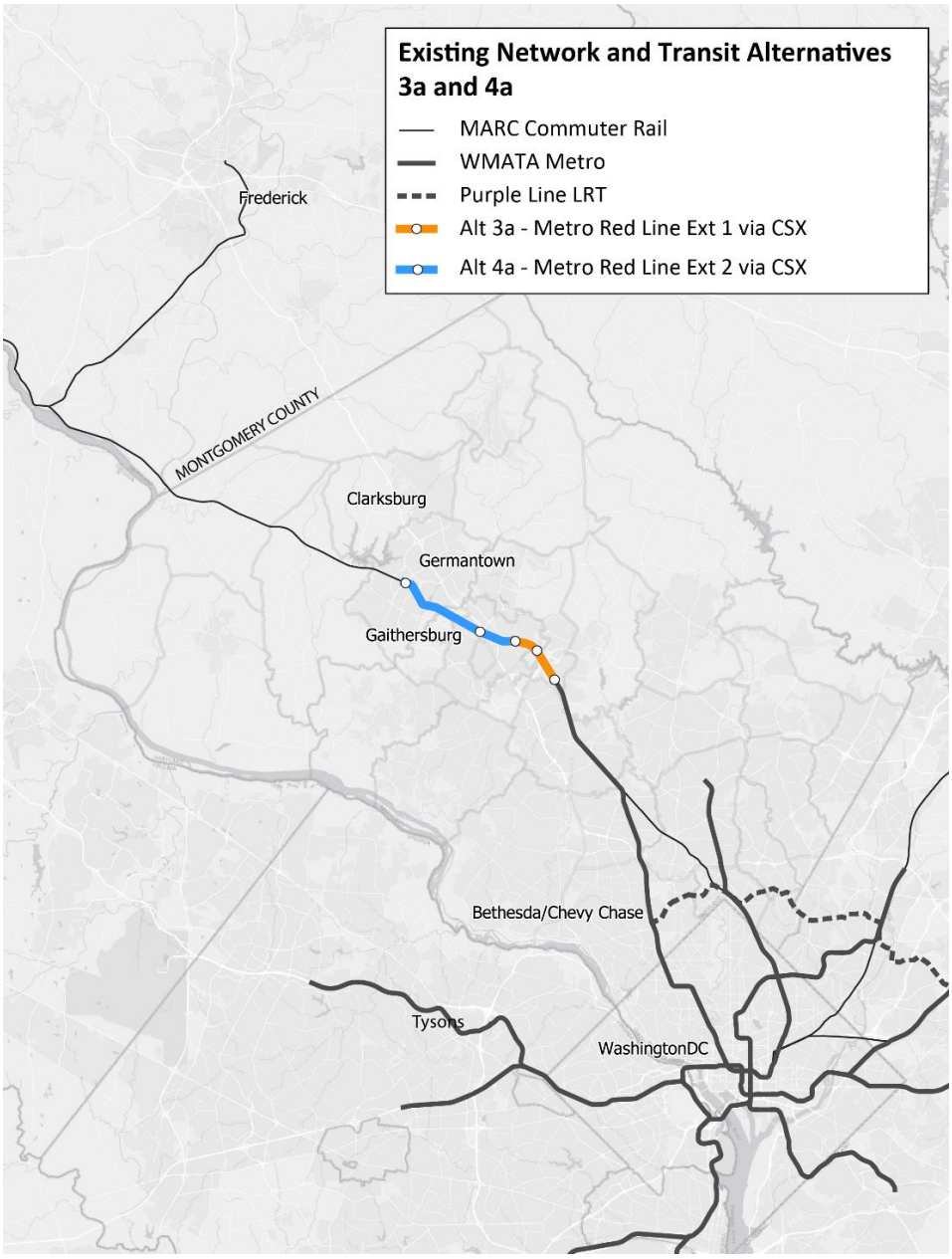


Figure 4: Alternative 2a / 2b station locations – Enhanced MARC Service

Alternative 3a/4a: Red Line Metro Extensions 1 + 2 via CSX

Alternatives 3 and 4 represent extensions of the Metro Red Line from the existing terminus at Shady Grove Metrorail to Gaithersburg (Alt 3) or Germantown (Alt 4). Two different alignments were considered for the extensions, either via the CSX right-of way (alternatives 3a / 4a) or via the MD 355 right-of-way (variations 3b / 4b).

For Alternatives 3a and 4a, two stations were assumed for each portion of the extension (four new stations total) in proximity to existing MARC stations between Shady Grove and Germantown. Some modifications at these locations are expected to ensure sufficient space and to accommodate multi-modal access. The proposed station locations for both extension alternatives are shown in Figure 5.



Preliminary Stop Locations:
Alternative 3a

- Shady Grove Metrorail Station [existing terminus]
- Washington Grove MARC Station
- Gaithersburg MARC Station

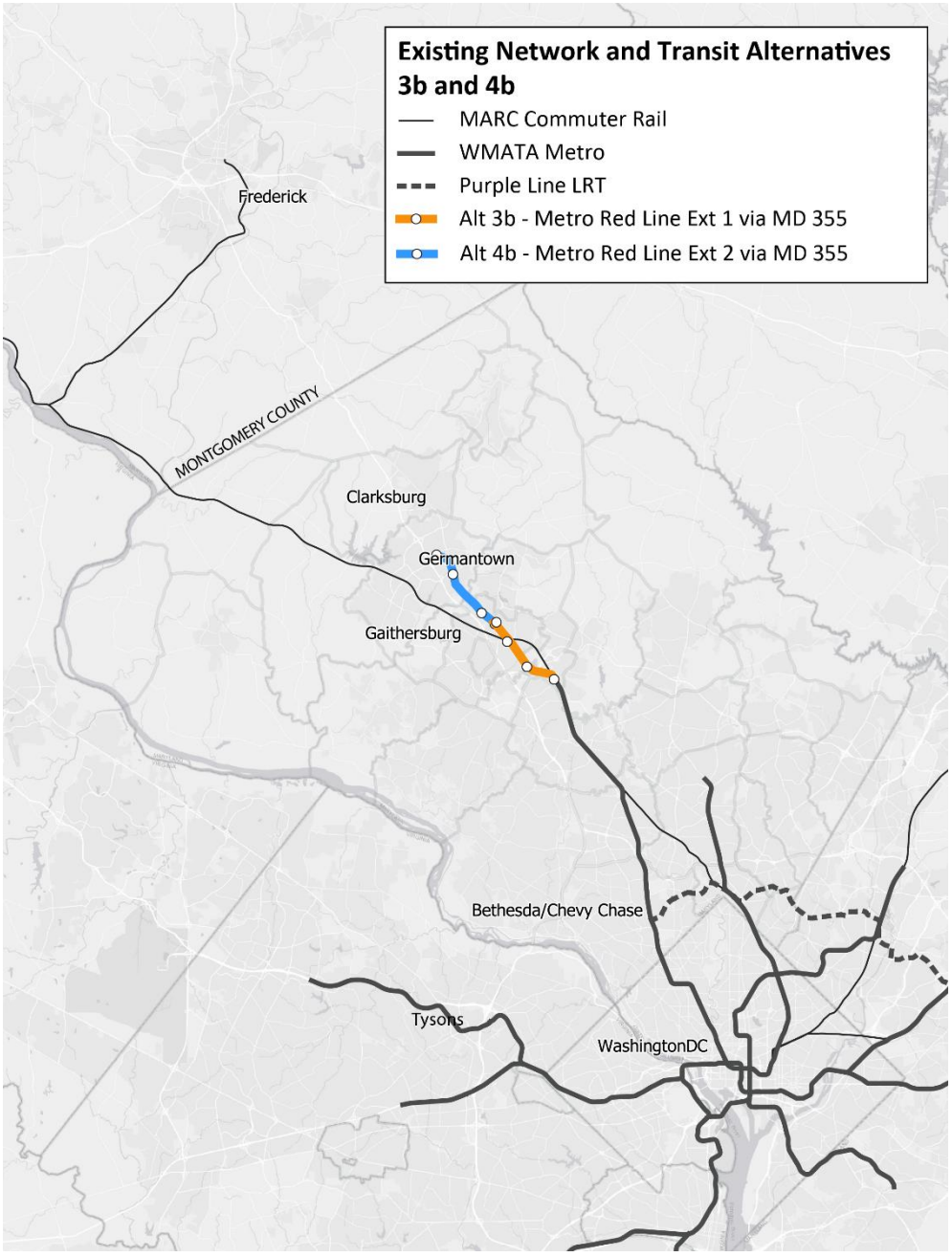
Alternative 3b

- MD 124 (Quince Orchard Road)
- MD 118 (Germantown Road)

Figure 5: Alternative 3a / 4a station locations – Metro Red Line Extensions 1 + 2 via CSX

Alternatives 3b/4b: Red Line Metro Extensions 1 + 2 via MD 355

For Alternatives 3b and 4b, three stations were assumed between Shady Grove and Gaithersburg (3b) as well as an additional three stations from Gaithersburg to Germantown (4b) for a total of six new stations for the combined extension. As noted previously, specific station locations were not identified for this phase of the analysis, instead using representative key nodes along the alignment. The preliminary station locations are shown in Figure 6.



Preliminary Stop Locations:

Alternative 3b

- Shady Grove Metrorail Station [WMATA Red Line terminus]
- MD 355 / South Westland Drive
- MD 355 / MD 117
- Lakeforest Mall

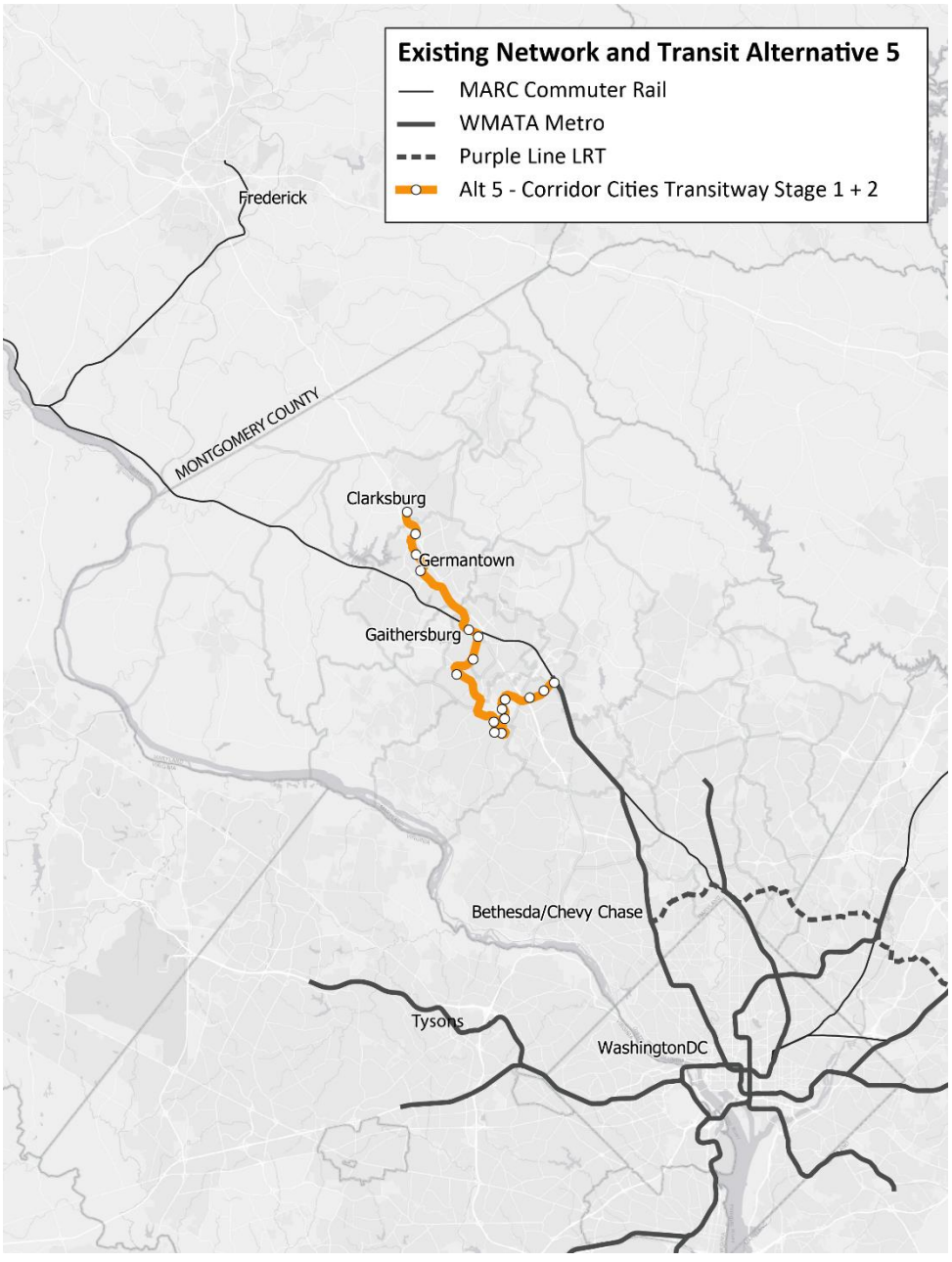
Alternative 4b

- MD 355 / Christopher Avenue
- MD 355 / Middlebrook Road
- Montgomery College Germantown Campus

Figure 6: Alternative 3b/4b stop locations - Metro Red Line Extensions 1 + 2 via MD 355

Alternative 5: Corridor Cities Transitway Stage 1 + 2

The existing Corridor Cities Transitway (CCT) plans for this BRT service include the proposed stop locations as proposed by the Maryland Department of Transportation (MDOT) including both Stage 1 and Stage 2, as shown in Figure 7.



Preliminary Stop Locations:

CCT Stage 1

- Shady Grove Metrorail Station [WMATA Red Line]
- East Gaither
- West Gaither
- Crown Farm
- DANAC
- LCS Central
- Universities at Shady Grove
- Traville Gateway
- LSC West
- Kentlands
- National Institute of Standards and Technology (NIST)
- Firstfield
- Metropolitan Grove MARC Station

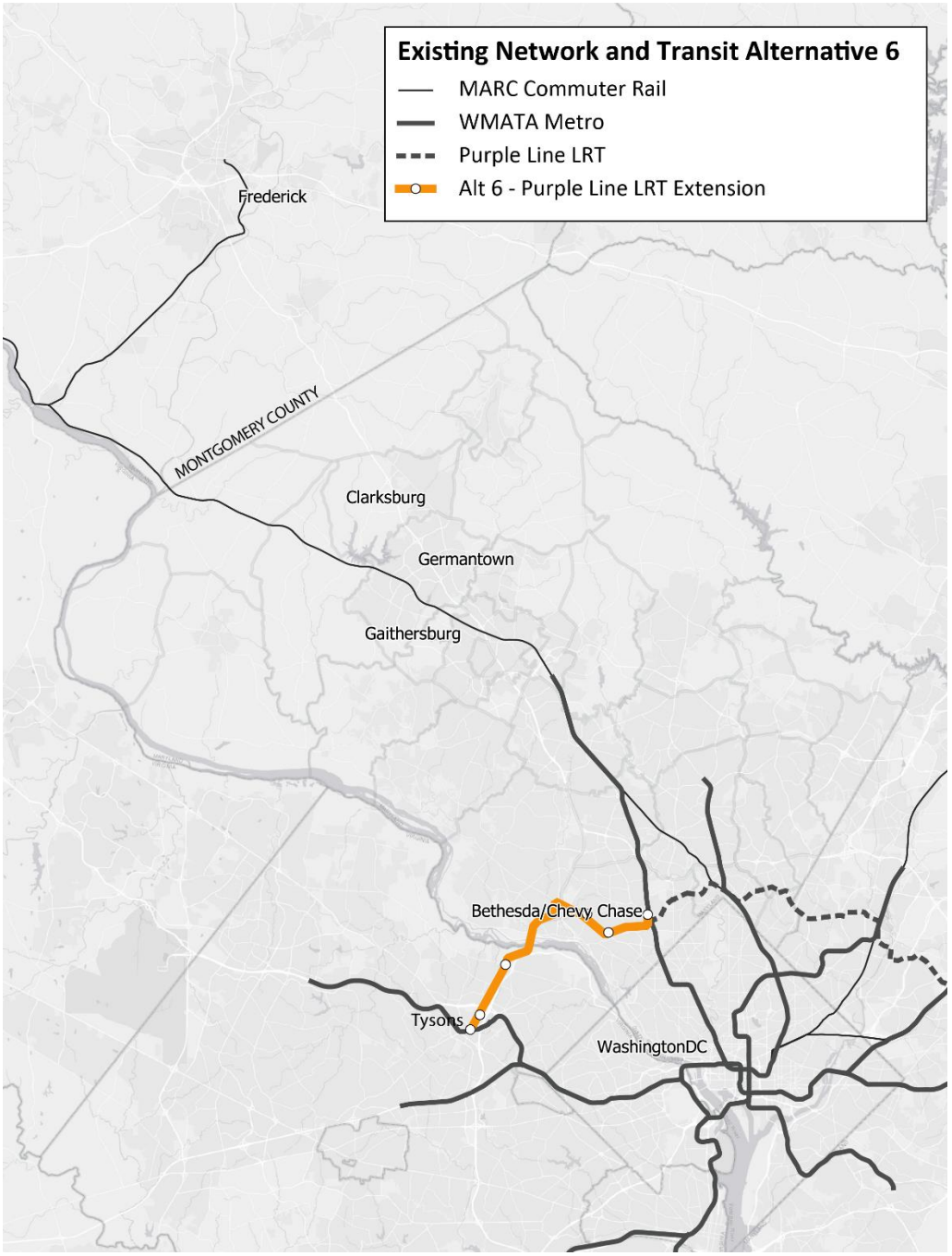
CCT Stage 2

- Metropolitan Grove MARC Station
- Germantown Town Centre
- Cloverleaf
- Dorsey Mill
- COMSAT

Figure 7: Alternative 5 station locations – Corridor Cities Transitway Stage 1 + 2

Alternative 6: Purple Line LRT Extension

The Purple Line extension includes an extension from the existing planned terminus at Bethesda Metrorail Station to the Tysons area of Northern Virginia. The preliminary stop locations were selected based on high level demographic data along the proposed alignment via Bradley Boulevard and Goldsboro Road to River Road, and from via the I-495 to the Tysons area. Note that the area northeast of the river crossing is largely lower density residential, so stop locations were limited. The assumed stop locations used in the analysis are shown below in Figure 8.



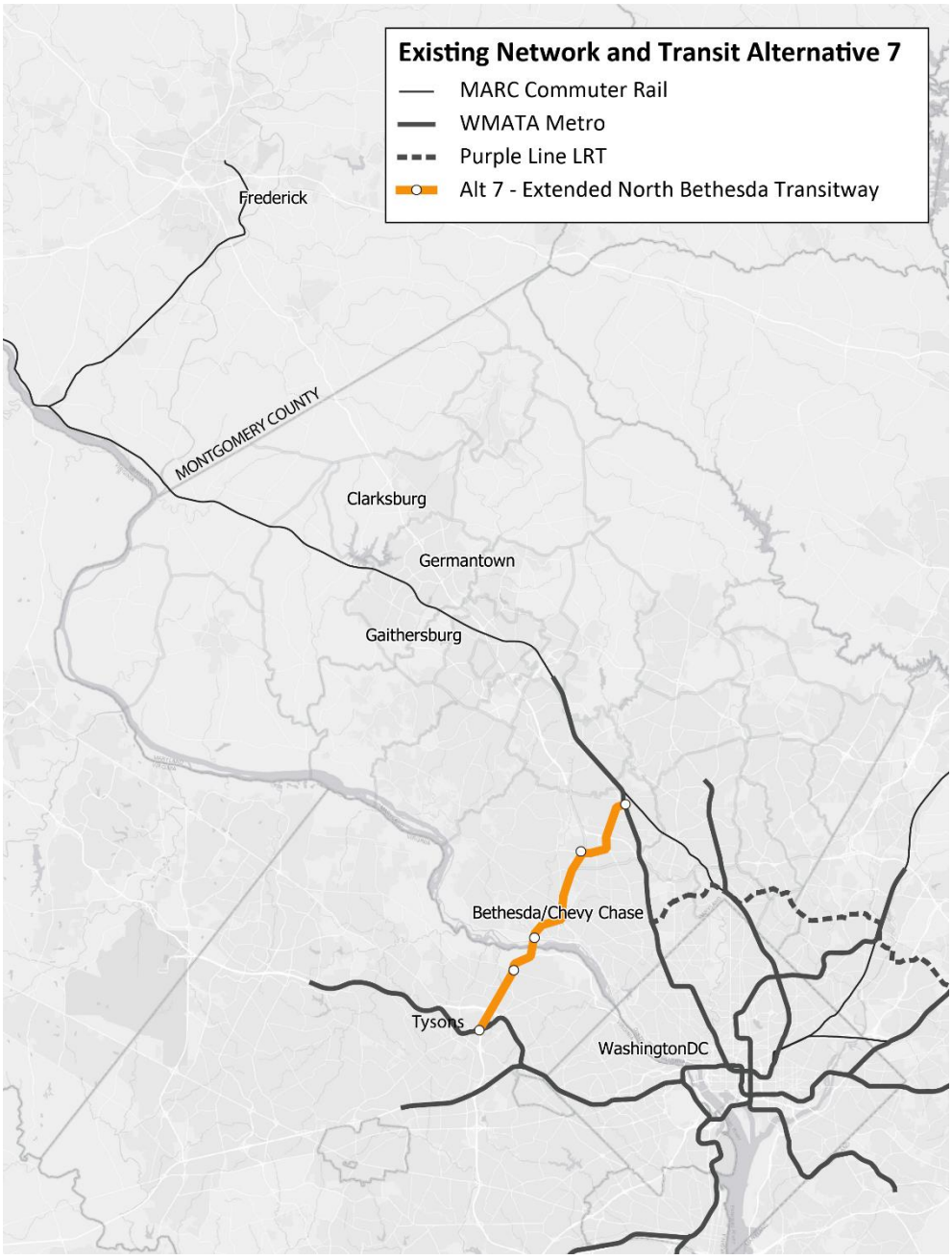
Preliminary Stop Locations:

- Bethesda Metrorail Station [WMATA Red Line]
- MD 190 / MD 614
- MD 190 / MD188
- I-495/VA 193
- McLean Metrorail Station [WMATA Silver Line]

Figure 8: Alternative 6 station locations – Purple Line LRT Extension

Alternative 7: Extended North Bethesda Transitway BRT

An extended version of the proposed North Bethesda Transitway would see the line run from White Flint Metrorail station to Montgomery Mall, then south on I-495 to the Tysons area, using stops similar to Alternative 6 south of the Potomac River in Northern Virginia. The assumed stop locations are shown in Figure 9 below.



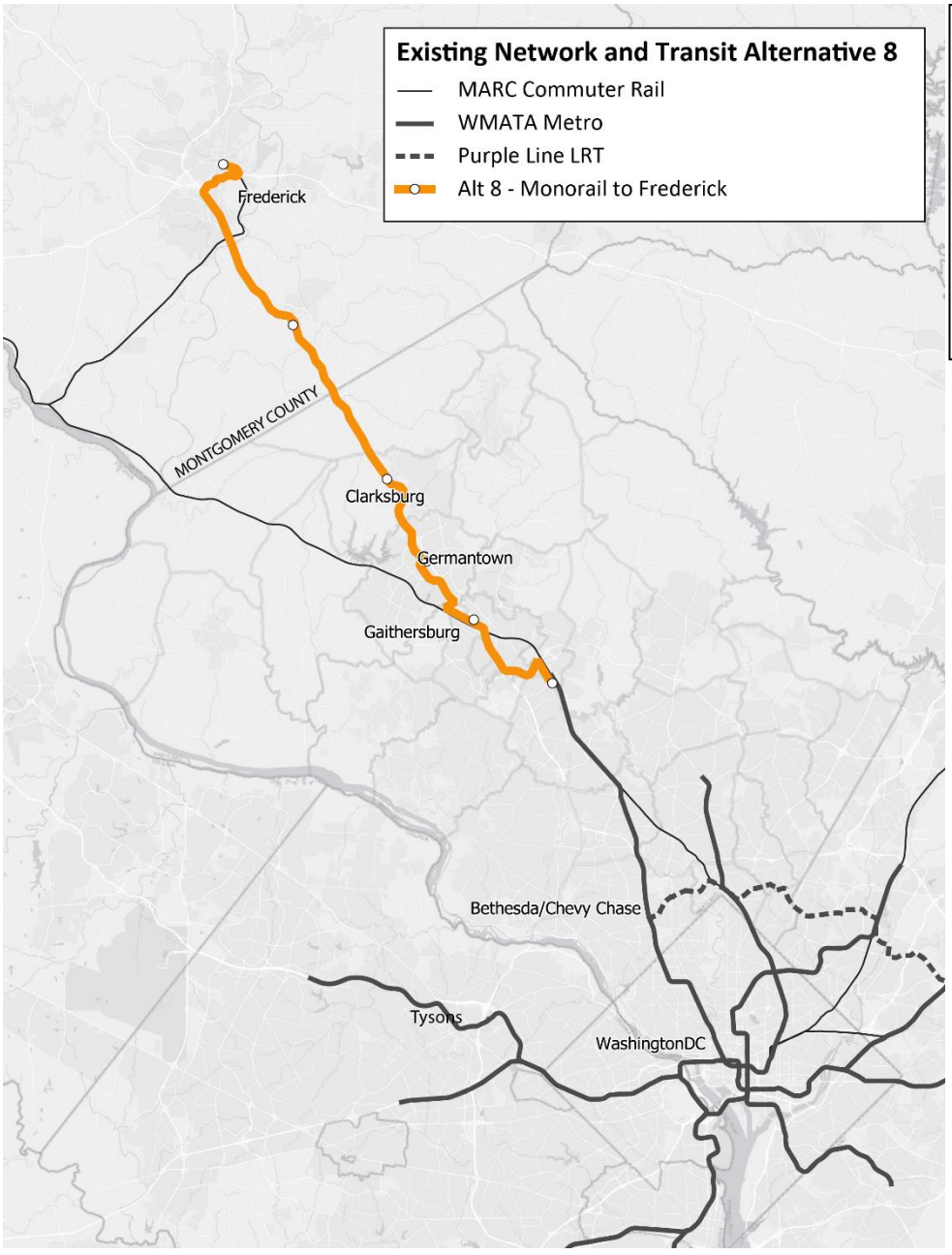
Preliminary Stop Locations:

- White Flint Metrorail Station
- Montgomery Mall Transit Center
- Clara Barton Pkwy
- I-495 / VA 193
- McLean Metrorail Station [WMATA Silver Line]
- Tysons Metrorail Station [WMATA Silver Line]

Figure 9: Alternative 7 stop locations – North Bethesda Transitway BRT

Alternative 8: Monorail to Frederick

The key stop locations from the High Road Foundation's proposal for monorail service from Frederick to Shady Grove Metrorail Station were incorporated into the pre-screening assessment. The preliminary stop locations are shown in Figure 10 below.



Preliminary Stop Locations:

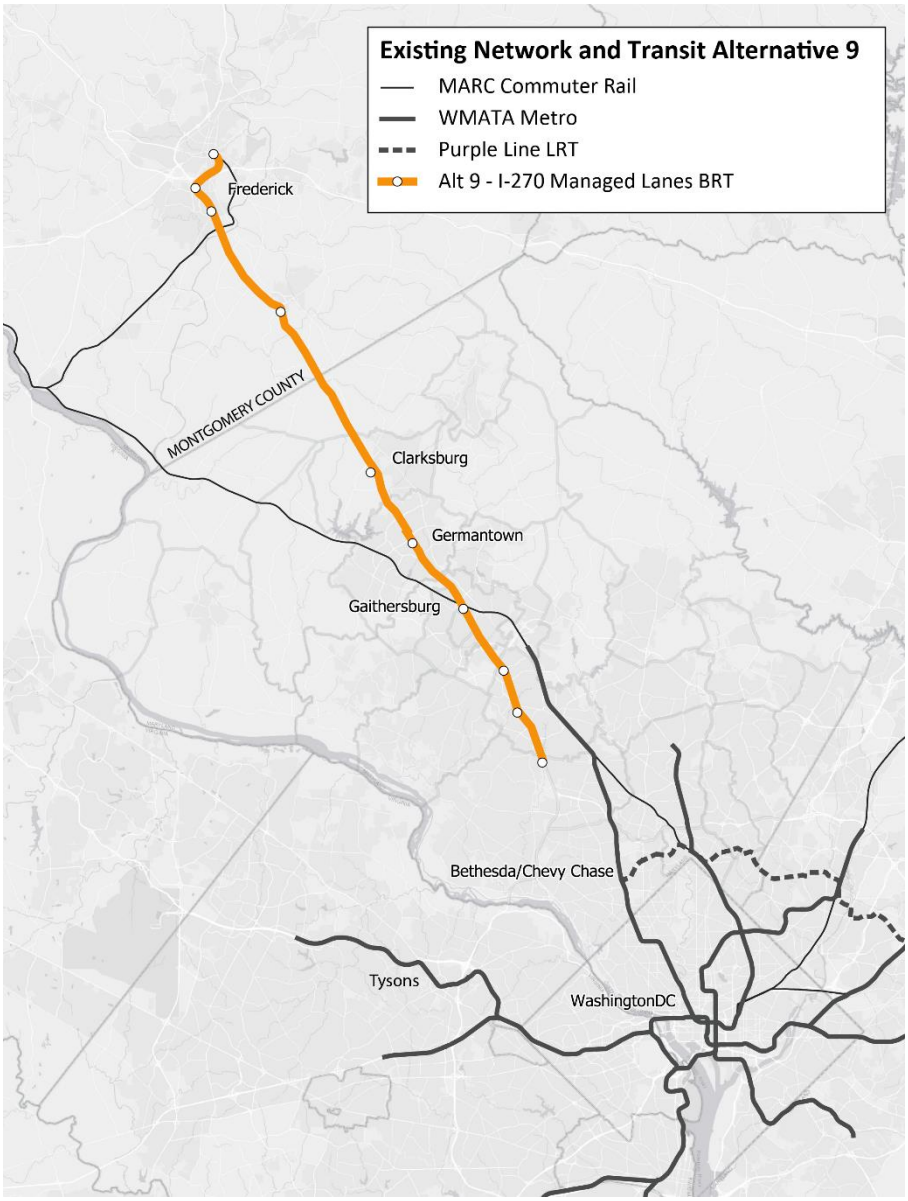
- Frederick
- Urbana
- Clarksburg Outlets
- Montgomery College
- Gaithersburg (MD 124)
- Universities at Shady Grove
- Shady Grove Metrorail Station [WMATA Redline]

Figure 10: Alternative 8 station locations – Monorail to Frederick

Alternative 9: I-270 Managed Lanes BRT

A proposal to use the planned managed lanes on I-270 for bus service including use of both high occupancy toll (HOT) lanes and high occupancy vehicle (HOV) lanes. Station locations may be dictated by whether transit uses either the HOT lanes or the HOV lanes and how access to these lanes is controlled. Note that the State's planned access points were not available at the time of development, and nodes were selected based analysis of travel, demographic, and land use data.

The preliminary stop locations are proposed roadways to the I-270 corridor, with transit vehicles exiting the managed lanes to mixed traffic at interchanges to access the station before returning to the managed lanes. This concept will require stations to accommodate travel in both directions and is thus somewhat limited. A combination of local and express service patterns should be considered to minimize travel times in balance with access.



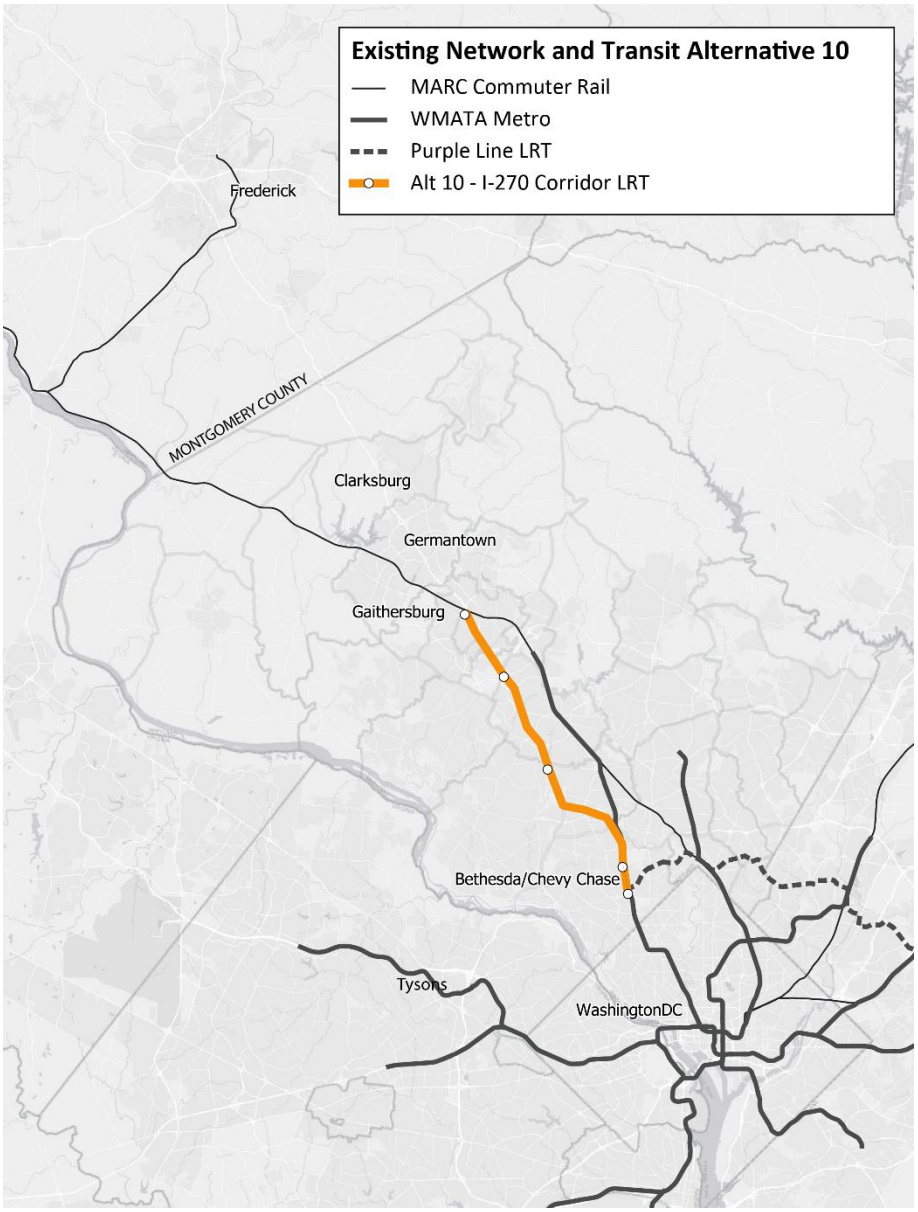
Preliminary Stop Locations:

- Frederick
- Frederick Crossing
- Francis Scott Key Mall
- Urbana Park & Ride
- Clarksburg Outlets
- Germantown Road
- MD 124 Park & Ride
- Shady Grove Road
- Montgomery Avenue (Rockville)
- Montrose Road

Figure 11: Alternative 9 station locations – I-270 Corridor Managed Lanes BRT

Alternative 10: I-270 Corridor LRT

LRT service connecting to the WMATA Red Line at Bethesda and Medical Center Metrorail Stations, extending north via the I-270 to Gaithersburg. Preliminary stops are located at high density nodes and where multi modal access connecting to other major zones can be easily accommodated. The assumed preliminary stop locations are shown in Figure 12.



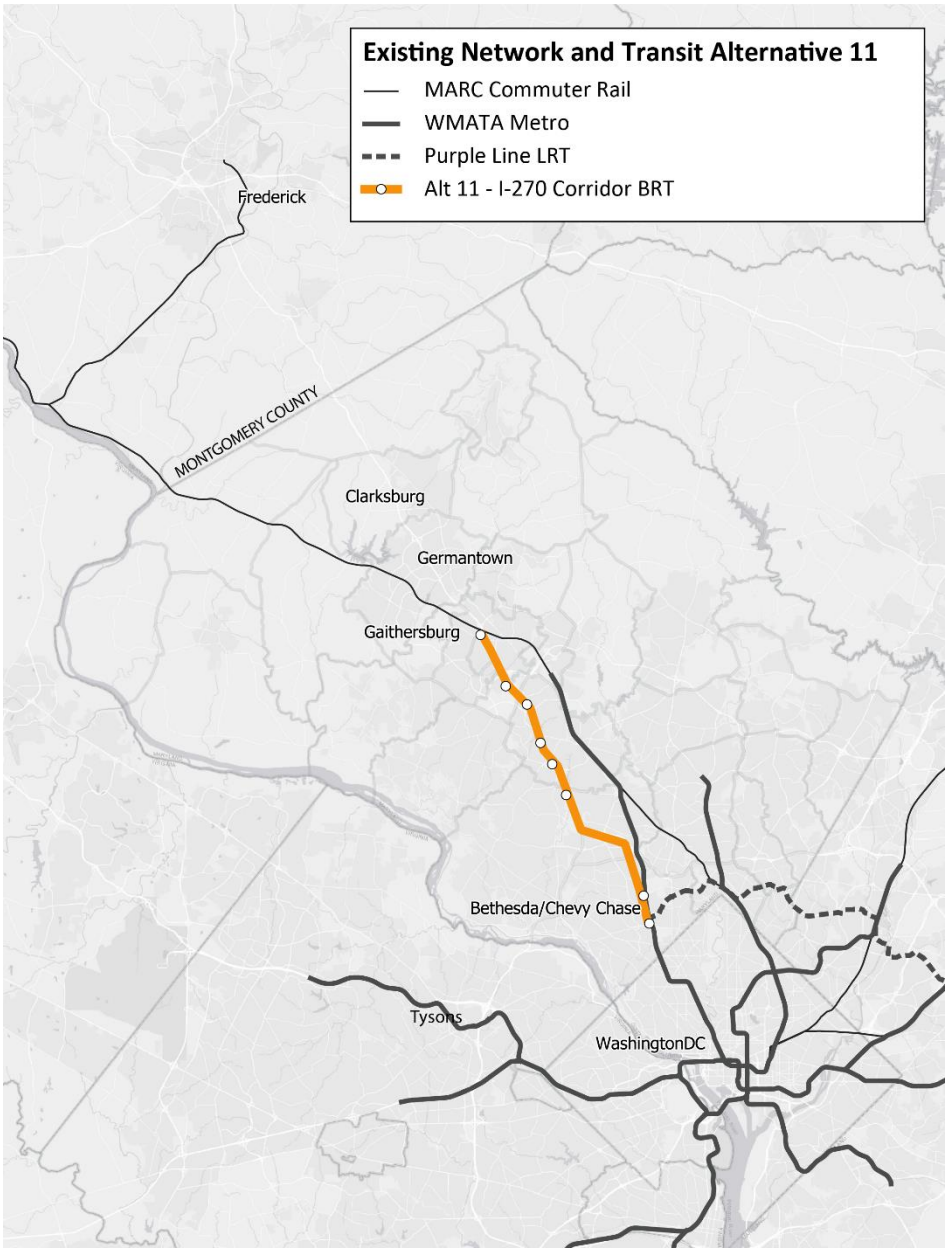
Preliminary Stop Locations:

- MD 124 Park & Ride
- Shady Grove Road
- Montrose Road
- Medical Center Metrorail Station [WMATA Red Line]
- Bethesda Metrorail Station [WMATA Red Line]

Figure 12: Alternative 10 station locations – I-270 Corridor LRT

Alternative 11: I-270 Corridor BRT

The alignment of this alternative is similar to Alternative 10, connecting Gaithersburg to Bethesda Metrorail Station via the I-270 corridor. However, as a BRT service with more closely spaced stops, there are a few additional stops. The preliminary stop locations are shown in Figure 13.



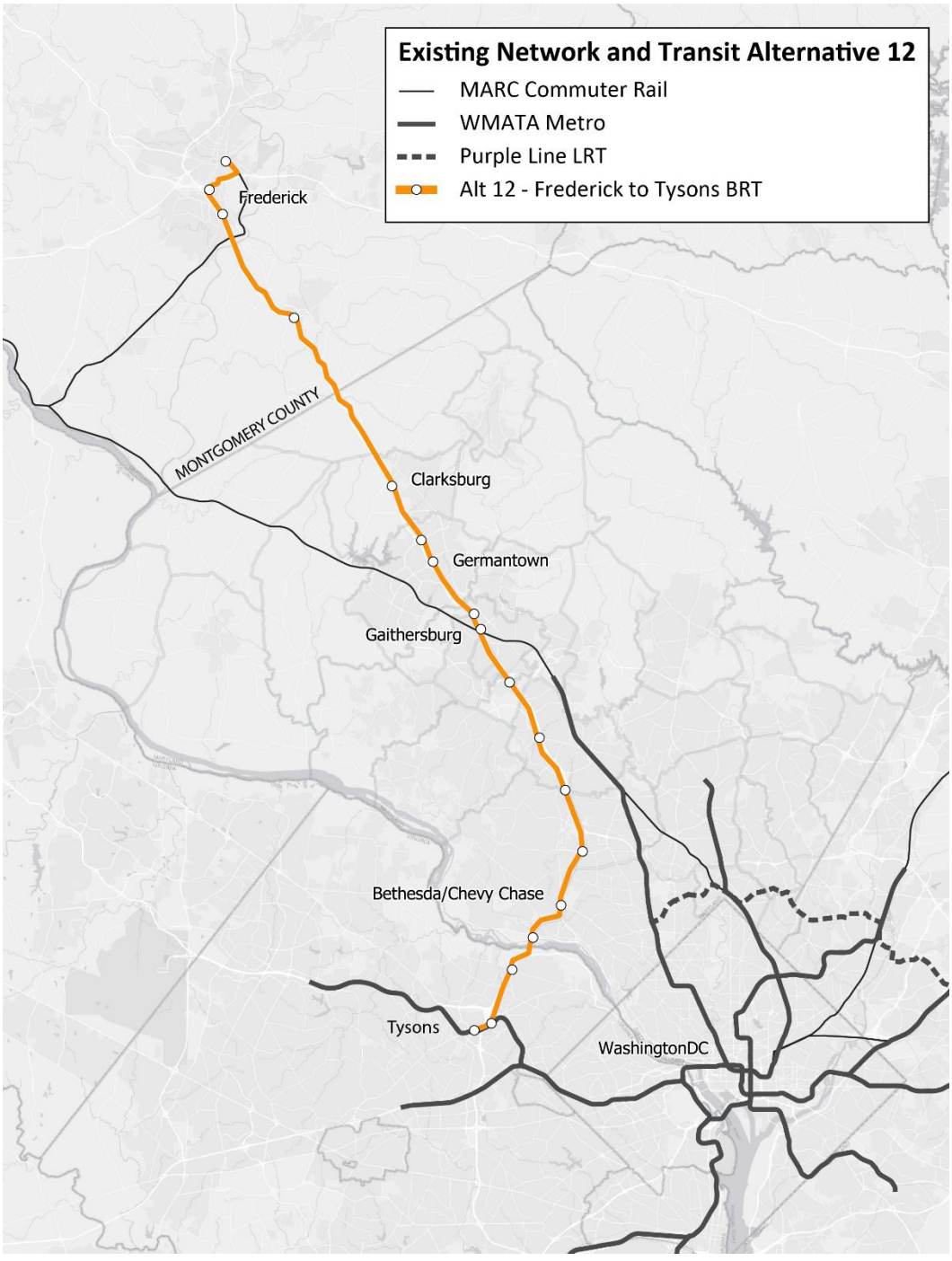
Preliminary Stop Locations:

- MD 124 Park & Ride
- RIO Lakefront
- Shady Grove Road
- MD 28 West Montgomery Avenue
- MD 189
- Montrose Road
- Medical Center Metrorail Station [WMATA Red Line]
- Bethesda Metrorail Station [WMATA Red Line]

Figure 13: Alternative 11 station locations - I-270 Corridor BRT

Alternative 12: Frederick to Tysons BRT

This longer distance routes share several stop locations with other Alternatives, including Alternatives 7, 8 and 9. Preliminary stop locations are show below in Figure 14.



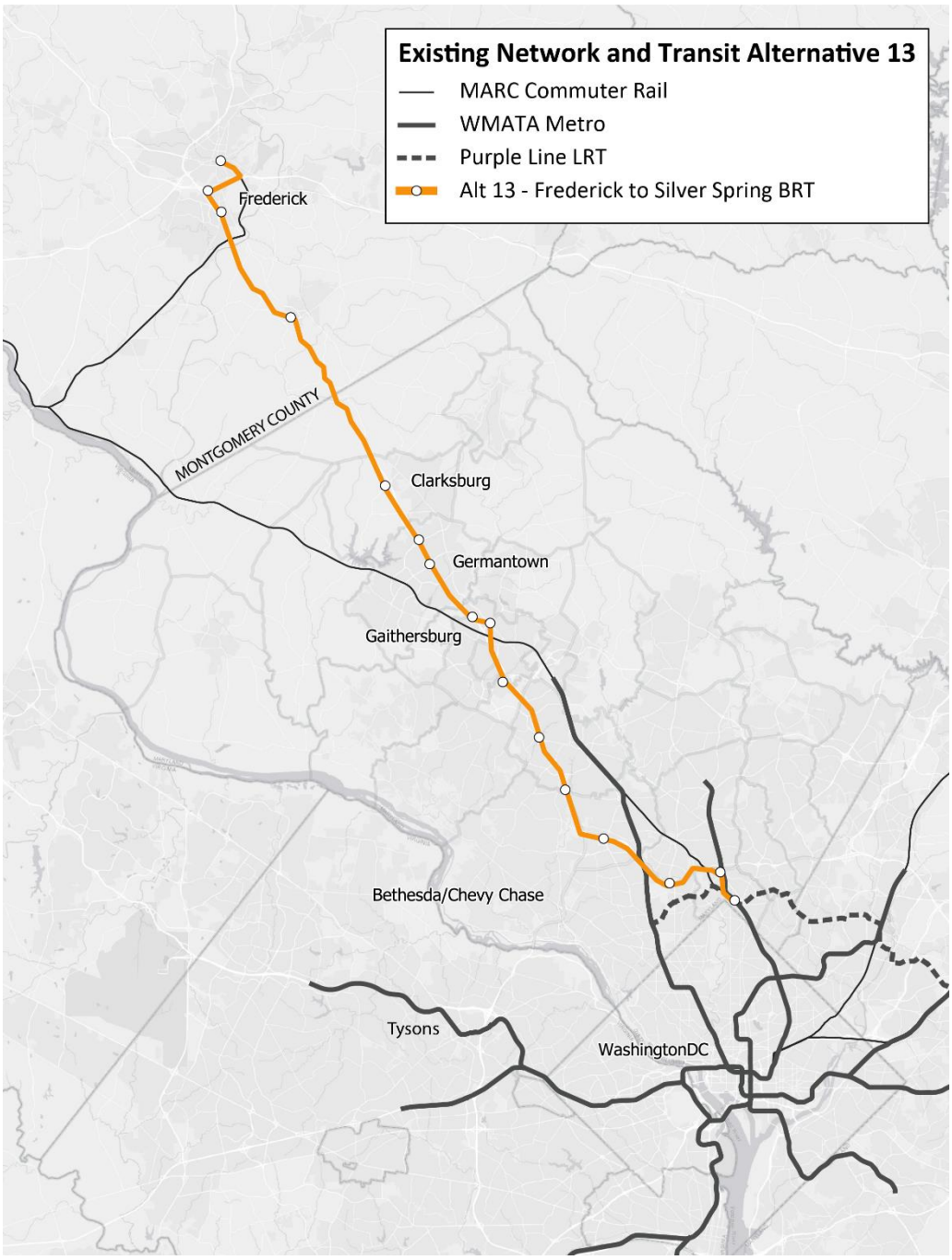
Pre-screen stop locations:

- Frederick (Downtown)
- Frederick Crossing
- FSK Mall
- Urbana Park/Ride
- Clarksburg
- Ridge Road
- Germantown Road
- Montgomery Village Ave
- Diamond Avenue (Gaithersburg)
- Shady Grove Road
- Montgomery Avenue
- Montrose Road
- I-495
- I-495 / River Road
- Clara Barton Parkway
- I-495 / VA 193
- McLean Metrorail Station [WMATA Silver Line]
- Tysons Metrorail Station [WMATA Silver Line]

Figure 14 - Alternative 12 station locations – Frederick to Tysons BRT

Alternative 13: Frederick to Silver Spring BRT

Alternative 13 shares a large portion of its alignment with Alternative 12, and the station locations along this common portion were selected to be the same. Station locations are shown in Figure 15.



Preliminary Stop Locations:

- Frederick (Downtown)
- Frederick Crossing
- FSK Mall
- Urbana Park/Ride
- Clarksburg
- Ridge Rd
- Germantown Rd
- Montgomery Village Ave
- Diamond Avenue (Gaithersburg)
- Shady Grove Rd
- Montgomery Ave
- Montrose Rd
- MD 187 (Georgetown Rd)
- MD 185 (Connecticut Ave)
- MD 97 (Georgia Ave)
- Silver Spring Paul S. Sarbanes Transit Center

Figure 15: Alternative 13 stop locations - Frederick to Silver Spring BRT

3 Pre-Screening Process

This section describes the pre-screening process, designed to select a short list of alternatives from the long list of project alternatives developed in Task 2. It includes an overview of the prioritization approach, details the analysis methodology, and provides the results of the performance evaluation.

Prioritization Approach

The prioritization of the long list of project alternatives and the selection of the short-listed concepts is guided by the four-step process illustrated in Figure 16 and described below.

Figure 16: Alternative Prioritization Approach Overview

Organize Project Alternatives by Cost and Geographic Coverage

First, the long-listed project alternatives are organized within a cost/coverage matrix to group projects by relative levels of high or low cost and high or low geographic service coverage. The relative high-level cost categorization is based on the proposed technology, associated infrastructure requirements, and anticipated level-of-segregation, among other factors. Relative geographic coverage considers both the extents of the route, stop spacing, and ridership catchment size. Table 1 presents the organization of the long-listed project alternatives by relative cost and coverage.

Table 1: Cost-Coverage Matrix

	Lower Coverage	Higher Coverage
Higher Cost	Alt 3a/b: Red Line Extension 1 Alt 4a/b: Red Line Extension 2 Alt 6: Purple Line LRT Extension	Alt 2: Enhanced MARC Service Alt 8: Monorail to Frederick
Lower Cost	Alt 5: Corridor Cities Transitway (CCT) Stage 1+2 Alt 7: Extended North Bethesda Transitway BRT Alt 10: I-270 LRT Alt 11: I-270 BRT	Alt 9: I-270 Managed Lanes BRT Alt 12: Frederick to Tysons BRT Alt 13: Frederick to Silver Spring BRT

Performance Criteria

The pre-screening performance analysis uses a simplified list of criteria ("themes") developed to evaluate the performance of the long-list alternatives against the primary project objectives and to approximate conventional transit outcomes (ridership, travel time savings, mode shift).

Notably, the pre-screening analysis assumes 'high-level' station locations (as described in the previous section), to be refined during the detailed assessment phase for the alternatives carried forward to the short list. Additionally, the analysis considers only the net performance increases across the performance metrics relative to existing rapid transit serving the I-270 corridor.

Table 2 presents a summary of the performance analysis themes and metrics used in the pre-screening analysis. More detailed descriptions of the analysis methodology examples are provided in the Performance Analysis and Evaluation section of this report, beginning on the following page.

Table 2: Performance Analysis Criteria Summary

Theme	Metric Description
Travel Time Competitiveness *Are travel times competitive?*	Travel time between key destinations on corridor, relative to auto and existing transit
Population with Access to Rapid Transit *Does it serve communities?*	Planned (2045) population within walking, transit, and driving access of assumed station locations with service to the I-270 corridor
Job Accessibility by Rapid Transit *Does it connect jobs?*	Planned (2045) jobs within walking and transit access of assumed station locations with service to the I-270 corridor
Development Potential *Does it support urban development?*	Planned population and employment growth (2045 relative to 2015) within walking or transit access of assumed station locations with service to the I-270 corridor
Equity Focus Areas *Does it support equity goals?*	Proportion of Montgomery County's Equity Focus Areas within walking, transit, and driving access of assumed stations

These criteria broadly align with the Plan's values:

- Strategic Connections: Serve high-demand origin and destination pairs, balancing costs of implementation with projected benefits.
- Economic Health: Enable existing development and master-planned communities to realize their potential as livable and economically vibrant places.
- Community Equity: Align with the county's social equity goals and principles.
- Environmental Resilience: Operate sustainably and reduce negative environmental impacts.

While environmental resilience is not explicitly identified in the indicators, they generally align with the Plan's air quality and climate goals by prioritizing options that reduce reliance on automobiles and promote transit-oriented development.

Project Ranking and Selection of the Short List Options

Following performance evaluation, the top performing alternatives are brought forward to create the shortlist of project alternatives. Referring to the initial cost/coverage matrix, one or two of the top performing alternatives from each quadrant are brought forward for a total of six alternatives.

The alternatives brought forward are then further refined through consultation with M-NCPPC staff, including confirmation of stop locations, route alignment, service patterns, operating assumptions (speed and travel time), peak- and off-peak service levels, and station amenities (parking availability).

The confirmed assumptions short list options are outlined in Section 4 and detailed in the appendices of Report 4.

Performance Analysis and Evaluation

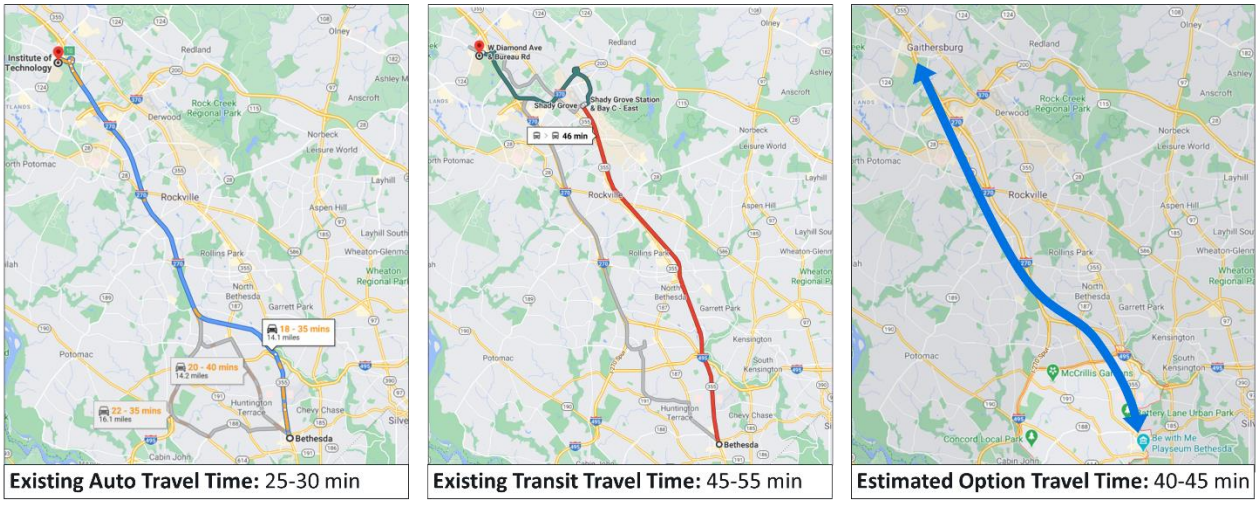
Further description of the performance analysis methodology is provided below for the five evaluation themes, along with the associated pre-screening evaluation results.

Theme 1: Travel Time Competitiveness

This theme is concerned with the extent to which a project alternative provides competitive travel times with driving and existing transit. The travel time competitiveness analysis provides a proxy for how attractive each alternative could be relative to existing travel options.

For each alternative, three to four key destinations were identified along the alignment, and the estimated travel time between these locations via the new option was compared to existing transit and auto travel times.

Travel times for the long-listed project alternatives were estimated via spreadsheet modeling using the assumptions confirmed in the Task 2A Mode Matrix. Google Maps was used to estimate the weekday PM peak period travel times for transit and auto drivers. An example evaluation is shown in Figure 17, and the details of the travel time analysis are presented in *Appendix A*.



Existing Auto Travel Time: 25-30 min | **Existing Transit Travel Time:** 45-55 min | **Estimated Option Travel Time:** 40-45 min

Figure 17: Theme 1 Example Evaluation – Travel Time Competitiveness

A score from 1-5 was then assigned to each project alternative based on relative travel time competitiveness, as summarized in Figure 18.

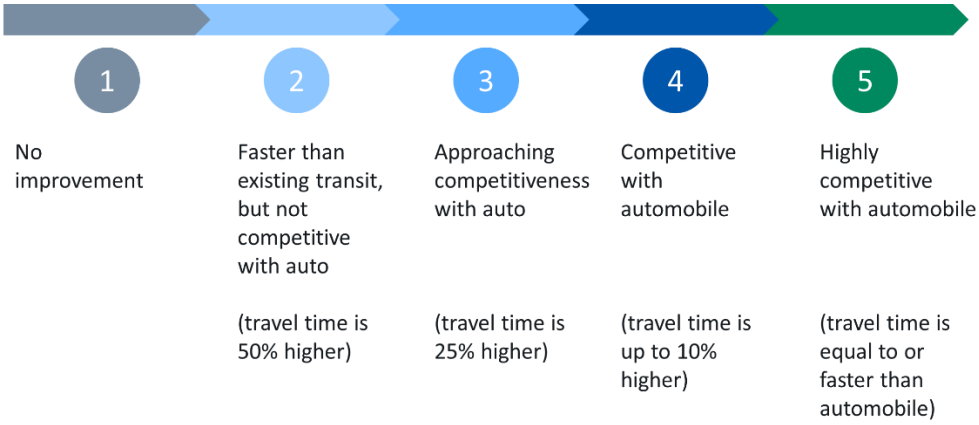


Figure 18: Travel Time Competitiveness Scoring Summary

The Theme 1 results are presented in Table 3 for the long list alternatives considered.

Table 3: Theme 1 Pre-Screening Results - Travel Time Competitiveness

Alt No.	Description	Mode	Travel Time Competitiveness
2	Enhanced MARC Service	Heavy Rail	5.0
3a	Red Line Ext 1 (to Gaithersburg) via CSX	Metro	4.0
3b	Red Line Ext 1 (to Gaithersburg) via MD 355	Metro	4.0
4a	Red Line Ext 2 (to Germantown) vis CSX	Metro	4.0
4b	Red Line Ext 2 (to Germantown) via MD 355	Metro	4.0
5	Corridor Cities Transitway (Stage 1 + 2)	BRT	2.0
6	Purple Line LRT Extension	LRT	3.0
7	North Bethesda Transitway BRT	BRT	3.0
8	Monorail to Frederick	Monorail	4.0
9	Managed Lanes BRT	BRT	2.0
10	I-270 Corridor LRT	LRT	3.0
11	I-270 Corridor BRT	BRT	2.0
12	Frederick to Tysons BRT	BRT	2.0
13	Frederick to Silver Spring BRT	BRT	2.0

Key Findings of Theme 1 Analysis

- All options offer improved travel times relative to existing transit
- Most options are competitive with automobile for the key destinations considered – however, only MARC offers travel times that are consistently equal to or faster than automobile travel times
  - Notably, existing transit travel times via MARC are equally competitive with automobile
- Options that operate in mixed traffic environments and for longer distances tend to perform more poorly in comparison to automobile travel times
  - Particularly true for options that serve locations further from typically more congested areas

Theme 2: Population with Access to Rapid Transit

This theme is concerned with how many people can access rapid transit serving the I-270 corridor, relative to the existing system.

GIS analysis of planned 2045 population data (obtained from the Travel/4 model) was used to count people within a 15-minute walk, transit ride, and drive of the station locations for each alternative. The 2045 model year was used to evaluate the potential ridership catchment of the planned future population across Montgomery County.

The catchment areas were calculated using networked buffers from the stations, representing the area accessible within a 15-minute walk or drive using the existing road network. The drive catchment areas were estimated using historical weekday PM period traffic data. Under the assumption that transit services are likely to change to support a new rapid transit service, a 3-mile networked buffer was used as a proxy for the area assumed to be accessible within 15 minutes of the station by transit should a given alternative be implemented.

Importantly, only new service areas (falling outside the 15-minute catchment of existing rapid transit stations) are counted to indicate the potential net benefits from a given project. However, qualitative analysis and professional judgement were applied to remove existing rapid stations from the analysis that currently lack direct service to the I-270 corridor. The existing Metro Silver Line stations west of downtown Washington DC, for example, were not included in the baseline existing network since there is no direct service to the I-270 corridor. The existing MARC stations were also not included in the baseline, following the assumption that the existing service levels (primarily peak-direction services) are not deemed “rapid transit”. Additionally, some stations were excluded from the existing baseline condition to reduce analytical complexity where introduction of an alternative does not change access to rapid transit service (e.g. south and east of Washington DC).

Figure 19 provides an example of the population within a 15-minute drive of Alternative 5 and Alternative 12 stations, relative to the baseline scenario. Areas of higher population density are shown in darker shades of blue, while the new and existing 15-minute drive catchment areas are shown in green and purple, respectively. Note that similar evaluation was carried out for walk and transit access.

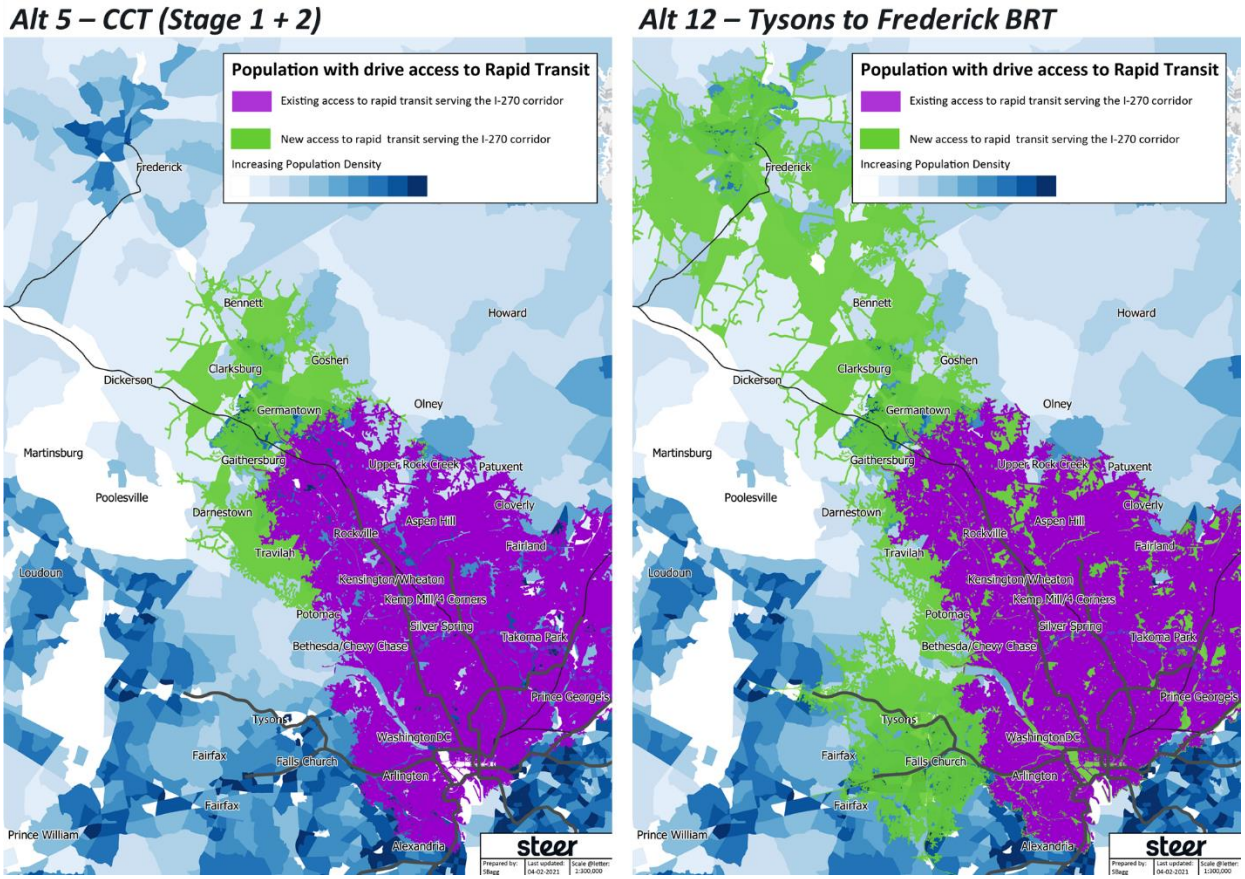


Figure 19: Theme 2 Example Evaluation - Population with access to Rapid Transit Serving the I-270 Corridor (by car)

For each alternative, the resulting output (total increase in population with access to rapid transit serving the I-270 corridor) was rescaled to a score from 1 to 5, with a score of 5 representing the top-performing alternative.

The Theme 2 results are presented in Table 4 for the long list alternatives.

Table 4: Theme 2 Pre-Screening Results - Population with Access to Rapid Transit Serving the I-270 Corridor

Alt No.	Description	Mode	Planned Population (2045)			Score			
			Drive	Transit	Walk	Drive	Transit	Walk	Avg
2	Enhanced MARC Service	Heavy Rail	1,121,200	250,500	43,800	4.0	2.5	2.5	3.0
3a	Red Line Ext 1 (to Gaithersburg) via CSX	Metro	110,100	95,200	13,900	1.0	1.0	1.0	1.0
3b	Red Line Ext 1 (to Gaithersburg) via MD 355	Metro	150,800	117,300	26,300	1.0	1.0	1.5	1.0
4a	Red Line Ext 2 (to Germantown) vis CSX	Metro	300,000	181,700	14,200	1.5	1.5	1.0	1.5
4b	Red Line Ext 2 (to Germantown) via MD 355	Metro	248,500	161,100	16,800	1.5	1.5	1.0	1.5
5	Corridor Cities Transitway (Stage 1 + 2)	BRT	440,500	260,500	66,900	2.0	2.5	3.5	2.5
6	Purple Line LRT Extension	LRT	366,300	177,300	50,500	2.0	1.5	3.0	2.0
7	North Bethesda Transitway BRT	BRT	418,200	168,500	34,300	2.0	1.5	2.0	2.0
8	Monorail to Frederick	Monorail	1,003,000	281,100	15,700	4.0	2.5	1.0	2.5
9	Managed Lanes BRT	BRT	954,200	292,200	28,700	3.5	2.5	1.5	2.5
10	I-270 Corridor LRT	LRT	228,800	127,700	17,400	1.5	1.5	1.0	1.5
11	I-270 Corridor BRT	BRT	231,800	153,800	33,200	1.5	1.5	2.0	1.5
12	Frederick to Tysons BRT	BRT	1,399,900	558,200	97,200	5.0	5.0	5.0	5.0
13	Frederick to Silver Spring BRT	BRT	1,084,300	332,200	53,400	4.0	3.0	3.0	3.5

Theme 2 Key Findings

- All options offer increased access to rapid transit serving the I-270 corridor
- Greatest benefits are offered by longer routes with stations that extend beyond the metro system where access is currently limited
- Alt 2 (upgraded MARC service) has same catchment area as today, but existing peak-direction service not considered all day rapid transit
  - An upgraded service has the potential to serve populations in existing station catchment areas throughout the day
- Alts 3 and 4 (Metro Extensions) achieve lower performance due to relatively short length of service and proximity of stations to existing rapid transit, with only limited areas of new coverage

Theme 3: Job Accessibility by Rapid Transit Serving the I-270 Corridor

This theme is concerned with how many jobs are accessible by rapid transit serving the I-270 corridor, relative to the existing system.

The methodology for Theme 3 is the same as for Theme 2, but instead considers access to jobs rather than employment. GIS analysis of planned 2045 employment data (Travel/4 model) was used to count jobs within a 15-minute walk and transit ride of the indicative station locations for each alternative. Notably, job access to/from transit stations was calculated by car, as it is assumed that those who use cars to access transit (from home), would not have access to a car for the last mile of their trip to work (or first mile for return commute).

As with Theme 2, only new service areas (falling outside the 15-minute catchment of existing rapid transit stations) are counted to indicate the potential net benefits from a given project.

Figure 20 provides an example of the analysis undertaken for Theme 3, highlighting the net increase in access to jobs from rapid transit serving the I-270 corridor by walking, relative to the existing condition for alternatives 5 and 12. Note that similar analysis was carried out using 15-minute transit access.

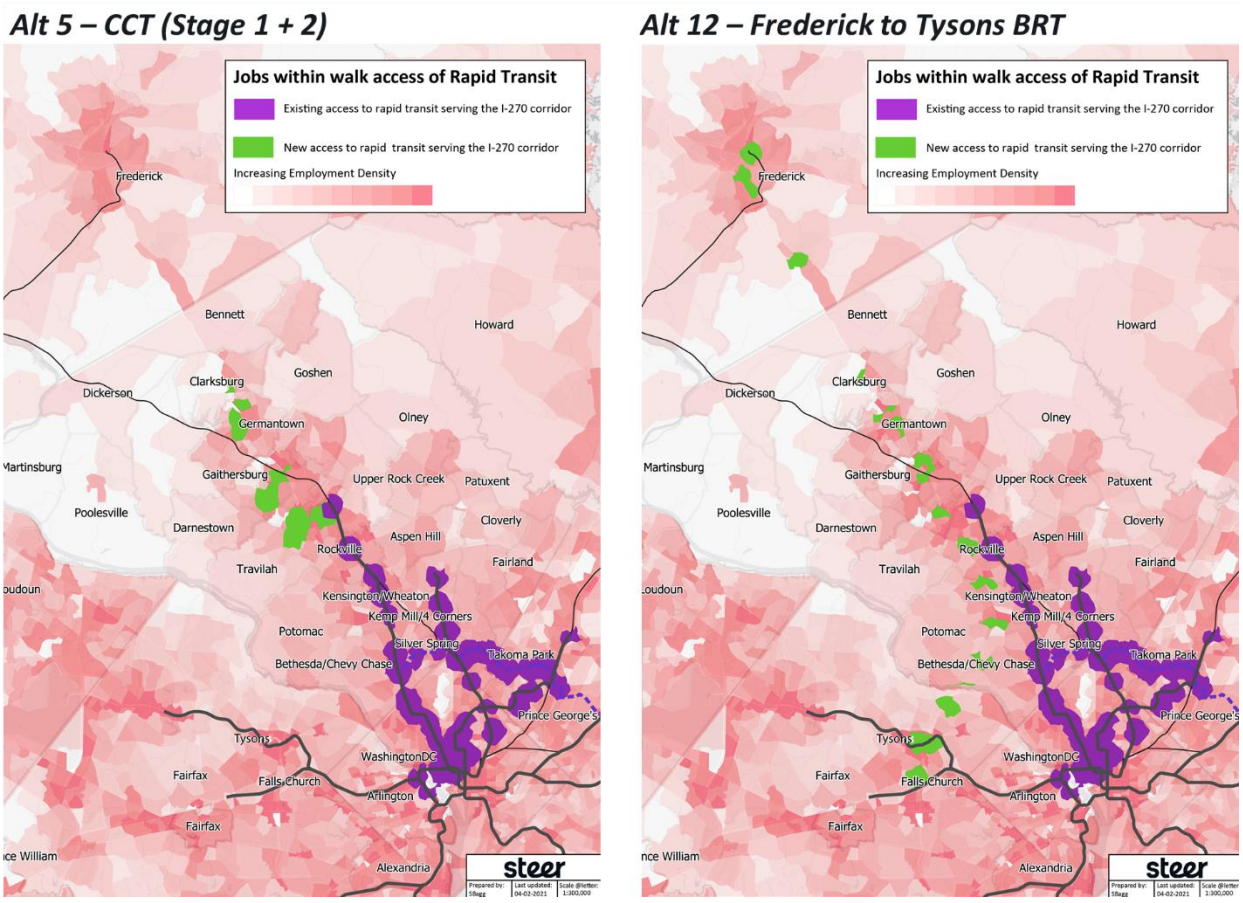


Figure 20: Theme 3 Evaluation Example - Access to Jobs from Rapid Transit serving the I-270 Corridor (by walking)

The example to the left highlights the employment opportunities that would be accessible by walking from rapid transit should Alternative 5 be implemented between the Red Line Metro terminus and Clarksburg. Similarly, the image to the right highlights the employment opportunities between Frederick and the Tysons area within walk access of rapid transit associated with Alternative 12.

The resulting outputs were then rescaled to a score from 1 to 5 by comparing each option to the highest performing option, providing a score that allows for a 'clearer' interpretation of project performance. Table 5 on the following page shows the net increase in job access and associated scores for each of the long-listed alternatives.

Table 5: Theme 2 Pre-Screening Results –Access to Employment from Rapid Transit Serving the I-270 Corridor

Alt No.	Description	Mode	Planned Jobs (2045)		Score		
			Transit	Walk	Transit	Walk	Avg
2	Enhanced MARC Service	Heavy Rail	160,600	26,700	2.0	1.5	2.0
3a	Red Line Ext 1 (to Gaithersburg) via CSX	Metro	57,500	7,300	1.0	1.0	1.0
3b	Red Line Ext 1 (to Gaithersburg) via MD 355	Metro	79,300	20,600	1.0	1.5	1.5
4a	Red Line Ext 2 (to Germantown) vis CSX	Metro	94,200	11,800	1.5	1.0	1.5
4b	Red Line Ext 2 (to Germantown) via MD 355	Metro	85,600	16,000	1.5	1.0	1.5
5	Corridor Cities Transitway (Stage 1 + 2)	BRT	135,800	84,500	2.0	3.0	2.5
6	Purple Line LRT Extension	LRT	201,200	88,800	2.5	3.0	3.0
7	North Bethesda Transitway BRT	BRT	196,800	72,100	2.5	2.5	2.5
8	Monorail to Frederick	Monorail	185,600	23,700	2.0	1.5	2.0
9	Managed Lanes BRT	BRT	196,900	52,400	2.5	2.0	2.5
10	I-270 Corridor LRT	LRT	70,900	33,800	1.0	1.5	1.5
11	I-270 Corridor BRT	BRT	96,400	35,000	1.5	1.5	1.5
12	Frederick to Tysons BRT	BRT	470,700	160,300	5.0	5.0	5.0
13	Frederick to Silver Spring BRT	BRT	212,600	65,200	2.5	2.5	2.5

Key Findings of Theme 3 Analysis:

- All options offer increased accessibility to jobs from the rapid transit network by walk/transit, relative to the existing conditions
- Longer routes with more stations, located in areas outside of the existing rapid transit catchment areas offer the greatest net benefits where no rapid transit alternatives exist
- Alt 2 (upgraded MARC service) has the same catchment area as today, but existing peak-direction service not considered all day 'rapid transit' in this analysis
- Alt 3 and 4 (Red Line Metro Extensions) achieve lower performance due to relatively short length of service and proximity of stations to existing rapid transit

Theme 4: Development Potential

This theme assesses the ability of each alternative to serve the planned growth in population and employment that will be accessible to/from rapid transit serving the I-270 corridor between 2015 and 2045.

GIS analysis of planned 2015 and 2045 population/employment data (Travel/4 model) was used to count the planned growth in population and jobs within a 15-minute walk, transit ride, and drive of the indictive station locations for each alternative, using the same coverage areas developed for Themes 2 and 3.

Only new service areas (falling outside the 15-minute catchment of existing rapid transit stations) are counted to indicate the potential net benefits from a given project.

The resulting outputs were then rescaled to a score from 1 to 5 by comparing each option to the highest performing option, providing a score that allows for a 'clearer' interpretation of project performance.

Planned population growth between 2015 and 2045 is shown at the TAZ level in Figure 21 and Figure 22 on the next two pages.

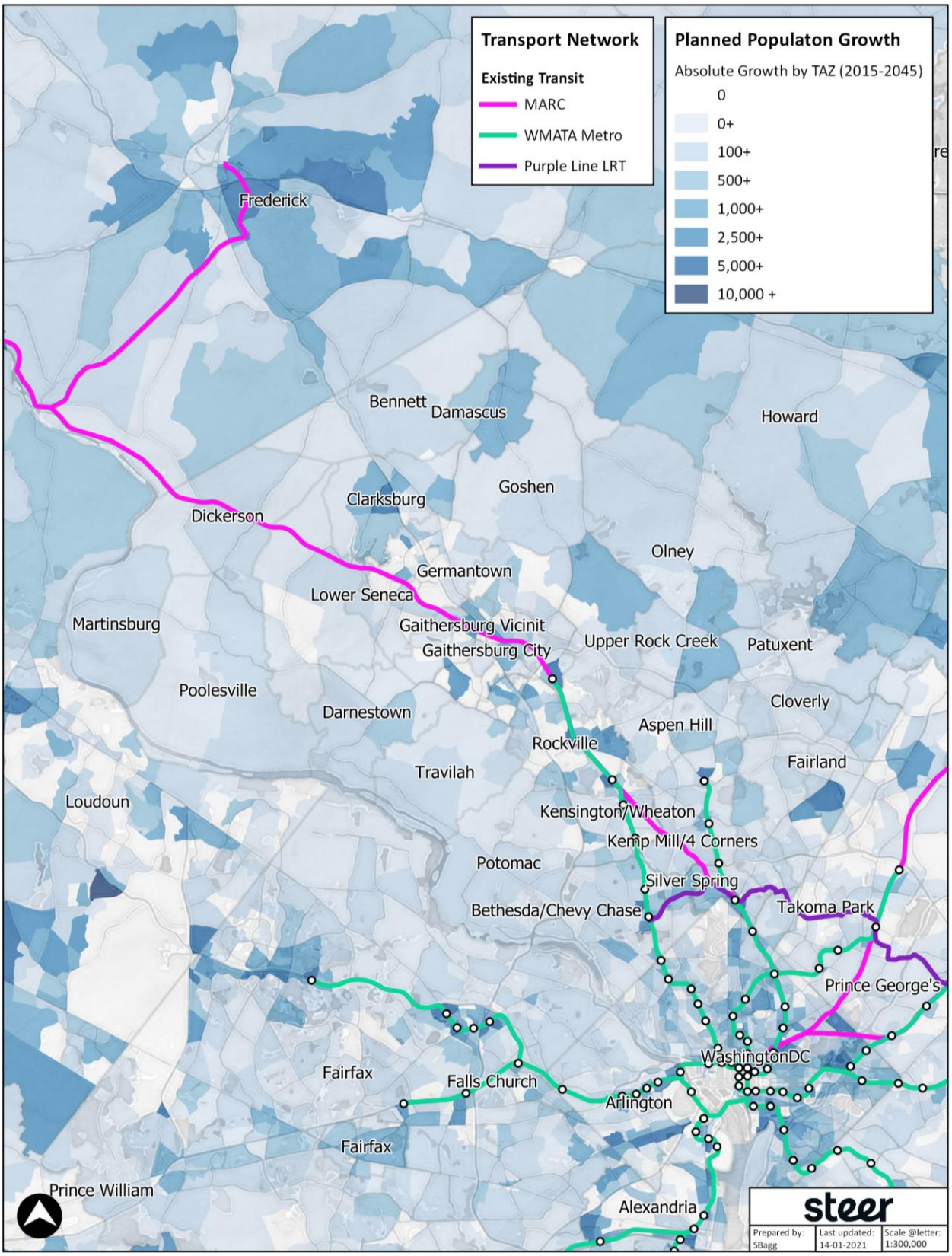


Figure 21: Planned Population Growth by TAZ (2045 vs 2015, Travel/4 model)

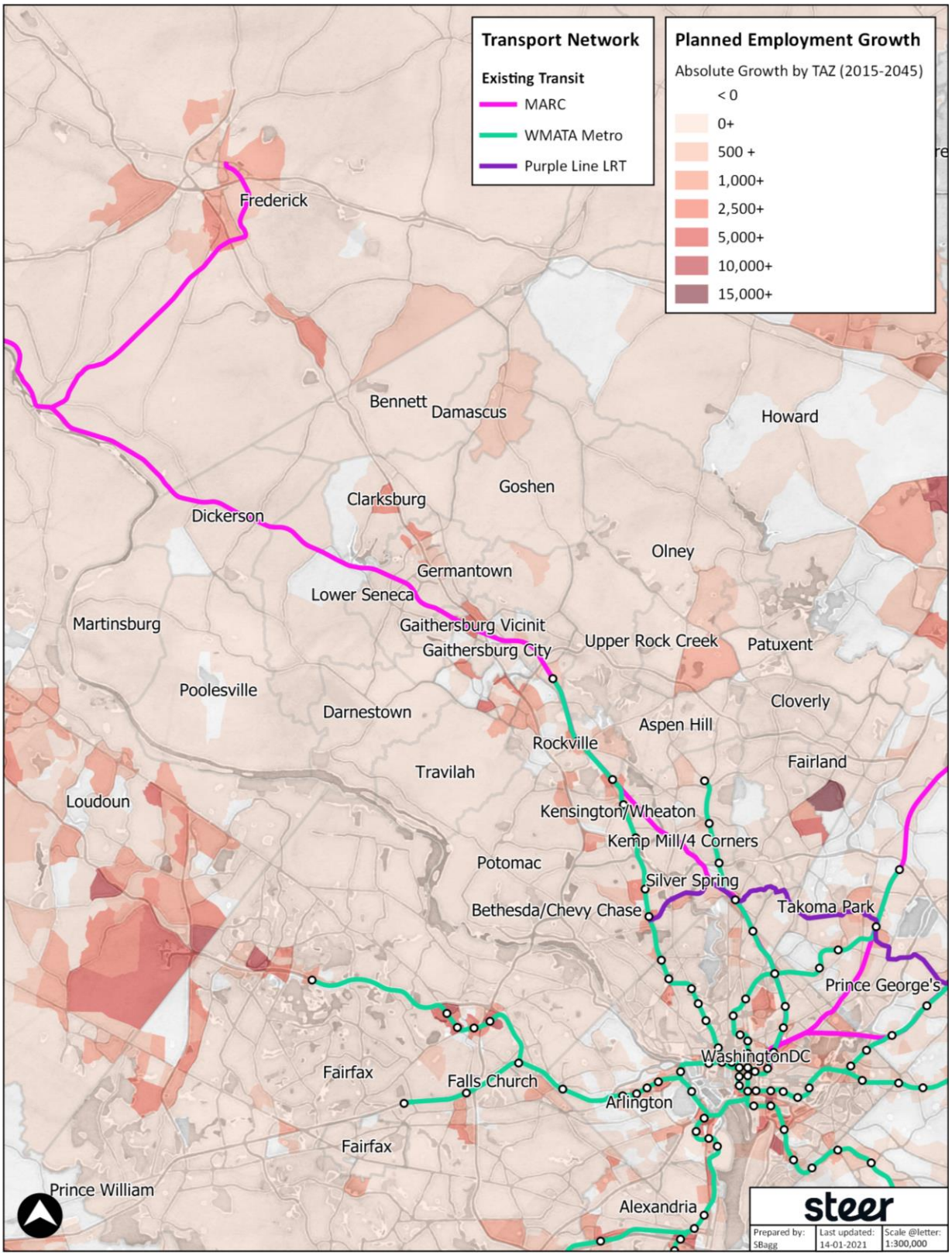


Figure 22: Planned Employment Growth by TAZ (2045 vs 2015, Travel/4 model)

The associated theme 4 results are presented in Table 6 below, and in Table 7.

Table 6: Theme 4 Evaluation Results - Urban Development Potential (Planned Population Growth)

Alt No.	Description	Mode	Planned Population Growth			Scores			
			Drive	Transit	Walk	Drive	Transit	Walk	Avg
2	Enhanced MARC Service	Heavy Rail	252,600	41,400	8,100	4.0	2.0	1.5	3.0
3a	Red Line Ext 1 (to Gaithersburg) via CSX	Metro	24,800	15,300	2,400	1.0	1.0	1.0	1.0
3b	Red Line Ext 1 (to Gaithersburg) via MD 355	Metro	33,900	19,700	6,100	1.0	1.0	1.5	1.0
4a	Red Line Ext 2 (to Germantown) vis CSX	Metro	67,600	24,900	4,000	1.5	1.5	1.0	1.0
4b	Red Line Ext 2 (to Germantown) via MD 355	Metro	55,900	23,400	3,600	1.5	1.0	1.0	1.0
5	Corridor Cities Transitway (Stage 1 + 2)	BRT	99,200	42,300	23,000	2.0	2.0	2.5	2.0
6	Purple Line LRT Extension	LRT	82,500	77,100	31,200	2.0	3.0	3.5	3.0
7	North Bethesda Transitway BRT	BRT	94,200	74,100	22,900	2.0	2.5	2.5	2.0
8	Monorail to Frederick	Monorail	226,000	57,000	7,000	4.0	2.0	1.5	3.0
9	Managed Lanes BRT	BRT	214,900	61,300	15,300	3.5	2.5	2.0	3.0
10	I-270 Corridor LRT	LRT	51,600	20,500	10,100	1.5	1.0	1.5	1.0
11	I-270 Corridor BRT	BRT	52,200	23,800	11,200	1.5	1.0	1.5	1.0
12	Frederick to Tysons BRT	BRT	315,300	151,400	51,700	5.0	5.0	5.0	5.0
13	Frederick to Silver Spring BRT	BRT	244,300	66,400	18,300	4.0	2.5	2.5	3.0

Table 7: Theme 4 Evaluation Results - Urban Development Potential (Planned Employment Growth)

Alt No.	Description	Mode	Planned Job Growth		Scores		
			Transit	Walk	Transit	Walk	Avg
2	Enhanced MARC Service	Heavy Rail	38,300	5,300	1.5	1.5	2.0
3a	Red Line Ext 1 (to Gaithersburg) via CSX	Metro	14,400	1,000	1.0	1.0	1.0
3b	Red Line Ext 1 (to Gaithersburg) via MD 355	Metro	22,200	2,100	1.0	1.0	1.0
4a	Red Line Ext 2 (to Germantown) vis CSX	Metro	26,200	2,600	1.5	1.0	1.0
4b	Red Line Ext 2 (to Germantown) via MD 355	Metro	24,700	4,400	1.5	1.0	1.0
5	Corridor Cities Transitway (Stage 1 + 2)	BRT	43,200	27,200	2.0	2.5	2.0
6	Purple Line LRT Extension	LRT	76,700	37,700	3.0	3.5	3.0
7	North Bethesda Transitway BRT	BRT	76,800	37,000	3.0	3.5	3.0
8	Monorail to Frederick	Monorail	57,500	8,600	2.5	1.5	2.0
9	Managed Lanes BRT	BRT	59,600	12,300	2.5	1.5	2.0
10	I-270 Corridor LRT	LRT	19,300	6,700	1.0	1.5	1.0
11	I-270 Corridor BRT	BRT	28,300	8,100	1.5	1.5	2.0
12	Frederick to Tysons BRT	BRT	150,300	62,000	5.0	5.0	5.0
13	Frederick to Silver Spring BRT	BRT	63,000	18,300	2.5	2.0	2.0

Key Findings of Theme 4 Analysis:

- Most options provide modest support for planned urban development.
- The greatest benefits are offered by longer routes running through areas of expected rapid growth.
- Note this preliminary evaluation does not consider the potential impact of options in stimulating unplanned development.

Theme 5: Equity Focus Areas

This theme is concerned with access to rapid transit serving the I-270 corridor from Montgomery County's Equity Focus Areas (EFAs), relative to existing access.

Montgomery County's EFAs were developed by Montgomery County staff based on a number of contributing indicator variables, including populations of people of color, individual and household income, and other variables. The location of the Montgomery County EFAs are shown in Figure 23.

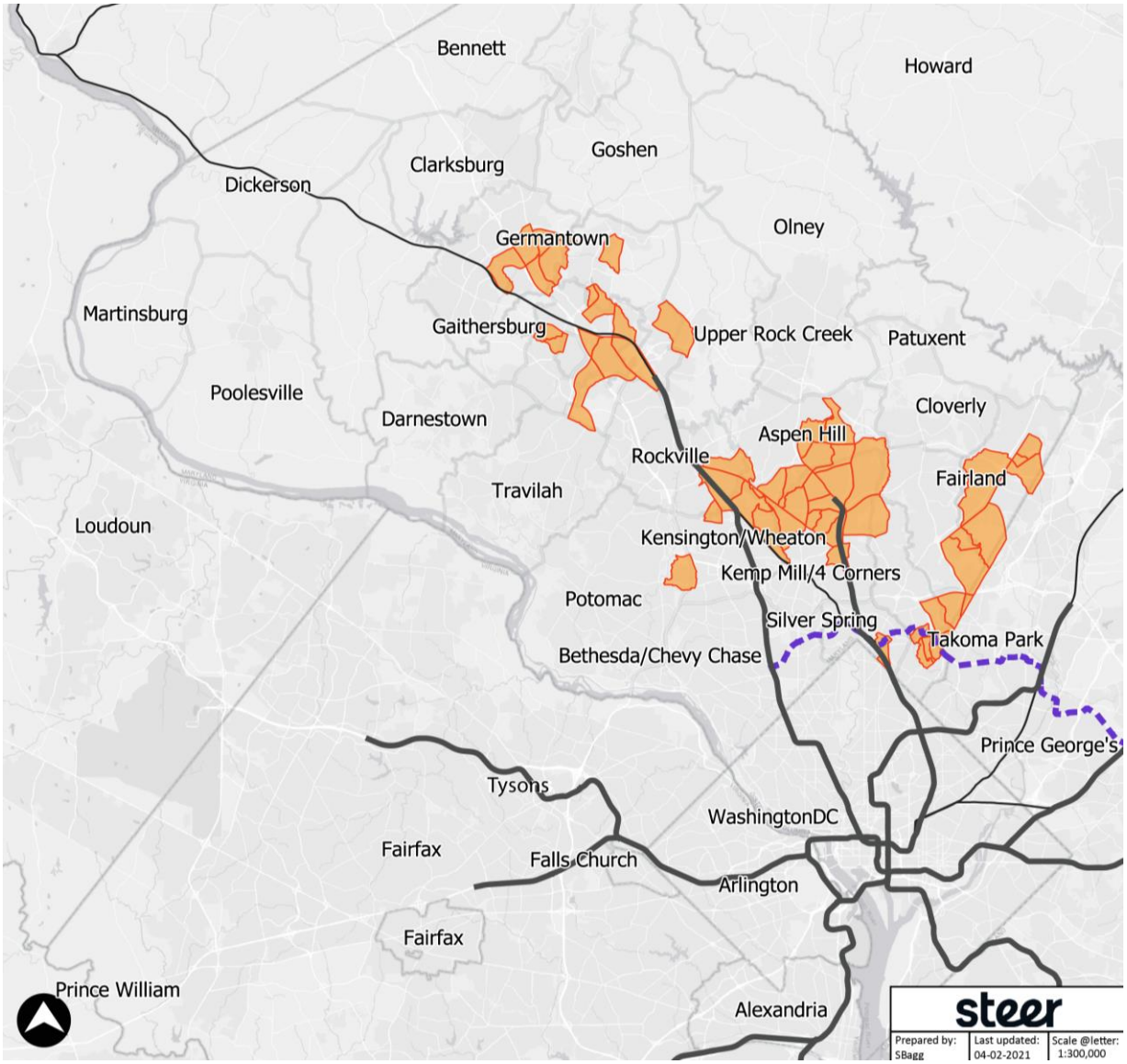


Figure 23: Montgomery County Equity Focus Areas

GIS analysis of Montgomery County's Equity Focus Area dataset was used to determine the increase in rapid transit access from EFAs within a 15-minute walk, transit ride, or drive of the indictive station locations for each alternative. As with the previous themes, only new service areas (falling outside the 15-minute catchment of existing rapid transit stations) are counted to indicate the potential net benefits from a given project.

The examples in Figure 24 below illustrate the relative gains in access to rapid transit serving the I-270 corridor from Montgomery County's Equity Focus Areas by walking (left) and driving (right) for Alternative 12, as an example, relative to the existing rapid transit network serving the I-270 corridor.

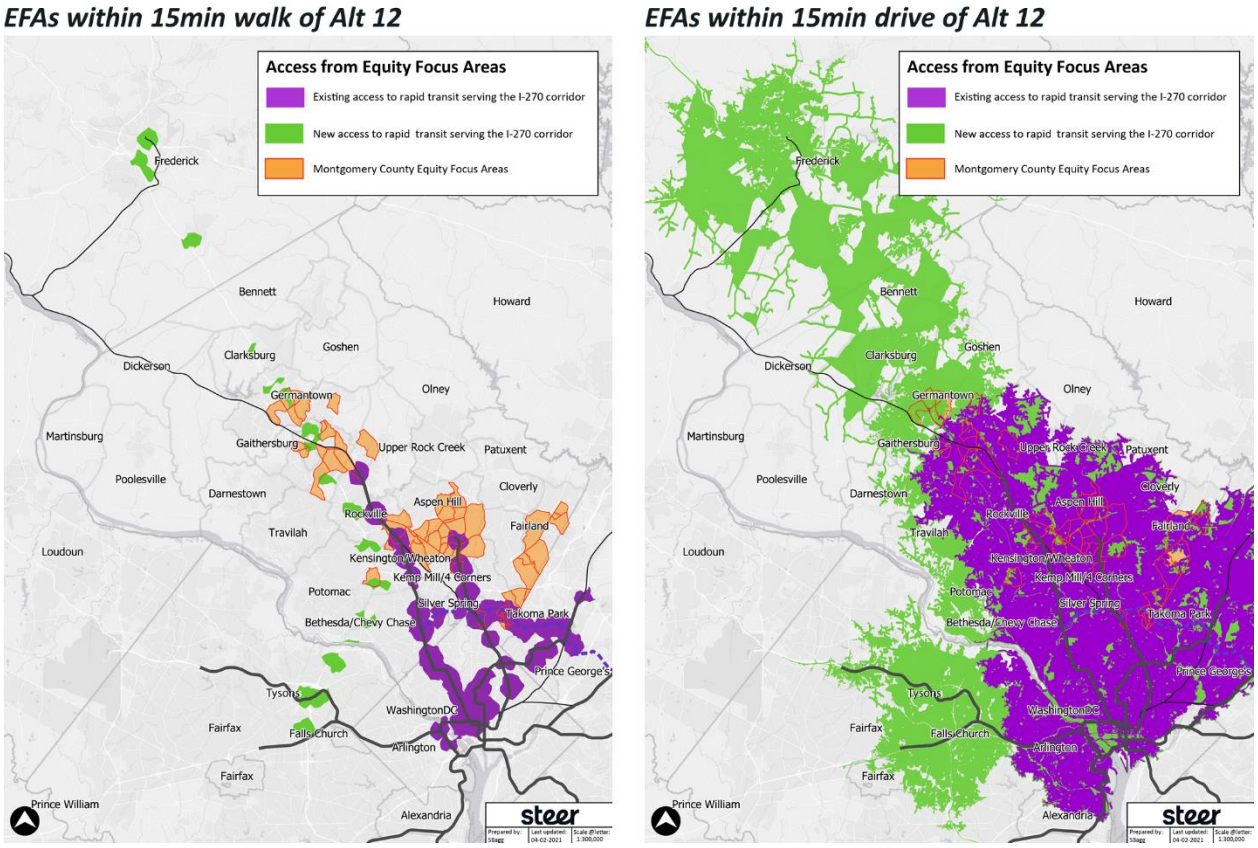


Figure 24: Theme 5 Evaluation Example - Equity Focus Areas

The above outputs show that using the existing rapid transit network, only a small proportion of EFAs are within walking distance of rapid transit serving the I-270 corridor. Any stations located within currently unserved EFAS would benefit those who do not have access to a car by making rapid transit a more accessible travel option.

Conversely, minimal gains can be achieved for access from EFAs by car, since most EFAs (south of Gaithersburg) are already within a 15 min drive of rapid transit serving the I-270 corridor.

The resulting outputs were rescaled to a score from 1 to 5 by comparing the raw output for each alternative to that of the highest performing option, providing a score that allows for a 'clearer' interpretation of project performance.

The results of the Theme 5 analysis are presented in Table 8.

Table 8: Theme 5 Pre-Screen Results - Equity Focus Areas

Alt No.	Description	Mode	*(new coverage as % of total EFA Area)*			Score			
			Drive	Transit	Walk	Drive	Transit	Walk	Average
2	Enhanced MARC Service	Heavy Rail	7.6%	15.5%	5.1%	4.5	4.0	4.5	4.5
3a	Red Line Ext 1 (to Gaithersburg) via CSX	Metro	7.6%	9.7%	3.2%	4.5	3.0	3.5	3.5
3b	Red Line Ext 1 (to Gaithersburg) via MD 355	Metro	7.6%	12.7%	5.7%	4.5	3.5	5.0	4.5
4a	Red Line Ext 2 (to Germantown) vis CSX	Metro	7.6%	16.3%	1.1%	4.5	4.5	2.0	3.5
4b	Red Line Ext 2 (to Germantown) via MD 355	Metro	7.6%	16.2%	4.0%	4.5	4.0	4.0	4.0
5	Corridor Cities Transitway (Stage 1 + 2)	BRT	8.3%	17.8%	2.7%	5.0	4.5	3.0	4.0
6	Purple Line LRT Extension	LRT	0.0%	0.0%	0.0%	1.0	1.0	1.0	1.0
7	North Bethesda Transitway BRT	BRT	0.0%	1.2%	1.4%	1.0	1.0	2.0	1.5
8	Monorail to Frederick	Monorail	7.6%	17.4%	1.1%	4.5	4.5	2.0	3.5
9	Managed Lanes BRT	BRT	7.6%	17.6%	1.5%	4.5	4.5	2.0	3.5
10	I-270 Corridor LRT	LRT	7.6%	11.5%	0.4%	4.5	3.5	1.5	3.0
11	I-270 Corridor BRT	BRT	7.6%	12.3%	0.5%	4.5	3.5	1.5	3.0
12	Frederick to Tysons BRT	BRT	7.6%	18.6%	2.4%	4.5	4.5	2.5	4.0
13	Frederick to Silver Spring BRT	BRT	7.8%	20.0%	2.7%	5.0	5.0	3.0	4.5

Key Findings of Theme 5 Analysis:

- With the exception of Alt 6, all alternatives offer increased access to rapid transit serving the I-270 corridor from Montgomery County's EFAs
- Alt 7 performs similar to Alt 6, with minimal gains by transit and walk access
- Most alternatives offer similar, limited gains in access from EFAs by car, since most EFAs are already within 15min drive of rapid transit serving the corridor
- Performance varies among the alternatives for improved access to rapid transit by walking, with routes where stations are sited within or directly adjacent to EFAs performing most favourably given the relatively small size of walk catchments relative to EFAs

Results Summary

The results for all five pre-screening evaluation themes are presented in together in Table 9 on the following page, and the total scores by cost/coverage quadrant are illustrated in Figure 25.

Table 9: Pre-Screening Results Summary

Alt No.	Description	Mode	Theme 1: Travel Time Competitiveness	Theme 2: Serves Communities	Theme 3: Connects to Jobs	Theme 4: Supports Urban Development	Theme 5: Supports Equity Goals	Combined Score
2	Enhanced MARC Service	Heavy Rail	5.0	3.0	2.0	2.0	4.5	16.5
3a	Red Line Ext 1 (to Gaithersburg) via CSX	Metro	4.0	1.0	1.0	1.0	3.5	10.5
3b	Red Line Ext 1 (to Gaithersburg) via MD 355	Metro	4.0	1.0	1.5	1.0	4.5	12.0
4a	Red Line Ext 2 (to Germantown) vis CSX	Metro	4.0	1.5	1.5	1.5	3.5	12.0
4b	Red Line Ext 2 (to Germantown) via MD 355	Metro	4.0	1.5	1.5	1.0	4.0	12.0
5	Corridor Cities Transitway (Stage 1 + 2)	BRT	3.0	2.5	2.5	2.0	4.0	14.0
6	Purple Line LRT Extension	LRT	3.0	2.0	3.0	3.0	1.0	12.0
7	North Bethesda Transitway BRT	BRT	3.0	2.0	2.5	2.5	1.5	11.5
8	Monorail to Frederick	Monorail	4.0	2.5	2.0	2.5	3.5	14.5
9	Managed Lanes BRT	BRT	2.0	2.5	2.5	2.5	3.5	13.0
10	I-270 Corridor LRT	LRT	3.0	1.5	1.5	1.5	3.0	10.5
11	I-270 Corridor BRT	BRT	2.0	1.5	1.5	1.5	3.0	9.5
12	Frederick to Tysons BRT	BRT	2.0	5.0	5.0	5.0	4.0	21.0
13	Frederick to Silver Spring BRT	BRT	2.0	3.5	2.5	2.5	4.5	15.0

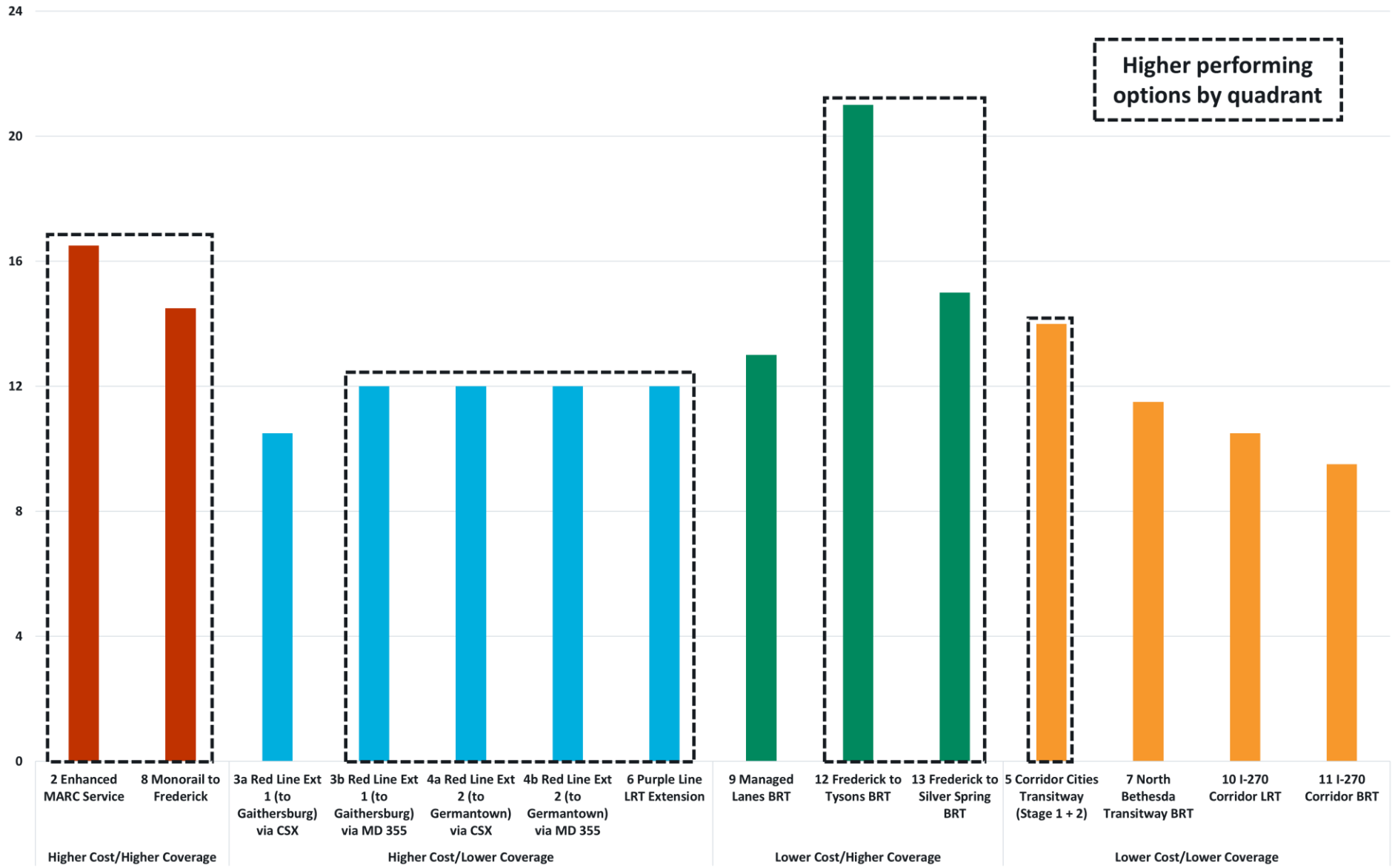


Figure 25: Results Summary by Cost/Coverage quadrants

Confirmed Short List

The cost coverage matrix in Table 10 below highlights (in blue) the top performing alternatives in each quadrant.

Table 10: Selecting the Short List of Alternatives

	Lower Coverage	Higher Coverage
Higher Cost	• **Alt 3a/b: Red Line Extension 1** • **Alt 4a/b: Red Line Extension 2** • **Alt 6: Purple Line LRT Extension**	• **Alt 2a/b: Enhanced MARC service** • **Alt 8: Monorail to Frederick**
Lower Cost	• **Alt 5: CCT Stage 1 + 2** • Alt 7: North Bethesda Transitway BRT • Alt 10: I-270 Corridor LRT • Alt 11: I-270 Corridor BRT	• Alt 9: I-270 Managed Lanes BRT • **Alt 12: Frederick to Tysons BRT** • Alt 13: Frederick to Silver Spring BRT

Based on the results of the pre-screening analysis and a review of recent planning efforts along the I-270 corridor, six options (including modifications from the long list) emerged as the best candidates for Corridor Forward's more detailed evaluation phase, listed below and shown in Figure 26 on the next page:

- MARC station and service upgrades along the Brunswick Line (Alt 2a/b)
- Red Line Extension to Germantown (Alt 4a/b)
- Corridor Cities Transitway with current alignment (Alt 5)
- Purple Line Extension to Tysons (Alt 6)
- Monorail (Option 8) or Light Rail along I-270 from Shady Grove to Frederick
- I-270 BRT from Frederick to Northern Virginia (Option 12) plus a supplemental concept for the Corridor Cities Transitway.

Together, these alternatives cover each of the four cost and coverage categories and provide geographic breadth. Some alternatives are more regional in nature, emphasizing connections to Montgomery County's neighboring jurisdictions (MARC, the Purple Line Extension, I-270 BRT), while others focus on strengthening connections within Montgomery County (Red Line Extension, Corridor Cities Transitway, and Monorail or Light Rail). Through another lens, some options extend or improve existing services (MARC, Purple Line Extension, Red Line Extension), while others envision new services (Corridor Cities Transitway, Monorail or Light Rail, and I-270 BRT).

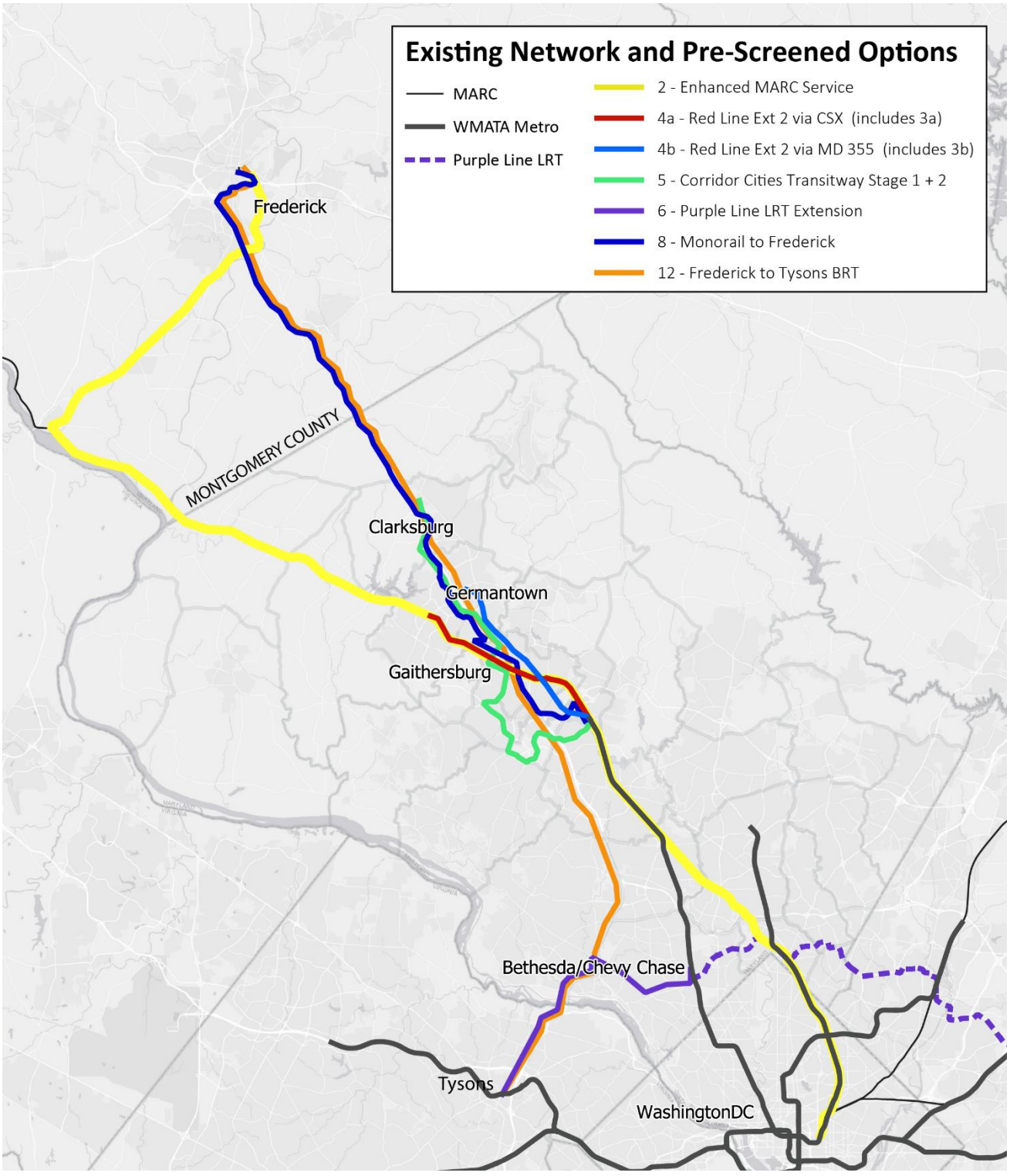


Figure 26: Shortlisted Project Alternatives

APPENDIX 2 ADDENDUM. MODE MATRIX

Prior to the development of options, the project team developed a general mode matrix as a reference to help the Planning Board and stakeholders understand some of the characteristics and differences of potential transit modes at a high planning level. The mode matrix, provided in the following pages, served as a reference through the duration of the project. The values included are intended to provide basic information about what is typical for each mode, but are not intended to directly indicate how a potential transit option will be designed, constructed, or operated. The values are also not intended to reliably describe an option's ultimate costs and benefits as on the ground context can impact cost and performance.

Corridor Forward: I-270 Transit Plan
Task 2A – Graphic Mode Matrix

October 2020

I-270 Corridor Forward – Task 2A

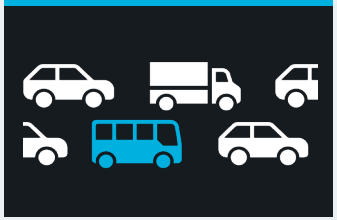
Montgomery Planning
M-NCPPC

steer

Transit Modes – Local Examples

steer

Bus

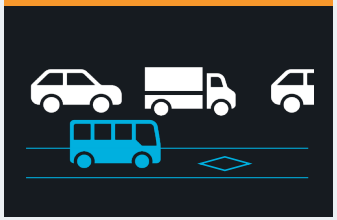


(Ride On / Extra)

Streetcar

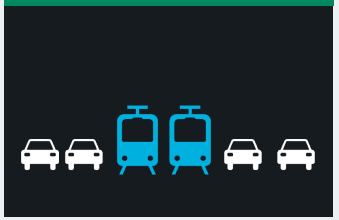
(DC Streetcar)

Bus Rapid Transit (BRT)



(Alexandria / Arlington Metroway)

Urban Style Light Rail

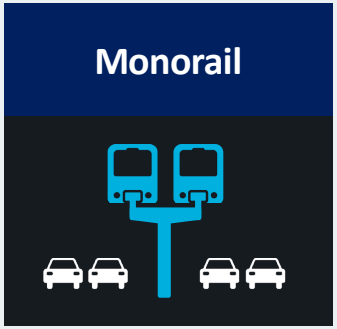


(Minneapolis-St. Paul LRT)

Light Rail Transit (LRT)

(Future Purple Line / Seattle Link)

Monorail



(Las Vegas Monorail)

Metro / Subway

(Metrorail)

Commuter Rail

(MARC)

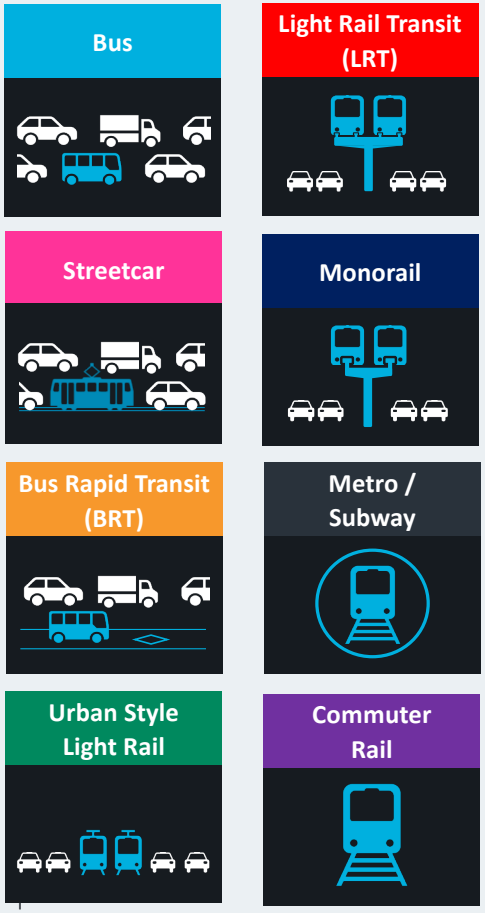
Stop Spacing

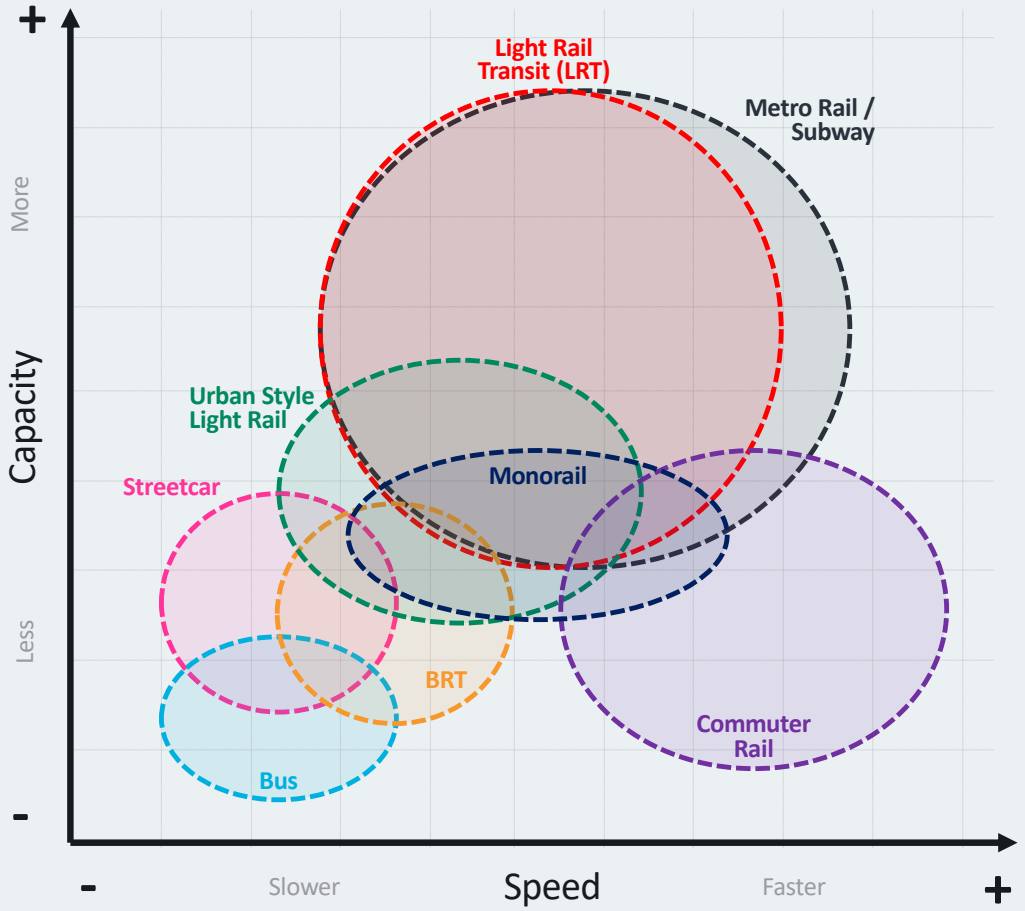
steer

Bus	Streetcar	Bus Rapid Transit (BRT)	Urban Style Light Rail
Local: 0.1 – 0.25 mi Limited: 0.25 – 0.5 mi Express: 0.5 – 1.0 mi	0.2 - 0.4 mi	0.25 - 1.0 mi	0.25 – 1.0 mi

Light Rail Transit (LRT)	Monorail	Metro / Subway	Commuter Rail
0.5 - 1.0 mi	0.5 - 1.0 mi	0.5 - 1.5 mi	1.5 - 3.0 mi

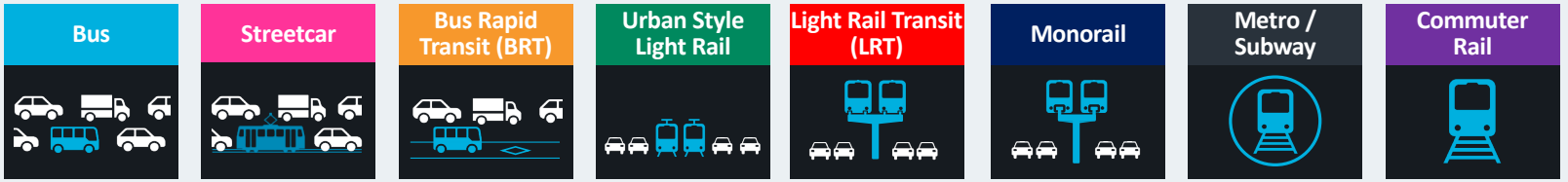
Speed vs. Capacity





Cost Factors

steer

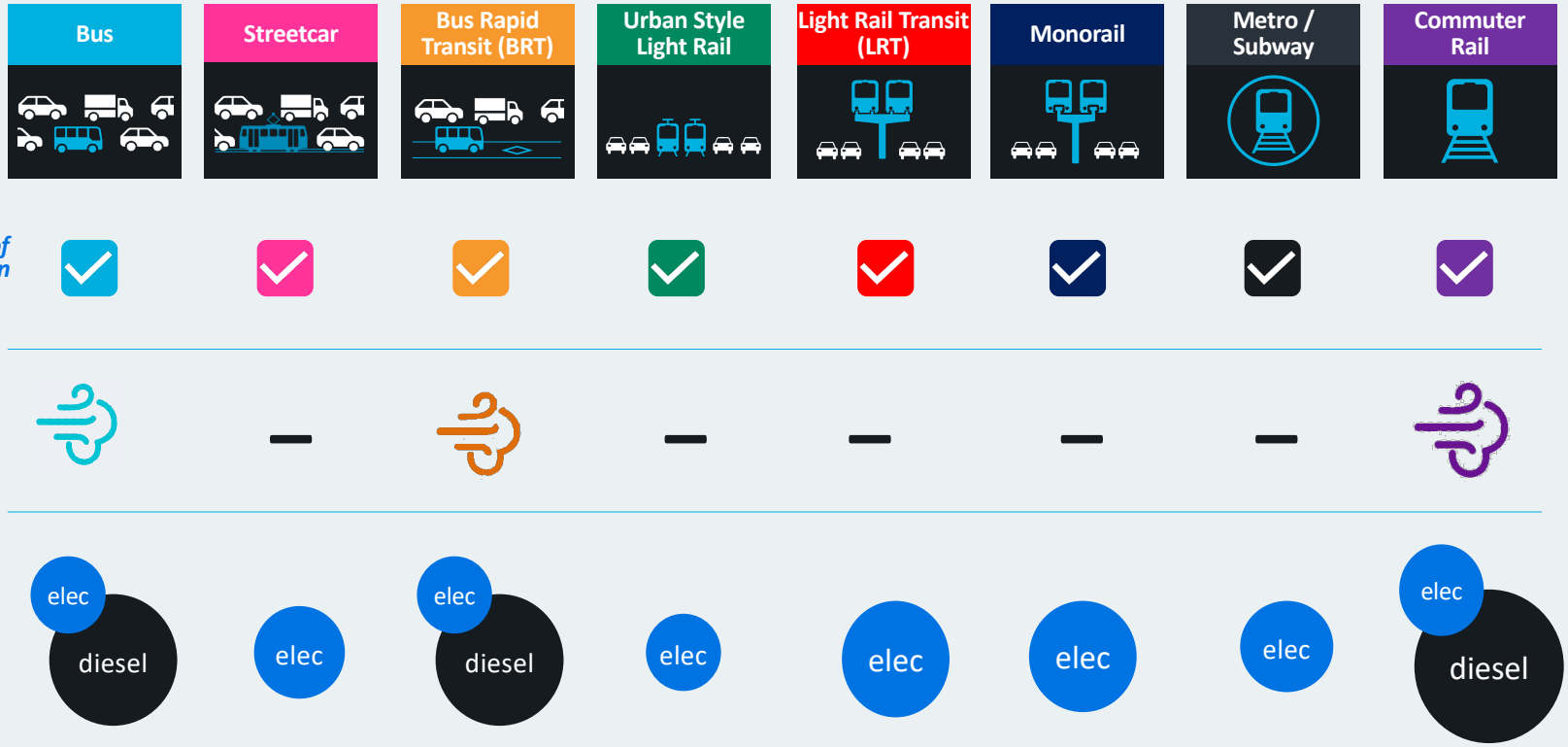


	Bus	Streetcar	Bus Rapid Transit (BRT)	Urban Style Light Rail	Light Rail Transit (LRT)	Monorail	Metro / Subway	Commuter Rail
Capital Cost Per Mile [1]	$6k to $12k / Mi.	$20M to $25M/ Mi.	$2M to $5M / Mi.	$60M to $80M/ Mi.	$200M to $300M/ Mi.	$80M to $160M/ Mi.	$500M to $800M / Mi.	$30M to $100M / Mi.
Operating Cost Per mile [2]	$11.82 / Mi.	$32.64 / Mi.	$21.84 / Mi.	$19.69 / Mi. [3]	$19.69 / Mi. [3]	$22.61 / Mi.	$13.22 / Mi.	$18.31 / Mi.
Operating Cost per Passenger Mile [2]	$1.31 / P-Mi.	$2.02 / P-Mi.	$1.31 / P-Mi.	$0.91 / P-Mi. [3]	$0.91 / P-Mi. [3]	$3.45 / P-Mi.	$0.54 / P-Mi.	$0.51 / P-Mi.

1. Capital cost data from example system
2. Operating cost data from 2018 NTD reports
3. NTD definitions combine urban LRT and guideway LRT

Environmental Impacts

steer



Note: electric vehicle lifecycle emissions are energy source dependent – comparison based on energy use

Implementation Factors

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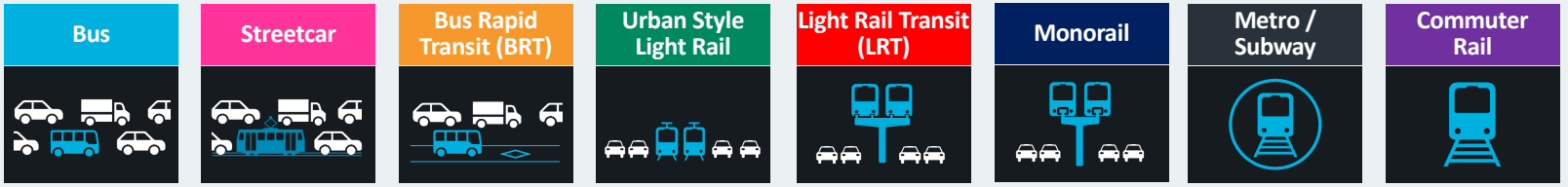


	Bus	Streetcar	Bus Rapid Transit (BRT)	Urban Style Light Rail	Light Rail Transit (LRT)	Monorail	Metro / Subway	Commuter Rail
Segregation	Mixed traffic	Mixed traffic	Dedicated ROW / shoulder lane	Dedicated Right-of-way (within street w/signals)	Grade-separated (Tunneled / Elevated)	Grade-separated (Tunneled / Elevated)	Grade-separated (Tunneled / Elevated)	Segregated Right-of-way (at grade)
Alignment Width	12 ft.	10 ft.	12 ft.	10 ft.	12 ft.	10 ft.	15 ft.	15 ft.
Maximum Grade	12%	8%	12%	8%	6%	6%	6%	2%

Detailed Matrix

steer

		Bus	Limited stop Bus	Bus Rapid Transit (BRT)	Streetcar	Urban Style Light Rail	Light Rail Transit (LRT)	Monorail	Metro / Subway	Commuter Rail
										
		Ride On	*Ride On Extra*	*Arlington Metroway*	*Washington DC Streetcar*	*Minneapolis-St Paul LRT*	*Seattle Link Light Rail*	*Las Vegas Monorail*	*Washington Metro*	*MARC (Maryland Commuter)*
Design Elements	*Level of Segregation*	Mixed Traffic	Mixed + Transit Service Priority	Dedicated ROW / HOV / shoulder lane	Mixed Traffic	Dedicated ROW (within street w/ signal prio.)	Grade-Separated (Tunneled / Elevated)	Grade-Separated (Tunneled / Elevated)	Grade-Separated (Tunneled / Elevated)	Segregated ROW (At-Grade)
	Typical Alignment Width	12 ft / direction	12 ft / direction	12 ft / direction	10 ft / direction	10 ft / direction	12 ft / direction	10 ft / direction	13 ft / direction	13 ft / direction
	Typical Stop/Station Spacing	Basic: 650 ft - 1600 ft Freq.: 1000 ft - 2600 ft	2600 - 5000 ft 0.5 mi - 1.0 mi	1300 - 5000 ft 0.25 mi - 1.0 mi	1000 ft - 2000 ft 0.2 mi - 0.4 mi	1300 - 5000 ft 0.25 mi - 1.0 mi	2500 - 5000 ft 0.5 mi - 1.0 mi	2500 ft - 5000 ft 0.5 mi - 1.0 mi	2500 - 7000 ft 0.5 mi - 1.5 mi	7,000 - 25,000 ft 1.5 - 5.0 mi
	Maximum Grade	12%	12%	12%	8%	8%	6%	6% [1]	6%	2%
Service	*Max Operating Speed*	50 mph	50 mph	50 mph	43 mph	50 mph	55 mph	50 mph	60 mph	50-75 mph
	Avg Operating Speed (from example)	13 mph	20 mph	20 mph	7 mph	18mph	25 mph	12 mph	27 mph	35 mph
Vehicle Elements	*Vehicle capacity*	standard: 80 articulated: 100	standard: 80 articulated: 100	standard: 80 articulated: 100	80 - 170	200 - 250 (30m vehicle)	130 - 250 / car	240/train[1]	standard car: 120 double-decker: 200	160-180 seated 250-300 standees
	Propulsion options	Diesel / N Gas / EV / Hybrid	Diesel / N Gas / EV / Hybrid	Diesel / N Gas / EV / Hybrid	Electric	Electric	Electric	Electric	Electric	Diesel / Elec. / Hybrid
	Tailpipe Emissions?	*Yes for*	*Yes for*	*Yes for*	-	-	-	-	-	*Yes for*
	Guideway requirements	None	None / HOV / Shoulder	Dedicated lanes	Tracks/guideway in shared traffic lane	Dedicated lanes	Tunneled / Elevated / Segregated at-grade	Elevated	Tunneled / Elevated	Dedicated ROW
Economic	*Property Value Impact*	*Low*	*Low*	*Low*	*Low*	*Med*	*Med*	**High**	**High**	**High**
	Est. Capital Cost	$6k - $12k / mi	$15k - $25k / mi	$2M - $5M / mi	$20M - $25M / mi	$60M - $80M / mi	$200M - $300M / mi	$80M - $160M / mi	$500M - $800M / mi	$30M - $100M / mi
	Est. Operating Cost per passenger mile [2]	$1.50 - $1.70 / p-mi	$1.50 - $1.70/ p-mi	$1.50 - $1.70/ p-mi	$2.10 / p-mi	$1.00 / p-mi	$1.25 / p-mi	$2.00 - $8.00/ p-mi	$0.75 / p-mi	$0.62 / p-mi

1. Bombardier specifications

2. 2018 NTD full Reporter data

APPENDIX 3. METRICS & PERFORMANCE

CONTENTS

LIST OF TABLES

LIST OF FIGURES

READ THIS FIRST – ANTICIPATED UPDATES

Corridor Forward analyzes transit options and networks across strategic, financial, economic, and implementation dimensions. Financial evaluations are built from unit rate assumptions developed from national benchmarks, but also locally comparable information. Following the project team's analysis and evaluation, the Montgomery County Department of Transportation provided feedback to Montgomery Planning and has requested additional analysis be undertaken. Montgomery Planning has agreed to undertake this additional analysis and will release results in a forthcoming addendum to this appendix. All values reported in this report reflect initially employed benchmarks.

EVALUATION APPROACH

Corridor Forward applies a business case analysis to assess the value of each of the six options retained following the pre-screening analysis described in Appendix 2. Business case analysis is defined as the collection of evidence assembled in a logical way to explain the contribution of a proposed investment, with the intent of determining if the investment is a good use of public funds. The business case process aids decision-making by developing evaluation dimensions that provide key variables of value to multiple stakeholder parties rather than solely the party running the analysis.

Typically, business case analysis is performed prior to engineering work and is used as a decision-making framework. In other words, it is a planning-level process that is not intended to account for every detail of an option's ultimate benefits and costs, but to instead provide a clear and consumable picture of a transit option's overall benefit, cost, and risk bundle. For Corridor Forward, the business case analysis results in high-level comparative analysis to further curate corridor-serving transit options, de-emphasizing those which had less merit. The business case analysis for the project included several steps:

A. Generate dimensions of analysis and required evidence (metrics) for each dimension
B. Generate evidence (metric outputs) for each transit option
C. Summarize how each transit option performs against each dimension
D. Assess consequences and trade-offs for each option

The business case approach used by the effort is for comparative purposes. Regarding costs, its analysis is not reflective of bottom-up engineering. Regarding modeling, staff calibrated and Montgomery Planning's standard travel demand model tool with the best known information at the time of modeling. The project team, which includes the project consultant Steer Group, undertook additional dynamic land use modeling and financial modeling. As the recommendations of Corridor Forward advance, additional studies will likely need to be completed, such asfacility planning or alternatives analysis.

Observing the isolated costs, benefits, and risks of isolated transit options allowed Montgomery Planning to sort and elevate transit options that may function well as a component of a larger network. Planning then tested potential networks, which in tandem with policy considerations, helped the staff arrive at its recommendations for near-term recommended dedicated bus lanes and the long-term, ambitious extension of the Red Line to Germantown.

ORGANIZATION OF APPENDIX

This appendix walks through the modeling tools employed for analysis. It then discusses the performance of the Plan's retained options and tested network packages by evaluation dimension. The project team developed four different performance dimensions: a strategic dimension, a financial dimension, an economic dimension, and an implementation dimension. Each dimension includes core questions, which the project team used to develop metrics to assess the performance of options and packages. The following sections detail the description, method of analysis, and performance of relevant metrics.

MODELING TOOLS USED

General Modeling Approach

Corridor Forward used a series of tools to inform metric outputs. Technical modeling included use of the Travel/4 travel demand model and a proprietary dynamic land use model referred to by the project consultant as the Regional Dynamic Model. The project also consultant-produced financial and economic spreadsheet models. The project team undertook benchmarking and input gathering to inform applications of modeling, as reported with the relevant sections of this appendix.

Travel/4 Travel Demand Modeling

For travel demand modeling, Montgomery Planning's consultant used the Department's Travel/4 Model, a fine-grained iteration of the Metropolitan Washington Council of Government's (MWCOG) regional travel demand model, to evaluate the retained services. The consultant modeled the six retained transit options using land use and network assumptions for two model years: 2015—a proxy for existing conditions—and 2045. The rationale for modeling the options using an existing conditions network was twofold. First, the existing conditions modeling outputs can be understood as probable "performance floors" for each option. Additionally, when comparing 2015 outputs to the 2045 outputs, Planning staff could better gauge how much of the option's performance may be attributed to growth. In other words, modeling results that depict larger disparities between 2015 and 2045 suggest that the county and/or region would need to realize projected growth as it is spatially allocated per current forecasts in order attain the projected benefits. For land use, the 2045 model year uses cooperative forecast versions 9.1a for locations exterior to the county and 9.2 for locations interior to the county. When modeling commenced in December 2020, MWCOG had approved the county's proposed 9.2 inputs, but the regional release and approval for 9.2 in its entirety remained forthcoming.

Staff retained all regionally-accepted CLRP items in the future year network, except for the following project-based decisions:

- Staff removed the Corridor Cities Transitway from the 2045 background network as this project was a retained option and was analyzed individually.
- Staff retained 2015 MARC transit coding assumptions for the 2045 background as this project was a retained option and was and analyzed individually.
- Staff removed the North Bethesda Transitway from the background network as an extension of the project was included on initial transit options menu.
- Staff added the under-construction Purple Line to the 2015 background network, given that a Purple Line extension was evaluated as one of the six retained transit options.
- One adjustment was made to the I-270 highway network in 2045, as described in

Table 1 below to account for the State's managed lanes project. Access locations related to the managed lanes project were integrated into the highway network based on the State's Draft Environmental Impact Statement (DEIS); however, access locations may change following coordination with the selected bidder.

Table 1. I-270 and I-495 Coding Assumptions

Model Version	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5
	I-270: Frederick to Clarksburg Rd	**I-270: Clarksburg Rd to I-370**	**I-270: I-370 to Spur**	**I-495 (west side): Spur to ALB Bridge**	**I-495 (east side): Spur to WW Bridge**
MWCOG Model Version 2.3.78	2 HOT lanes each direction	2 HOT lanes each direction + 1 HOV lane in PM peak (I-270 northbound only)	2 HOT lanes each direction + 1 HOV lane each direction (AM southbound; PM northbound)	2 HOT lanes each direction	2 HOT lanes each direction
Corridor Forward Evaluation	Same as above	Same as above	2 HOT lanes each direction (HOV lane is converted to one of the HOT lanes)	Same as above	Same as above

Notes: HOT = high-occupancy toll, HOV = high-occupancy vehicle

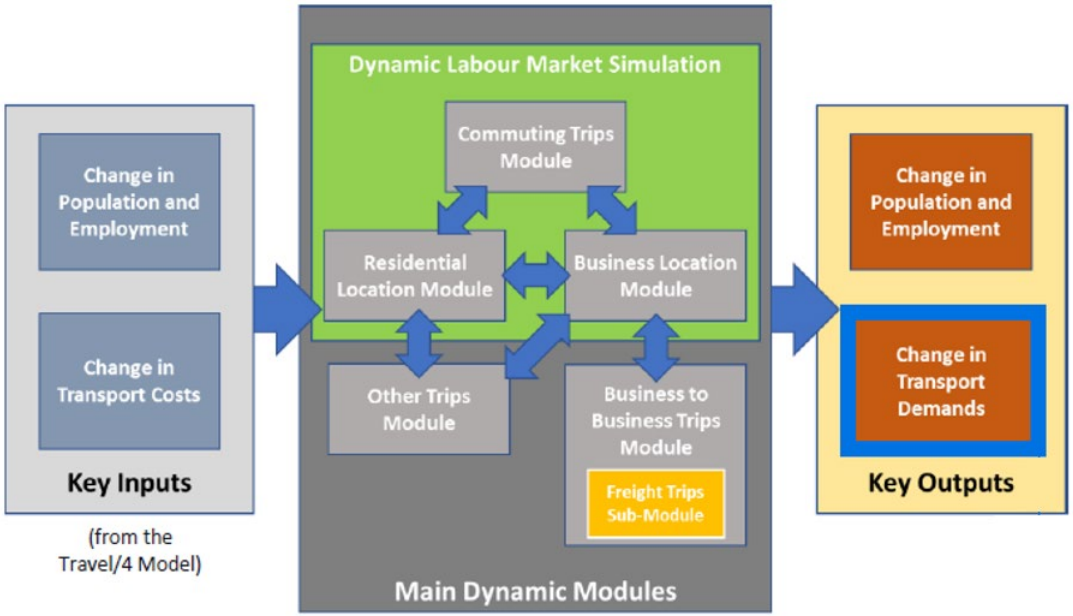
Regional Dynamic Model

Beyond travel demand modeling, the project consultant provided Montgomery Planning access to a dynamic land use model referred to as the Regional Dynamic Model. The model applies system dynamics principles to simulate how changes to generalized travel times between geographic areas can influence both the level of real estate supply and where firms and people choose to locate. The project consultant used this proprietary model to assesses the potential for any studied option to change the distribution of jobs and population in response to attractiveness of the areas for households and businesses. To do this, the model:

- Establishes a 2015 baseline, calibrated with 2015 travel demand model skims from Travel/4 and existing conditions land use patterns;
- Creates a 2045 ceiling across all zones based on Travel/4 regional forecasts;
- Creates a 2045 business as usual scenario—without application of options—for comparison purposes, allowing the build out and allocation of population and employment over time;
- Runs 2045 option scenarios to test the provision of transit, programming an option's opening in within years between the model's run-time span; and
- Observes the comparison of the spatial allocation of jobs and employment between the options scenarios and business-as-usual scenario.

Figure 1 displays a high level overview of the inputs and modules associated with the regional dynamic model. Modeling limitations impact the tool's value—particularly for bus options and for options that traverse larger analysis zones; however, the tool can suggest hypothetical trends that could potentially occur with the provision of a given option. Given that the magnitude of land use reallocation for tested options was minor, one can assume that the cooperative forecast's land use assumptions are reasonable. The model's outputs hint at the location and direction of trends that could be anticipated were an option(s) to be implemented.

Figure 1. Conceptual Overview of the Regional Dynamic Model (source: Steer Group)



Economic and Financial Modeling

The consultant used a two-step approach to calculate financial metrics. First, the consultant developed unit rate cost inputs in coordination with Montgomery Planning. At base, capital costs included rails, guideways, and vehicles. Benchmarks are sourced from the Eno Center for Transportation's Capital Construction Database, local sources like the Corridor Cities Transitway 2017 Environmental Assessment, the Maryland Department of Transportation's 2020 *Monorail Feasibility Study*, and 2018 *MARC Rail Cornerstone Plan.* Operational costs are sourced from the 2019 National Transit Database, maintained by the Federal Transit Administration or local sources like the Corridor Cities Transitway EA. All costs are inflated to 2021 dollars.[1]

Next, the project consultant created financial profiles for each option informed by ridership and revenue inputs from the Travel/4 model, as well as assumptions about the discount rate, inflation rate, and appraisal horizon. Financial outputs include capital estimates, operating estimates, fare revenue, net present value, revenue to cost ratio, net financial impacts, and 2045 revenue to operating cost ratios. The total financial profiling process is shown in Figure 2. The economic dimension employs cost inputs from the financial analysis, with slight variation in discount rate (discussed in the relevant section below).

[1] The Montgomery County Department of Transportation (MCDOT) has requested Planning staff update its capital and operation benchmarking metrics for bus service (presenting costs in ranges) and capital cost benchmarking for Metrorail (using only the Silver Line Phase 1 rather than an average of similar projects, including the Silver Line). More information is provided in the Options' Service and Costing Assumptions section.

Benefits from the Travel/4 travel demand model are monetized and run through a spreadsheet model assessing the value of capital and operating cost impacts over time accounting for societal benefits. The economic modeling process is shown in Figure 3.

Figure 2. Financial Profiling Process

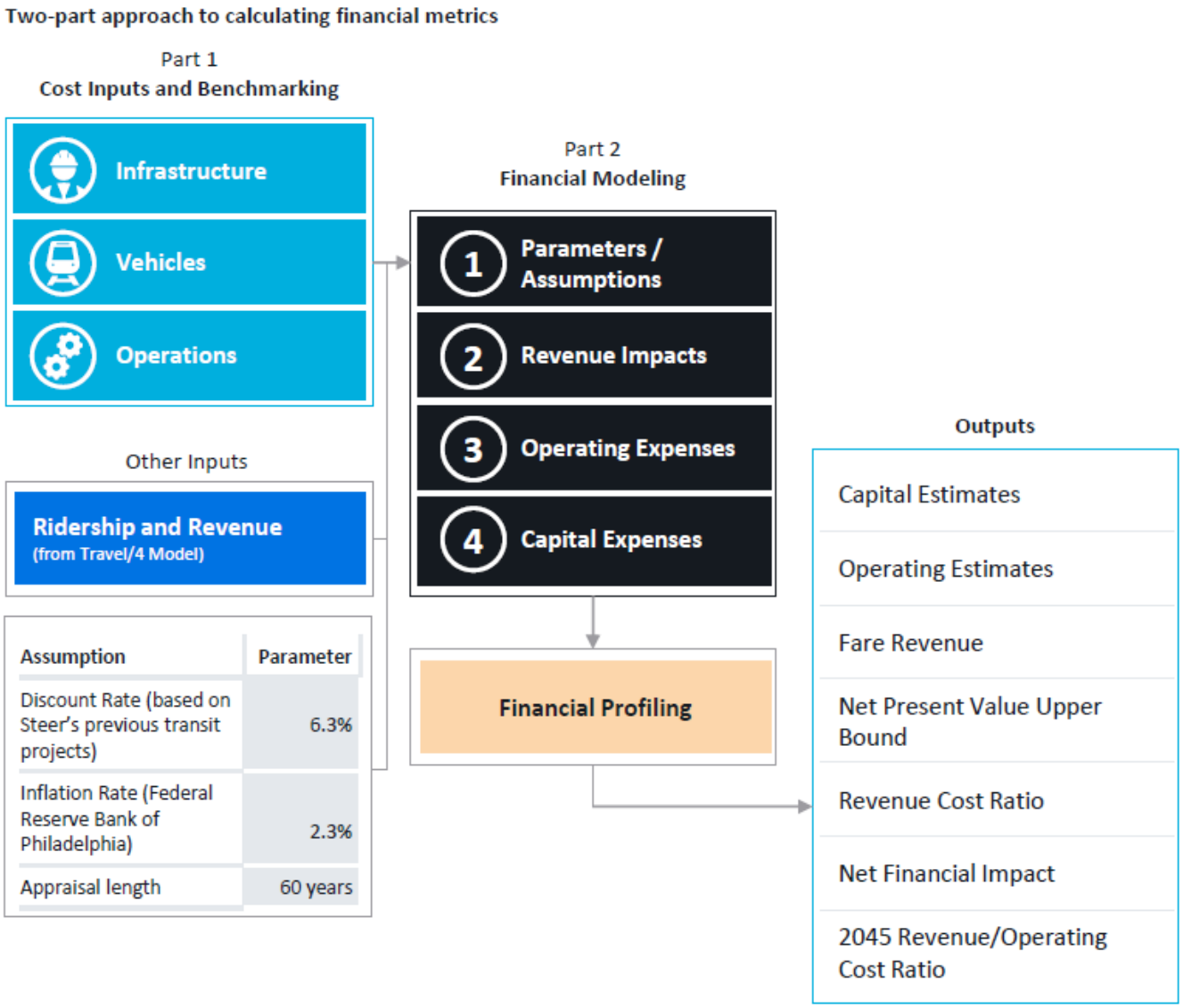
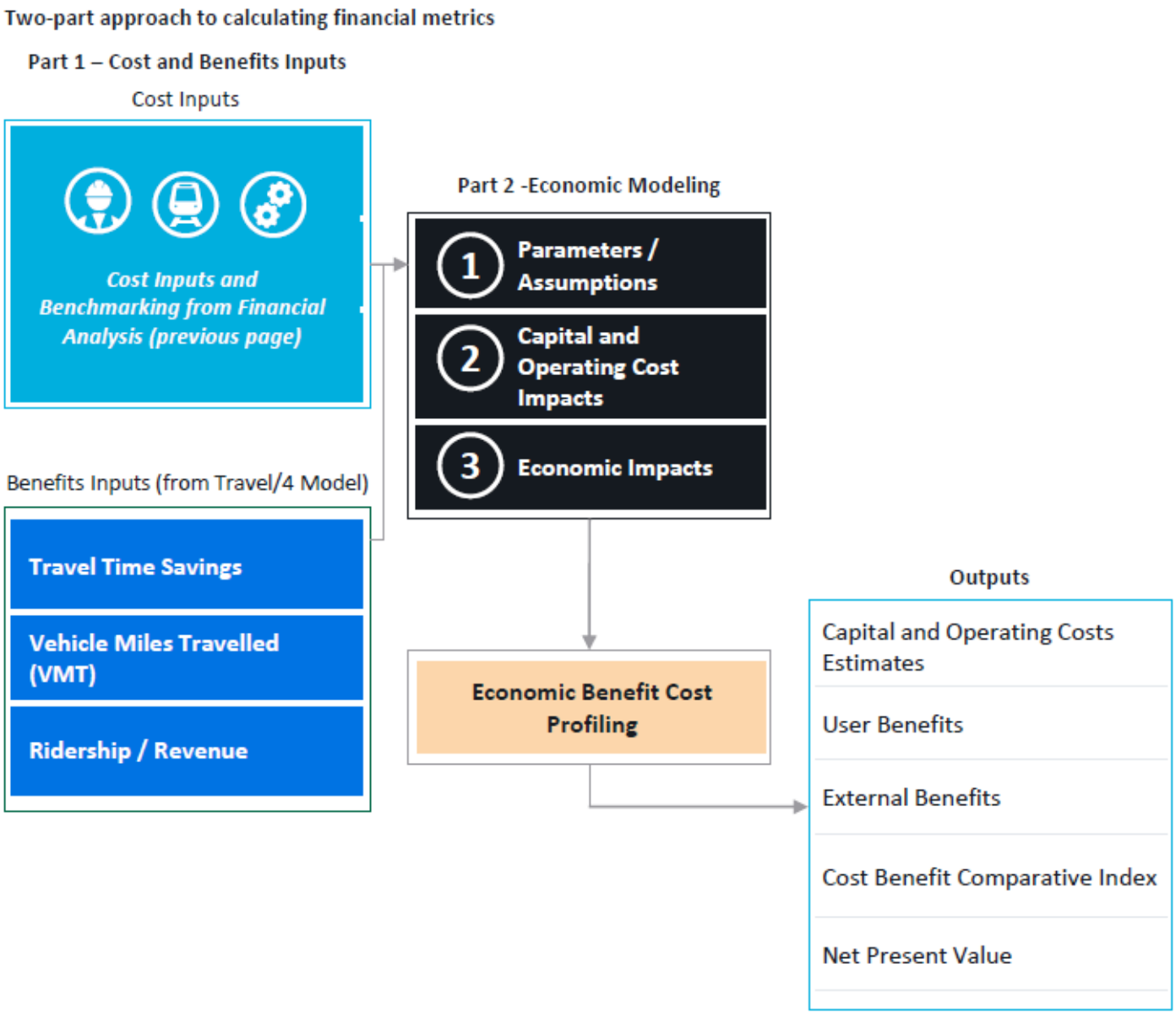


Figure 3. Economic Profiling Process



PERFORMANCE AND METRICS ACROSS EVALUATION DIMENSIONS

Results are reported for each dimension and network package. For more information about the individual options, please see Appendix 2. For mor information about the development of network packages, please see the "Network Evaluation" section of this Appendix.

STRATEGIC DIMENSION

The strategic dimension focuses on non-monetized performance and excludes practical constraints related to implementation. This dimension asks the core question, **"How does the option support county and regional policies, goals, and objectives?"** In this regard, this dimension addresses the Plan's goal, which in turn is derived from three values of *Thrive Montgomery 2050* and a transit specific value added by the project team. The Plan's goal is depicted in Table 2 below:

Table 2. Corridor Forward Goal

Corridor Forward Goal: Advance a transit network that:		
Corridor Forward	**Strategic Connections**	Serves high-demand origin and destination pairs, balancing the costs of implementation with projected benefits.
Thrive Montgomery 2050	**Economic Health**	Enables existing development and master planned communities to realize their potential as livable and economically vibrant places.
	Community Equity	Aligns with the county's social equity goals and principles.
	Environmental Resilience	Operates sustainably and reduces negative environmental impacts.

The project team developed metrics within the strategic dimension that address the four values included in the Plan goal. Table 3 presents the results of the analysis for modeling in the forecast year. Table 4 reports key metrics for modeling in existing conditions (i.e. a 2015 land use and transportation network, demonstrating the assumed "performance floor" of each option). Table 5 describes metrics and the process used to source the outputs of the metrics.

Table 3. Strategic Dimension Performance Outputs for 2045 Modeling

Category	Metric	Business As Usual	Enhanced MARC Rail	Red Line Extension	Corridor Cities Transitway	Purple Line Extension	New Frederick Rail Connection	Managed Lanes Enhanced Commuter Bus	Network Package One	Network Package Two	Network Package Three
Strategic Dimension	Regional transit trips	1.7M	+0.23% (+3.8k)	+0.49% (+8.3k)	+0.44% (+7.4k)	+0.33% (+5.5k)	+0.49% (+8.3k)	+0.55% (+9.3k)	+1.26% (+21.4k)	+1.22% (+20.7k)	+1.02% (+17.3k)
	County Transit Trips	268.4K	+0.74% (+1.9k)	+1.90% (+5.1k)	+2.63% (+7.1k)	+0.57% (+1.5k)	+1.36% (+3.6k)	+2.19% (+5.9k)	+5.68% (+15.3k)	+5.42% (+14.6k)	+3.76% (+10.1k)
	Regional Transit Mode Share	7%	+0.02%	+0.03%	+0.03%	+0.02%	+0.03%	+0.04%	+0.09%	+0.08%	+0.07%
	Montgomery County Transit Mode Share	7%	+0.05%	+0.14%	+0.19%	+0.04%	+0.10%	+0.16%	+0.42%	+0.40%	+0.28%
	Reductions in Daily Vehicle Miles Traveled (VMT)	219M	-0.03% (-73.0k)	-0.07% (-157.4k)	-0.01% (-29.4k)	-0.02% (-44.5k)	-0.07% (-159.4k)	-0.05% (-110.0k)	-0.13% (-283.2k)	-0.13% (-285.0k)	-0.13% (-293.7k)
	Annual Reductions of Crashes Causing Fatalities based on Annual VMT Reductions	576	-0.2	-0.4	-0.08	-0.1	-0.4	-0.3	-0.75	-0.75	-0.77
	Annual Reductions of Crashes Causing Injuries based on Annual VMT Reductions	49.7k	-16.60	-35.78	-6.68	-10.11	-36.24	-25.01	-64.37	-64.78	-66.75
Economic Health	Jobs accessible within 45 minutes on transit	209,629	0.09%	4.62%	1.25%	0.74%	1.63%	2.11%	6.30%	6.19%	5.69%
	Jobs Filled	2,194,065	+0.018% (2,194,453)	+0.101% (2,196,272)	+0.006% (2,194,187)	+0.001% (2,194,086)	-0.004% (2,193,977)	-0.015% (2,193,728)	N/A[1]	N/A[1]	N/A[1]
	Population	3,512,563	+0.003% (3,512,673)	+0.007% (3,512,808)	+0.001% (3,512,592)	+0.001% (3,512,600)	+0.004% (3,512,689)	-0.001% (3,512,529)	N/A[1]	N/A[1]	N/A[1]
Environmental Resilience	CO_2 emissions (grams)	88.3B	-0.03% (-29.5M)	-0.07% (-63.6M)	-0.01% (-11.9M)	-0.02% (-18.0M)	-0.07% (-64.4M)	-0.05% (-44.4M)	-0.13% (-114.4k)	-0.13% (-115.1M)	-0.13% (-118.6k)
Montgomery County Equity	Jobs accessible by MCO Equity Focus Area (EFA) populations in 45 minutes on transit	224,687	0.23%	6.82%	0.95%	-0.53%	1.54%	1.63%	8.14%	8.86%	8.03%

[1]The Regional Dynamic Model was not run for the network packages

Table 4. Strategic Dimension Performance Outputs for Existing Conditions Modeling (Key Metrics Only)

Category	Metric	Business As Usual	Enhanced MARC Rail	Red Line Extension	Corridor Cities Transitway	Purple Line Extension	New Frederick Rail Connection	Managed Lanes Enhanced Commuter Bus
Strategic Dimension	Regional transit trips	1.16M	+0.27% (+3,145)	+0.69% (+8,049)	+0.33% (+3,862)	+0.31% (+3,634)	+0.40% (+4,611)	+0.48% (+5,599)
	County Transit Trips	183.8K	+0.89% (+1,643)	+2.65% (+4,871)	+2.08% (+3,825)	+0.73% (+1,346)	+1.01% (+1,857)	+1.86% (+3,423)
	Regional Transit Mode Share	6.00%	0.02%	0.04%	0.02%	0.02%	0.02%	0.03%
	Montgomery County Transit Mode Share	6.00%	0.05%	0.16%	0.13%	0.04%	0.06%	0.11%
	Reductions in Daily Vehicle Miles Traveled (VMT)	178M	-0.04%	-0.09%	-0.01%	-0.02%	-0.07%	-0.05%

Table 5. Description of Strategic Dimension Metrics

Value	Benefits	Metrics	Source	Estimation Approach
Strategic Connections	• Increased transit trips	• Net new regional transit trips • Net new Montgomery County transit trips • Transit mode share change for Montgomery County • Transit mode share change for region	Travel/4 Model	• Trips extracted from Travel/4 based on in scope TAZs • Mode share based on the proportion of total linked trips that use transit for some or all the trips divided by all trips in region
	• Reduced congestion and automobile related externalities	• Daily VMT • Annualized VMT on number of crashes causing fatalities • Annualized VMT on number of crashes causing injuries	Travel/4 Model	• Extracted from Travel/4 based on trips that change from auto to transit • VMT calculated by multiplying the number of trips by their lengths from their origins to destinations in each time period of a day, then summing all the VMT to a total in a geographical area (region, Montgomery County, and Montgomery County EFAs. • VMTs are fully counted for trips with both origins and destinations in the study area. Only 50% of VMTs are counted if only one end of trip is within the study area. • VMT multiplied by a unit factor for crashes per VMT; rates derived from the National Highway Traffic Safety Administration.
Economic Health	• Increased employment served by investment	• Change in average number of jobs accessible to travelers within 45 minutes on transit across all origin TAZs	Travel/4 Model	• Extracted using M-NCPPC-owned script for average number of jobs accessible
	• Support for regional growth	• Change in population and employment (jobs filled) to account for growth that is reallocated and stimulated to zones adjacent to transit compared to the 2045 BAU	Travel/4 Mode, Regional Dynamic Model and GIS for visualization	• Use of Regional Dynamic Model
Environmental Resilience	• Reduced transportation greenhouse gas emissions and environmental impacts	• Change in VMT, reported as changes in greenhouse gas emissions and local pollutants (CO_2 emissions per mile, hydrocarbons, exhaust carbon monoxide, exhaust nitrogen oxides)	Travel/4 Model	• Change in VMT extracted from Travel/4 is used to estimate reduction in pollution based on emission rates multiplied by the grams of emission/pollutant per VMT
Montgomery County Equity	• Improved EFA access to jobs	• Change in average number of jobs accessible to travelers within 45 minutes on transit from Equity Focus Areas	Travel/4 Model	• Extracted using M-NCPPC-owned script for average number of jobs accessible

FINANCIAL DIMENSION

The financial dimension poses the core question, **"What are the financial impacts of each option?"** It focuses solely on the lifecycle cash flow impacts of delivering the project, which are discounted using a financial discount rate—in this case over a sixty-year horizon. The analysis employs a financial discount rate of 6.4 percent per year and an inflation rate of 2.3 percent per year.[1] The modeling employs the following process:

- The model estimates revenue in 2045 and scales it down to 'opening day' (which varies by option) based on a growth rate derived from the 2015 and 2045 business as usual model runs. Change in revenue is assumed to be equal to an average assumed fare multiplied by the change in a service's ridership. Growth is capped after 15 years of operations (for example, if an option were to being operation in 2025, its growth would be capped in 2055).
- Costs are estimated for each year of the 60-year operating lifecycle as well as an initial capital delivery phase. Renewal costs—costs incurred to replace expired components of the option throughout the analyses 60-year lifecycle—are also included. Table 6 depicts financial metric outputs per option and network. Table 7 provides a description of each metric and its derivation. Initial benchmarking costs (pre-analysis costs) are described in the "Options' Service and Costing Assumptions" section of this appendix.

Table 6. Financial Dimension Performance Outputs

Metric	Enhanced MARC Rail	Red Line Extension	Corridor Cities Transitway	Purple Line Extension	New Frederick Rail Connection	Managed Lanes Enhanced Commuter Bus	Network Package One	Network Package Two	Network Package Three
Capital (millions)[1]	$1,193	$1,423	$894	$1,596	$2,962	$706	$2,540	$2,223	$1,960
Renewals (millions)[1]	$74	$101	$245	$446	$828	$189	$505	$457	$421
Operating (millions)	$360	$170	$490	$282	$862	$990	$1,183	$1,102	$866
Fare Revenue (millions)	$30	$57	$128	$66	$293	$282	$314	$279	$254
Net Present Value (millions)	$-1,596	$-1,637	$-1,500	$-2,257	$-4,358	$-1,604	$-3,915	$-3,502	$-2,994
Revenue / Cost Ratio	0.08	0.33	0.26	0.24	0.34	0.28	0.27	0.25	0.29

[1]The economic and financial dimensions apply different discount rates, resulting in different cost values across the two dimensions

Table 7. Financial Dimension Metrics

Category	Consideration	Description	Source
Costs	Capital and renewal costs	Total costs to deliver option infrastructure and renew it over the 60-year evaluation period	Benchmarking – See Options' Service and Costing Assumptions section of appendix
	Operating costs	Total costs incurred for day-to-day operations and maintenance	Benchmarking – See Options' Service and Costing Assumptions section of appendix
Revenue	Fare revenue	Change in revenue due to the delivery of the new option	Travel/4 Model: change in ridership multiplied by average fare
Financial Indicators	Revenue / operating cost ratio	Illustrates the relative value of incremental revenue to incremental operating costs	Revenue /Operating Costs
	Net present value	Illustrates the value of an investment	Present value of cash inflows less the present value of cash outflows over the life the investment, in this case a sixty-year horizon.

Both the financial and economic dimension analyses build upon capital and operating cost benchmarking. At the time of this writing, Planning staff are working with the Montgomery County Department of Transportation to update cost evaluations for bus and heavy rail. . The initial calculations are based on local and national benchmarks from the Eno Center for Transportation and are sufficiently reasonable for the purposes of the comparative analysis; however, updates will be presented following the initial release of the appendices on November 9, 2021, as an addendum, to provide further detail.

ECONOMIC DIMENSION

The economic dimension asks the core question, "**What are the overall financial impacts of the corridor in economic terms accounting for societal benefits?"** The dimension focuses on the lifecycle benefits and costs of each option over a 60 year period. Like the financial analysis, all benefits and costs are discounted; however, the economic dimension applies a social discount rate of 4.0 percent per year. Note that this discount rate differs from the discount rate applied in the financial analysis. Table 8 depicts economic metric outputs per option and network. Table 9 provides a description of each metric and its derivation.

Table 8. Economic Dimension Performance Outputs

Metric	Enhanced MARC Rail	Red Line Extension	Corridor Cities Transitway	Purple Line Extension	New Frederick Rail Connection[3]	Managed Lanes Enhanced Commuter Bus	Network Package One	Network Package Two	Network Package Three
Capital and Renewal Costs (millions)[1]	$1,250	$1,500	$1,110	$1,990	$3,690	$870	$2,980	$2,620	$2,330
Operating Costs (millions)	$330	$160	$460	$260	$800	$930	$1,110	$1,030	$810
Transit Travel Time Savings (millions)	$180	$590	$330	$200	$470	$560	$1,300	$1,250	$1,140
Auto Travel User Impacts - Operating and Decongestion (millions)	$190	$410	$90	$110	$410	$340	$840	$850	$870
GHG Reductions (millions)	$10	$20	$4[2]	$5[2]	$20	$10	$30	$30	$30
Air Quality Improvements (millions)	$20	$40	$10	$10	$40	$30	$80	$80	$90
Reduced Collisions (millions)	$130	$270	$60	$80	$270	$220	$560	$560	$580
Improved Health (millions)	$10	$20	$20	$10	$20	$30	$60	$60	$50
Cost to Benefit Comparative Indices	0.33	0.81	0.33	0.19	0.27	0.66	0.70	0.78	0.88
Net Present Value (millions)	-$1,056	-$320	-$1,055	-$1,828	-$3,255	-$608	-$1,212	-$814	-$392

[1]The economic and financial dimensions apply different discount rates, resulting in different cost values across the two dimensions

[2]Values are rounded to the nearest million as benefits are less than $10 million

[3]Economic assessment examines monorail as mode for New Frederick Rail Connection as it is assumed to be lower cost than light rail

Table 9. Economic Analysis Assumptions

Considerations	Assumption	Value
Start of appraisal	Start year of appraisal (usually current year)	2021
Appraisal length (in years)	Capital delivery and 60 years of operation	60
Start of operations	Start year of operations	Different for each alternative – See Options Assumptions beginning on page [x]
Length of growth cap period	A cap is usually applied to real inflation. This is length (in years) after start of appraisal.	15 years after opening day for operations
Year growth cap is achieved	Year that growth cap is implemented	2060
Social discount rate	A social discount rate	4.00%
Real inflation rate	Assumed price increase above inflation for cost-related items	1.00%
Ridership Growth rate	Assumed annual growth rate drawn from demand model	1.46%

The general process used to calculate the economic performance of each option follows:

1. Set out operating, capital, and renewal costs for each year of the appraisal, including an initial construction period followed by a 60-year operating period;
2. Extract change in travel time and automobile VMT from the Travel/4 Model for 2015 and 2045;
3. Estimate a growth rate (using VMT and travel time references) between the 2015 and 2045 model runs; apply the rate through to the cap year of 2060;
4. Estimate annual travel time savings and automobile VMT changes for each year in the appraisal period (60 years) using the growth rate assumptions;
5. Monetize change in travel time and VMT for each year using the unit rate factors included in Table 10;
6. Apply a social discount rate starting in 2022 to discount each annual benefit and cost to express each option's performance in real 2021 USD. Each year is discounted by multiplying a given year's performance by the following equation [1/ (1+social discount rate)^(year – 2021)].

Table 10. Economic Analysis Unit Rate Sources

Parameter	Notes	Value in 2021	Unit
Value of Time (VOT)	Personal value of time. **Source page 33/42 of Benefit-Cost Analysis Guidance for Discretionary Grant Programs (US DOT)**	$17.37	2021 USD per person hour
VOT Growth Rate	Source: **page 14/42 of Benefit-Cost Analysis Guidance for Discretionary Grant Programs (US DOT)**	0.00%	Percent change
Increased physical activity (walked)	**page 125/199 of Metrolinx Business Case Manual Volume 2: Guidance**	$1.93	2021 USD per mile walked
Auto operating cost savings	Source: **page 34/42 of Benefit-Cost Analysis Guidance for Discretionary Grant Programs (US DOT) –** used light duty vehicles	$0.45	2021 USD per Mile
Reduced collisions (safety benefits) - injury	Source: **page 32/42 of Benefit-Cost Analysis Guidance for Discretionary Grant Programs (US DOT)** – cost of injury	$2,991,57	2021 USD
Reduced collisions (safety benefits) - death	Source: **page 32/42 of Benefit-Cost Analysis Guidance for Discretionary Grant Programs (US DOT)**– cost of death	$12,710,763	2021 USD
Deaths - Value per VMT		$0.234	2021 USD per auto VMT reduction
Injury - Value per VMT		$0.115	2021 USD per auto VMT reduction
GHG value (CO2)	source: **page 35/42 of Benefit-Cost Analysis Guidance for Discretionary Grant Programs (US DOT)**	$0.021	2021 USD per auto VMT reduction
Direct PM 2.5	Source for emissions per VMT: **Bureau of Transportation Statistics**,value per metric tonne drawn from **page 35/42 of Benefit-Cost Analysis Guidance for Discretionary Grant Programs (US DOT)**	$0.03	2021 USD per auto VMT reduction
NOx		$0.02	2021 USD per auto VMT reduction
Decongestion	Metrolinx Manual Volume 2: Guidance. 2019	$0.104	2021 USD per auto VMT reduction

Regarding initial "Cost to Benefit Comparative Indices": Based on allocated resources for Corridor Forward, the Cost to Benefit Comparative Indices do not include all of the specific criteria and methodologies for cost-benefit analyses prescribed by the Federal Transit Administration (FTA). For example, the FTA analyses methodologies also suggest accounting for additional benefits beyond what is included in the subject planning level analysis, such as property tax revenue increase. These types of analyses are typically completed when a project is advanced further beyond master planning, such as during alternatives analyses or facility planning. Initially, previous staff reports prepared for Planning Board consideration referred to this metric as benefit-to-cost ratio (BCR), but to reduce confusion for those in the industry who expect this metric to include more sophisticated bottom-up engineering estimates and tax revenue growth analyses, this comparative metric is now referred to as a "cost to benefit comparative index."

IMPLEMENTATION DIMENSION

The implementation dimension poses the core question "**What constraints and challenges would need to be accounted for to successfully deliver and operate the transit option?"** This dimension focuses on exploring the overall feasibility of each option in a general high-level manner. While the other dimensions use quantitative inputs, the implementation dimension is primarily a qualitative analysis (with some support from geographic information systems [GIS] to inform understanding). As such, this is a planning-level assessment, that provides an understanding of—at a high-level—general constraints and challenges that could impact the delivery, operation, and success of an option. The implementation dimension considers five different domains. Each of these domains was assigned a low, medium-low, medium, medium-high, and high risk value. Then, based on these combined values, staff applied an overall risk assessment value to each transit option. The five domains are discussed below.

1. **Roles and Responsibilities** – Who are the strategic stakeholders (and/or likely stakeholders) and what would their role be in advancing, delivering, or operating an option? Options with a greater number of stakeholders, fewer jurisdictions, and fewer private interests were deemed less complex and received more favorable score assignments.
2. **Decision-Making** – What is the likely political decision-making process required to advance the project into subsequent stages of development? Options with more direct or well-understood paths of advancement through the political and funding processes were deemed less complex and thus received more favorable score assignments.
3. **Feasibility Assessment** – Describe the infrastructure necessary to support an option. Options with more complex infrastructure needs, such as tunnels or targeted elevation, were deemed more complex and received less favorable score assignments. This domain considers grade crossings, operations and maintenance needs, and at a high-level, right-of-way needs—including air rights. This analysis was informed with a GIS desktop analysis.
4. **Operating Model** – Who would most likely operate this facility? Do they have the capacity to manage operations? Would complex operating agreements be necessary? Options with existing operators and interjurisdictional MOUs and processes that secure support for operations were assigned more favorable scores. Options that do not exist today, or would require new inter-jurisdictional coordination, or potentially a private-sector operating arrangement scored less favorably.
5. **Spatial/External Impacts** – At a high-level and based on spatial analysis, what are the historic, equity, environmental, and utility impacts associated with the project? A desktop GIS analysis informed the score assignments for this domain. Staff placed simple buffers around the options' study alignments and summarized the number of potential impacts for each option.

Table 11 summarizes the implementation dimension's score assignments across each domain.

Table 11. Implementation Dimension Performance Outputs for 2045 Modeling

Metric	Enhanced MARC Rail	Red Line Extension	Corridor Cities Transitway	Purple Line Extension	New Frederick Rail Connection	Managed Lanes Enhanced Commuter Bus
Overall Risk Assessment	**Moderate-High**	**Moderate-High**	**Low-Moderate**	**Moderate-High**	**Moderate**	**Low-Moderate**
Roles & Responsibilities Risk Level	High	High	Low-Moderate	High	Moderate	Moderate
Decision-Making Risk Level	High	High	Moderate	High	Moderate	Low-Moderate
Feasibility Assessment Risk Level	Moderate	High	Moderate	High	Moderate-High	Moderate
Operating Model Risk Level	Low	Low	Low	Moderate	Moderate	Low
Spatial/External Impacts Risk Level	High	Low-Moderate	Low-Moderate	Low-Moderate	Low-Moderate	Low

OPTIONS' SERVICE AND COSTING ASSUMPTIONS

ENHANCED MARC RAIL

Table 12. Enhanced MARC Rail Assumptions Profile

Assumed Opening Year in RDM and Financial Modeling[1]			Total End to End Run Time	
2035			• Pattern A - Brunswick to Union Station, 96 Minutes • Pattern B – Frederick to Union Station Express Service, 105 minutes • Pattern C – Martinsburg to Union Station, 132 minutes	
Tested Alignment	Retains existing alignment of Brunswick Line, with segments of additional mainline track in locations noted in MTA's 2018 *MARC Rail Cornerstone Plan* including segments between the District and Silver Spring, Garrett Park and the Monocacy River, and the entire Frederick Branch (approximately 45.8 miles). Tests three service patterns contemplated by MTA's 2018 *MARC Rail Cornerstone Plan* Adds two additional stations in at Shady Grove Metrorail and White Flint across all three programmed service patterns (shown in Table 13). See Figure 4 for depiction of alignment.			
Frequencies	15 minute peak hour headways for stations served by all three service patterns. See Table 14 and Table 15 for tested frequencies and a hypothetical morning service schedule (supplied to demonstrate how the service could be run).			
	Unit Rate(s)	**Benchmark Source(s)**	**Unit Rate Application**	**Total Estimated Cost[2]**
Capital Costs: Guideway Related Infrastructure	$27.54 million per mile	2018 MTA *MARC Rail Cornerstone Plan* estimates for additional mainline track on Brunswick and Camden lines; 2020 Eno Center for Transportation Capital Construction Database reporting on Denver Regional Transportation District Gold G Line and San Francisco eBART Extension	45.8 miles of guideway and associated infrastructure	$1.3 billion
Capital Costs: Vehicles	$8.87 million per locomotive $5.04 million per rail car	Locomotive: 2015 MTA MARC Rail and 2020 New Jersey Transit locomotive purchases Rail cars: 2011 MTA MARC Rail and 2019 New Jersey Transit rail car purchases.	9 diesel locomotives 39 rail cars	$79.9 million
Operational Costs	$24.87 per revenue mile	2019 National Transit Database, MTA MARC Reporting	856,076 miles of annual revenue service provided by the option	$22.6 million annually

[1] Opening year assumptions do not reflect actual anticipated dates of opening but are required to capture impacts within the model horizon for the comparative assessment and financial modeling. Thus, 2035 is assumed as the opening year of more complex options to allow for ten years of impact, whereas 2030 is assumed as the opening year of bus options.

[2] All costs converted from source year into 2021 dollars. Total costs precede financial and economic dimension analyses, which account for discounting and inflation across a time-horizon.

Figure 4. Enhanced MARC Rail Alignment (Regional Scale)

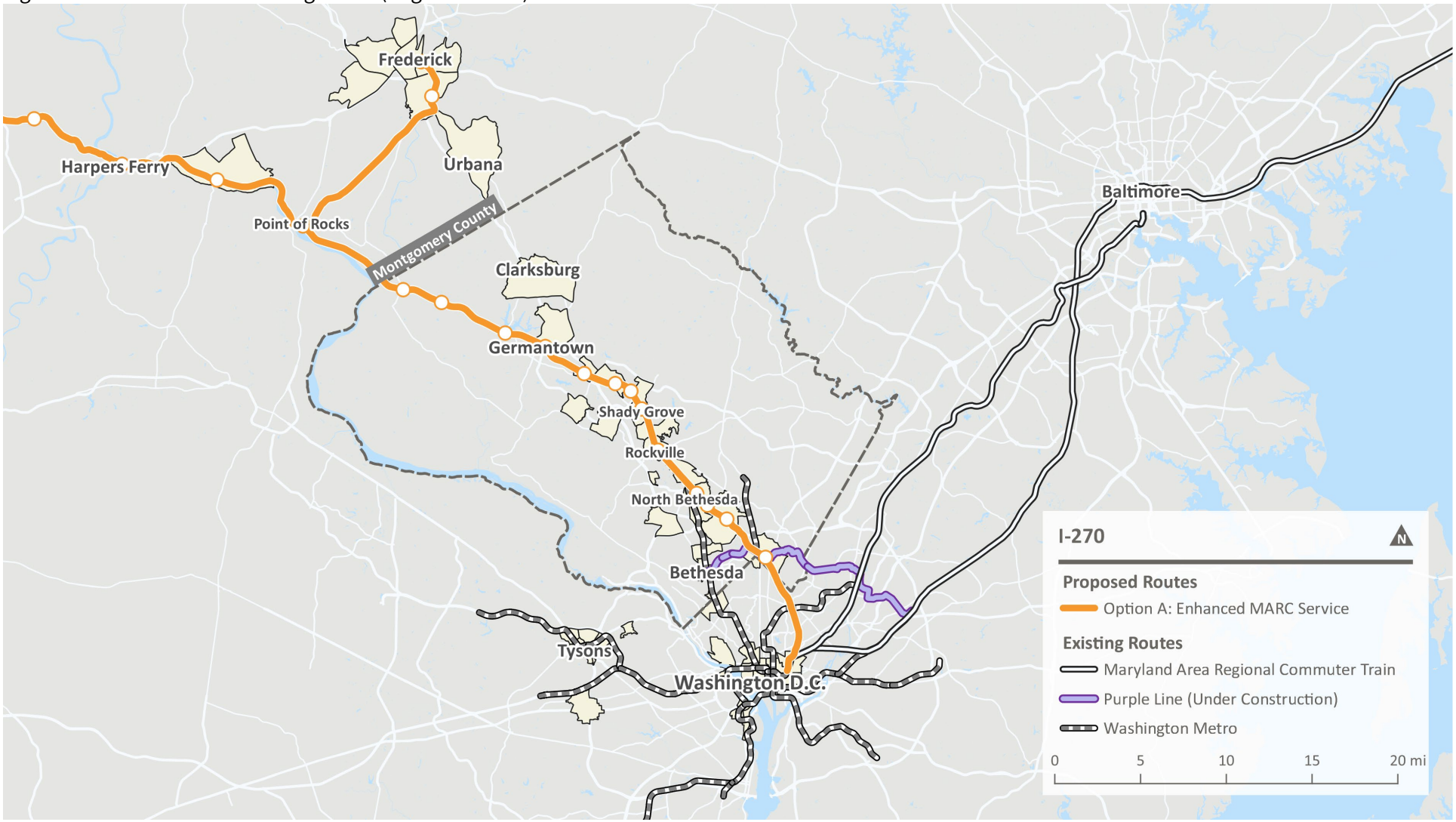


Table 13. Enhanced MARC Rail Tested Service Patterns

Station	Pattern A – Local Service	Pattern B – Frederick Express	Pattern C – Martinsburg Express
Martinsburg			C
Duffields			C
Harpers Ferry			C
Brunswick	A		C
Frederick		B	
Monocacy		B	
Point of Rocks	A	B[1]	C
Dickerson	A		
Barnesville	A		
Boyds	A		
Germantown	A	B	C
Metropolitan Grove	A	B	C
Gaithersburg	A	B	C
Washington Grove	A		
Shady Grove[2]	A	B	C
Rockville	A	B	C
White Flint[2]	A	B	C
Garrett Park	A		
Kensington	A		
Silver Spring	A	B	C
Union Station	A	B	C

[1] Today, the Frederick spur from the Metropolitan Branch Subdivision is south of Point of Rocks. Currently, MARC Brunswick Line service to Frederick cannot serve Point of Rocks; however, per the service patterns shown on MTA's 2018 *MARC Rail Cornerstone Plan*, a connection is envisioned. This Plan assumes this connection is possible for testing purposes.

[2] New stations are assumed at Shady Grove and White Flint for testing purposes as these stations are master-planned today. This Plan assumes that if the state were to make wholesale improvements to MARC mainline track, the investment would be grounds to allow the provision of new stations at master-planned locations, which today is contradictory to CSX Transportation policy.

Table 14. Enhanced MARC and Annual Revenue Miles and Tested Headways

Day	Service Pattern	1-way (miles)	Trips/ day[1]	Days / year	Miles / year	Early AM (5-7am)	AM Peak (7-930am)	Mid-day (930-3pm)	PM Peak (3-7pm)	Evening (7-11pm)	Late Night (11pm-1am)
Mon-Fri	A - Brunswick to Union Station [inbound]	49.6	11	251	136,946	30	30	180	180	-	-
	B - Frederick to Union Station [inbound]	56.6	7	251	99,446	60	60	180	180	-	-
	C - Martinsburg to Union Station [inbound]	74.0	7	251	130,018	60	60	180	180	-	-
	A - Union Station to Brunswick [outbound]	49.6	11	251	136,946	180	180	180	30	-	-
	B - Union Station to Frederick [outbound]	56.6	7	251	99,446	180	180	180	60	-	-
	C - Union Station to Martinsburg [outbound]	74.0	7	251	130,018	180	180	180	60	-	-
Sat	A - Brunswick to Union Station [inbound]	49.6	3	52	7,738	-	-	180	180	-	-
	B - Frederick to Union Station [inbound]	56.6	3	52	8,830	-	-	180	180	-	-
	C - Martinsburg to Union Station [inbound]	74.0	3	52	11,544	-	-	180	180	-	-
	A - Union Station to Brunswick [outbound]	49.6	3	52	7,738	-	-	180	180	-	-
	B - Union Station to Frederick [outbound]	56.6	3	52	8,830	-	-	180	180	-	-
	C - Union Station to Martinsburg [outbound]	74.0	3	52	11,544	-	-	180	180	-	-
Sun & Holiday	A - Brunswick to Union Station [inbound]	49.6	3	62	9,226	-	-	180	180	-	-
	B - Frederick to Union Station [inbound]	56.6	3	62	10,528	-	-	180	180	-	-
	C - Martinsburg to Union Station [inbound]	74.0	3	62	13,764	-	-	180	180	-	-
	A - Union Station to Brunswick [outbound]	49.6	3	62	9,226	-	-	180	180	-	-
	B - Union Station to Frederick [outbound]	56.6	3	62	10,528	-	-	180	180	-	-
	C - Union Station to Martinsburg [outbound]	74.0	3	62	13,764	-	-	180	180	-	-
Totals				365	856,076						

[1]Trips per day are based on the frequencies shown on the right side of the table.

Table 15. Hypothetical Morning Service Schedule (Supplied for Ease of Understanding)

Eastbound (5:00AM – 9:00AM)	**Pattern A**	**Pattern B**	**Pattern A**	**Pattern C**	**Pattern A**	**Pattern B**	**Pattern A**	**Pattern C**	**Pattern A**	**Pattern B**	**Pattern A**	**Pattern C**	**Pattern A**	**Pattern B**
Martinsburg				4:55				5:55				6:55		
Duffields				5:11				6:11				7:11		
Harpers Ferry				5:20				6:20				7:20		
Brunswick	4:50		5:20	5:35	5:50		6:20	6:35	6:50		7:20	7:35	7:50	
Frederick		5:00				6:00				7:00				8:00
Monocacy		5:06				6:06				7:06				8:06
Point of Rocks	5:00	5:21	5:30	5:45	6:00	6:21	6:30	6:45	7:00	7:21	7:30	7:45	8:00	8:21
Dickerson	5:06		5:36		6:06		6:36		7:06		7:36		8:06	
Barnesville	5:11		5:41		6:11		6:41		7:11		7:41		8:11	
Boyds	5:16		5:46		6:16		6:46		7:16		7:46		8:16	
Germantown	5:23	5:42	5:53	6:04	6:23	6:42	6:53	7:04	7:23	7:42	7:53	8:04	8:23	8:42
Metropolitan Grove	5:28	5:47	5:58	6:09	6:28	6:47	6:58	7:09	7:28	7:47	7:58	8:09	8:28	8:47
Gaithersburg	5:34	5:53	6:04	6:15	6:34	6:53	7:04	7:15	7:34	7:53	8:04	8:15	8:34	8:53
Washington Grove	5:37		6:07		6:37		7:07		7:37		8:07		8:37	
Shady Grove	5:39	5:57	6:09	6:19	6:39	6:57	7:09	7:19	7:39	7:57	8:09	8:19	8:39	8:57
Rockville	5:45	6:03	6:15	6:25	6:45	7:03	7:15	7:25	7:45	8:03	8:15	8:25	8:45	9:03
White Flint	5:50	6:08	6:20	6:30	6:50	7:08	7:20	7:30	7:50	8:08	8:20	8:30	8:50	9:08
Garrett Park	5:52		6:22		6:52		7:22		7:52		8:22		8:52	
Kensington	5:56		6:26		6:56		7:26		7:56		8:26		8:56	
Silver Spring	6:07	6:26	6:37	6:48	7:07	7:26	7:37	7:48	8:07	8:26	8:37	8:48	9:07	9:26
Union Station	6:26	6:45	6:56	7:07	7:26	7:45	7:56	8:07	8:26	8:45	8:56	9:07	9:26	9:45

Note: This is representative of what the above service could hypothetically look like in reality and is for informational/demonstration purposes only.

RED LINE EXTENSION

Table 16. Red Line Extension Assumptions Profile

Assumed Opening Year in RDM and Financial Modeling[1]			Total End to End Run Time	
2035			15 minutes between Germantown Town Center and Shady Grove	
Tested Alignment	From its existing terminus in Shady Grove, the tested Red Line Extension option continues at-grade north adjacent to the CSX Transportation-owned Brunswick Line right-of-way, diverting into elevation at MD 118 in Germantown Town Center. The tested extension included stops at Olde Towne Gaithersburg, MD 124/Fairgrounds and Germantown Town Center. Figure 5 depicts the alignment at a regional scale.			
Frequencies	The option retains WMATA Metrorail existing pre-COVID frequencies for testing, as shown in Table 17 below.			
	Unit Rate(s)	**Benchmark Source(s)**	**Unit Rate Application**	**Total Estimated Cost[2]**
Capital Costs: Guideway Related Infrastructure[3]	At-Grade: $220.1 million per mile Elevated: $223.3 million per mile	Benchmarks sourced from Eno Center for Transportation's 2020 Capital Construction Database. At-Grade: Average of three projects including WMATA Silver Line, Phase 1, WMATA Silver Line, Phase 2, and Bay Area Rapid Transit Warm Springs Extension. Elevated: Miami Dade Airport Link Metrorail Extension and Bay Area Transportation Coliseum Oakland Airport Line.	7 miles of at-grade service and .08 miles of elevated service	$1.7 billion
Capital Costs: Vehicles	$2.75 million per 8000 series railcar	2021 WMATA release on contract purchase of Hitachi 8000 series railcars	42 additional rail cars	$115.5 million
Operational Costs	$13.07 per revenue mile	2019 National Transit Database, WMATA Metrorail Reporting	770,297 annual revenue miles	$10.7 million annually

[1] Opening year assumptions do not reflect actual anticipated dates of opening but are required to capture impacts within the model horizon for the comparative assessment and financial modeling. Thus, 2035 is assumed as the opening year of more complex options to allow for ten years of impact, whereas 2030 is assumed as the opening year of bus options.

[2] All costs converted from source year into 2021 dollars. Total costs precede financial and economic dimension analyses, which account for discounting and inflation across a time-horizon.

[3] Following the development of assumptions and cost-modeling, the Montgomery County Department of Transportation has requested Planning staff use only Silver Line Phase 1 as the Red Line Extension's capital cost benchmark with the rationale that it is both an elevated and at-grade running service constructed in local market conditions. While this is true, the Eno Center for Transportation's capital cost database includes costs that cover various inputs, including right-of-way acquisition, grade-crossings, operations and maintenance needs, etc. Increasing the number of benchmarks generalizes the differences of each capital project and works toward the law of averages. Despite this, staff agreed to update the analysis with the requested figure. This Appendix uses the initial reported benchmarks to build cost analyses in the financial and economic dimensions. An addendum to the appendix is forthcoming, which anticipates refinements to the Red Line's capital costs.

Figure 5. Red Line Extension Alignment (Regional Scale)

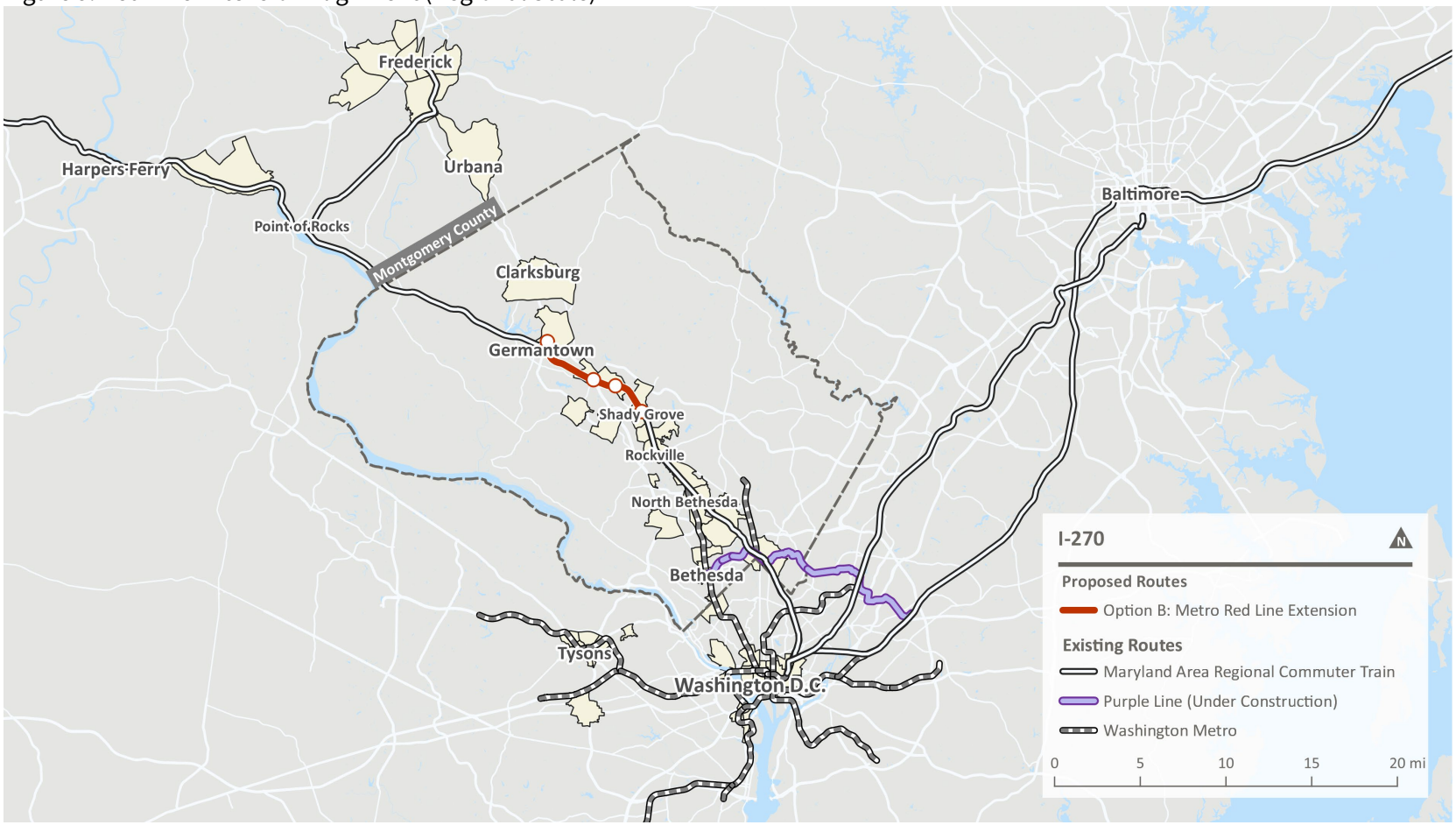
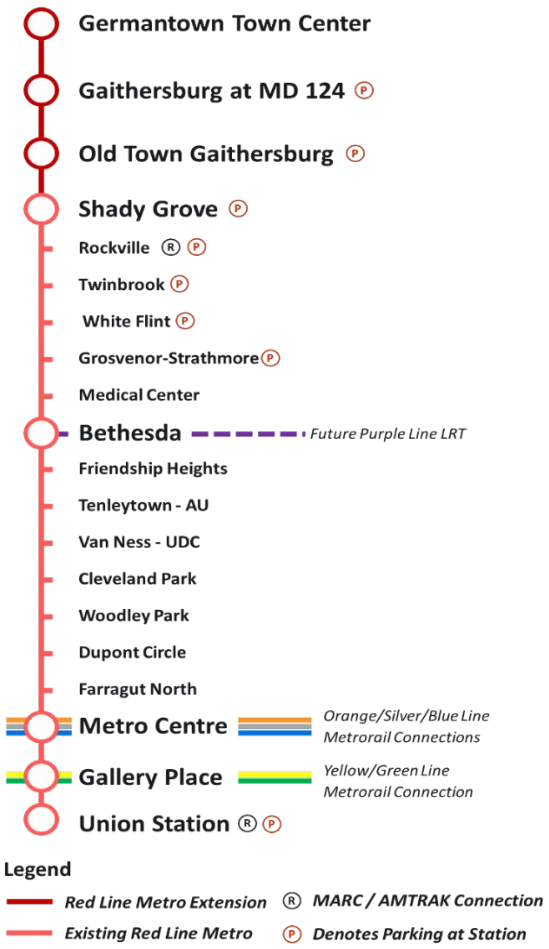


Table 17. Red Line Extension Miles Traveled and Headways

Day	2-way (mile)	Trips /day[1]	Days/year	Miles/year	Early AM (5-7am)	AM Peak (7-930am)	Mid-day (930-3pm)	PM Peak (3-7pm)	Evening (7-11pm)	Late Night (11pm-1am)
Mon - Thurs	15.6	160	201	501,696	6	6	6	6	15	-
Fri	15.6	164	50	127,920	6	6	6	6	15	15
Sat	15.6	84	52	68,141	-	12	12	12	15	15
Sun/Holiday	15.6	75	62	72,540	-	12	12	12	15	-
Total			365	**770,297**						

[1]Trips per day are based on the frequencies shown on the right side of the table.

Figure 6. Red Line Extension Illustrative Service Diagram



CORRIDOR CITIES TRANSITWAY

Table 18. Corridor Cities Transitway Assumptions Profile

Assumed Opening Year in RDM and Financial Modeling[1]			Total End to End Run Time	
2030			69 minutes between Shady Grove and COMSAT	
Tested Alignment	Assumes the 2017 Maryland Transit Administration Environmental Assessment alignment with both phases, including 17 stops between Shady Grove Metrorail and the COMSAT site in Clarksburg.			
Frequencies	Consistent with the 2017 Maryland Transit Administration's Environmental Assessment frequencies at five-minute peak hour headways. See Table 19 for full description of assumed frequencies.			
	Unit Rate(s)	**Benchmark Source(s)**	**Unit Rate Application**	**Total Estimated Cost[2]**
Capital Costs: Guideway Related Infrastructure[3]	$62.26 million per mile	Average of two high-quality BRT services, including Cleveland Ohio's Healthline (less expensive) as reported in the Eno Center for Transportation's 2020 Capital Construction Database and the MTA's 2017 CCT Environmental Assessment (more expensive)	17 miles of at-grade service	$1.1 billion
Capital Costs: Vehicles	$1.08 million per high quality articulated bus	Average of the unit cost from two real purchases made by New Jersey Transit and Metrolink (Toronto) as well as the estimated total cost from the 2017 CCT Environmental Assessment divided by the assumed need of 35 buses.	35 high-quality articulated buses	$37.9 million
Operational Costs[3]	High: $13.93 per revenue mile Low: $6.70 per revenue mile	High: a national average of BRT operation costs reported to the 2019 National Transit Database Low: MCDOT requested operations figure based on the US-29 combined mixed traffic/dedicated bus lane BRT service.	1,692,520 annual revenue miles	High: $25.0 million annually Low: $11.3 million annually

[1] Opening year assumptions do not reflect actual anticipated dates of opening but are required to capture impacts within the model horizon for the comparative assessment and financial modeling. Thus, 2035 is assumed as the opening year of more complex options to allow for ten years of impact, whereas 2030 is assumed as the opening year of bus options.

[2] All costs converted from source year into 2021 dollars. Total costs precede financial and economic dimension analyses, which account for discounting and inflation across a time-horizon.

[3] Following the development of assumptions and cost-modeling, the Montgomery County Department of Transportation has requested Planning staff use lower rates for bus rapid transit capital costs and operations. Staff agreed to update costs for the Managed Lanes Enhanced Commuter Bus option; however, because the CCT has been substantially studied by MTA, the initial rates are retained. Staff notes that if *only* the 2017 EA capital cost rate were used rather than the average of the CCT and the Healthline—staff's approved benchmark—the costs of the CCT would be greater. On the operations side, MCDOT requested the use of $6.70 per revenue mile unit rate (2021 dollars) rather than the 2019 NTD based figure of $13.93 per revenue mile. The requested $6.70 figure is only $0.58 greater than typical local bus service reported to the 2019 NTD. Based on the frequencies assumed by MTA for the CCT and tested for this effort, Planning staff feel the $13.93 rate may be more appropriate but has agreed to provide a range. Note that in 2019, Montgomery County RideOn reported a $9.20 per mile unit rate for local bus operations to the NTD for local bus service suggesting the $6.70 figure may be optimistic. The current Appendix builds its financial analyses off of the high costs as these were the initial reference benchmarks for the project. An addendum to the appendix is forthcoming.

Figure 7. Corridor Cities Transitway Alignment (Regional Scale)

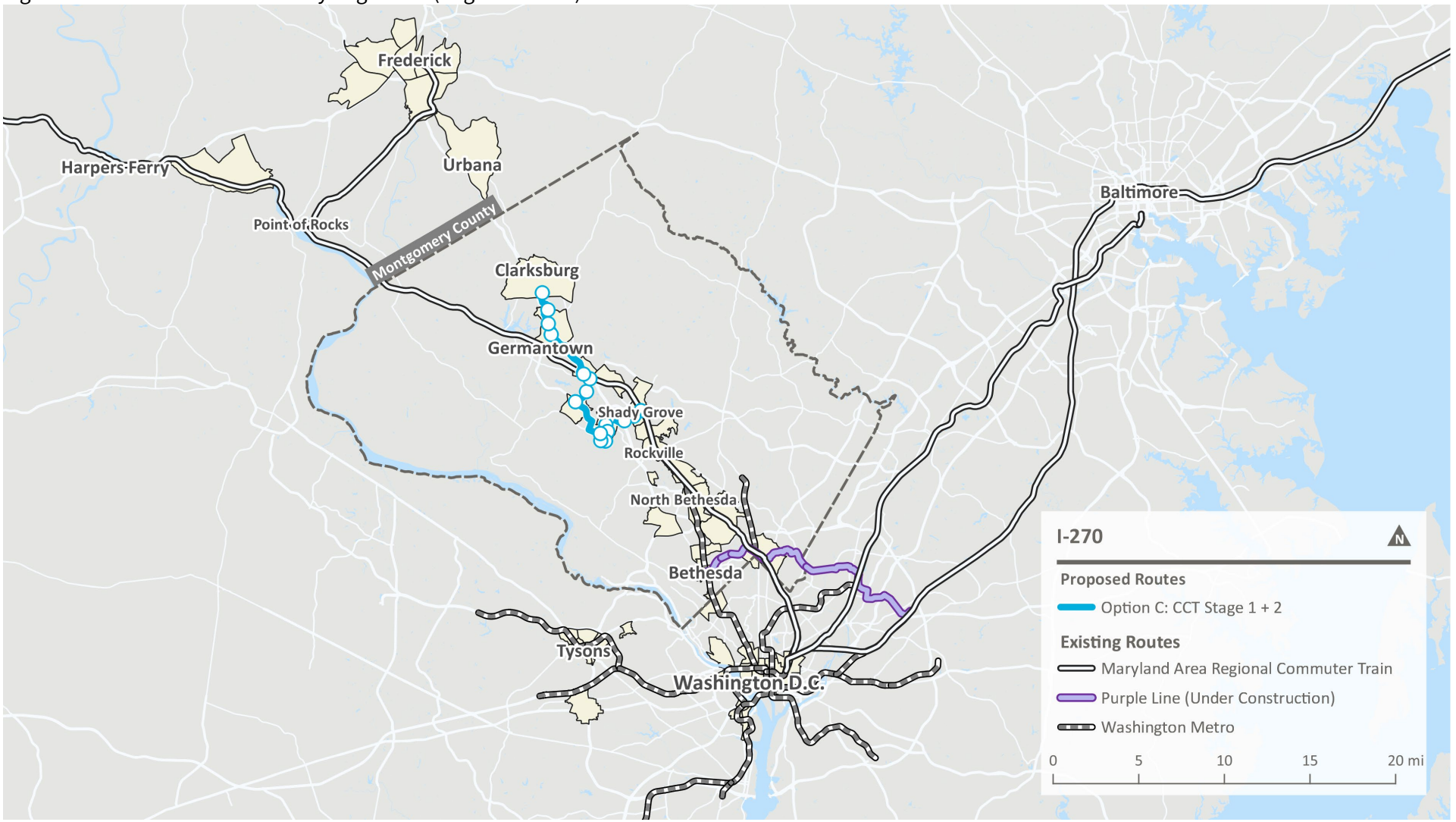
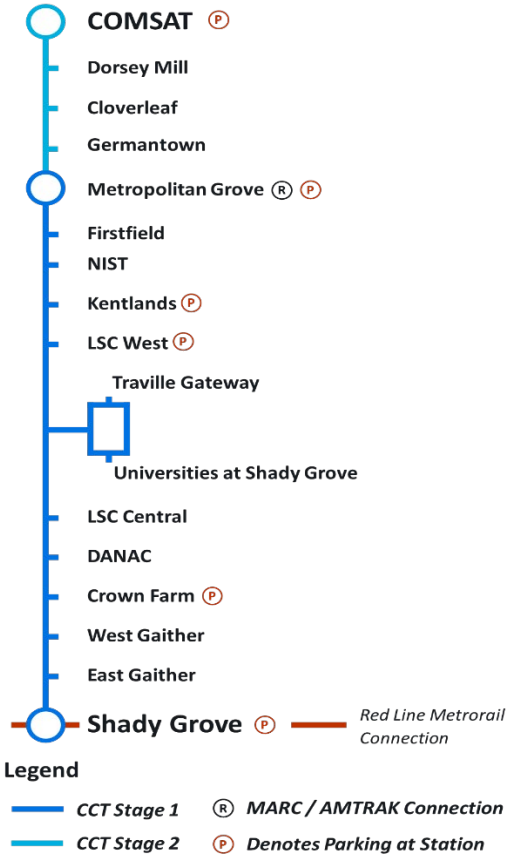


Table 19. Corridor Cities Transitway Miles Traveled and Headways

Day	2-way (mile)	Trips /day[1]	Day /year	Miles/year	Early AM (5-7am)	AM Peak (7-930am)	Mid-day (930-3pm)	PM Peak (3-7pm)	Evening (7-11pm)	Late Night (11pm-1am)
Mon - Thurs	34	156	201	1,066,104	10	5	10	5	10	10
Fri	34	162	50	275,400	10	5	10	5	10	10
Sat	34	96	52	169,728	-	10	10	10	15	15
Sun/Holiday	34	86	62	181,288	-	10	10	10	15	-
Total			365	**1,692,520**						

[1]Trips per day are based on the frequencies shown on the right side of the table.

Figure 8. Corridor Cities Transitway Illustrative Service Diagram



PURPLE LINE EXTENSION

Table 20. Purple Line Extension Assumptions Profile

Assumed Opening Year in RDM and Financial Modeling[1]			Total End to End Run Time	
2035			33 minutes between Bethesda and Tysons	
Tested Alignment	In the westbound direction, the alignment follows the Capital Crescent Trail through Bethesda down to River Road below grade, then elevates to run at-grade along River Road until reaching the highway. Along the highway and into Tysons, the light rail is assumed to be elevated. There are four conceptual stops included in the model of the extension, located at River Road/Little Falls Parkway, River Road and MD-188, McLean Metrorail Station, and Tysons Metrorail Station.			
Frequencies	Assumed to be the same as the under-construction Purple Line. See Table 21 for a description of assumed frequencies.			
	Unit Rate(s)	**Benchmark Source(s)**	**Unit Rate Application**	**Total Estimated Cost[2]**
Capital Costs: Guideway Related Infrastructure	At-grade: $92.35 million per mile Elevated: $202.02 million per mile Tunneled: $410.40 million per mile	An average of systems by grade reported in the Eno Center for Transportation's 2020 Capital Construction Database. At-grade: Link (Sound Transit, WA) Angle Lake Extension, Translink (British Columbia) Millenium Line Sky Train, Montreal REM Phase 1 Elevated: Phoenix (AZ) Valley Metro Gillbert Road Extension, Charlotte, NC Lynx Blue Line Extension, Sacramento Blue Line LRT Extension Ph 2, Minneapolis Metro Green Line LRT Tunneled: Sound Transit U-Link (WA), Milan Line 5 Phase 2 (Milan, Italy)	11.6 miles total: 4.3 at-grade 7.0 elevated 0.3 tunneled	$1.9 billion
Capital Costs: Vehicles	$9.09 million per five-section light rail vehicle	Average of MTA LRV purchase (Purple Line) and Sound Transit Light Rail purchase	14 five-section light rail vehicles	$127.2 million
Operational Costs	$20.71 per revenue mile	National average reported to the 2019 National Transit Database, excluding outliers above the 90th percentile and below the 10th percentile.	805,829 annual revenue miles	$17.7 million annually

[1] Opening year assumptions do not reflect actual anticipated dates of opening but are required to capture impacts within the model horizon for the comparative assessment and financial modeling. Thus, 2035 is assumed as the opening year of more complex options to allow for ten years of impact, whereas 2030 is assumed as the opening year of bus options.

[2] All costs converted from source year into 2021 dollars. Total costs precede financial and economic dimension analyses, which account for discounting and inflation across a time-horizon.

Figure 9. Purple Line Extension Alignment (Regional Scale)

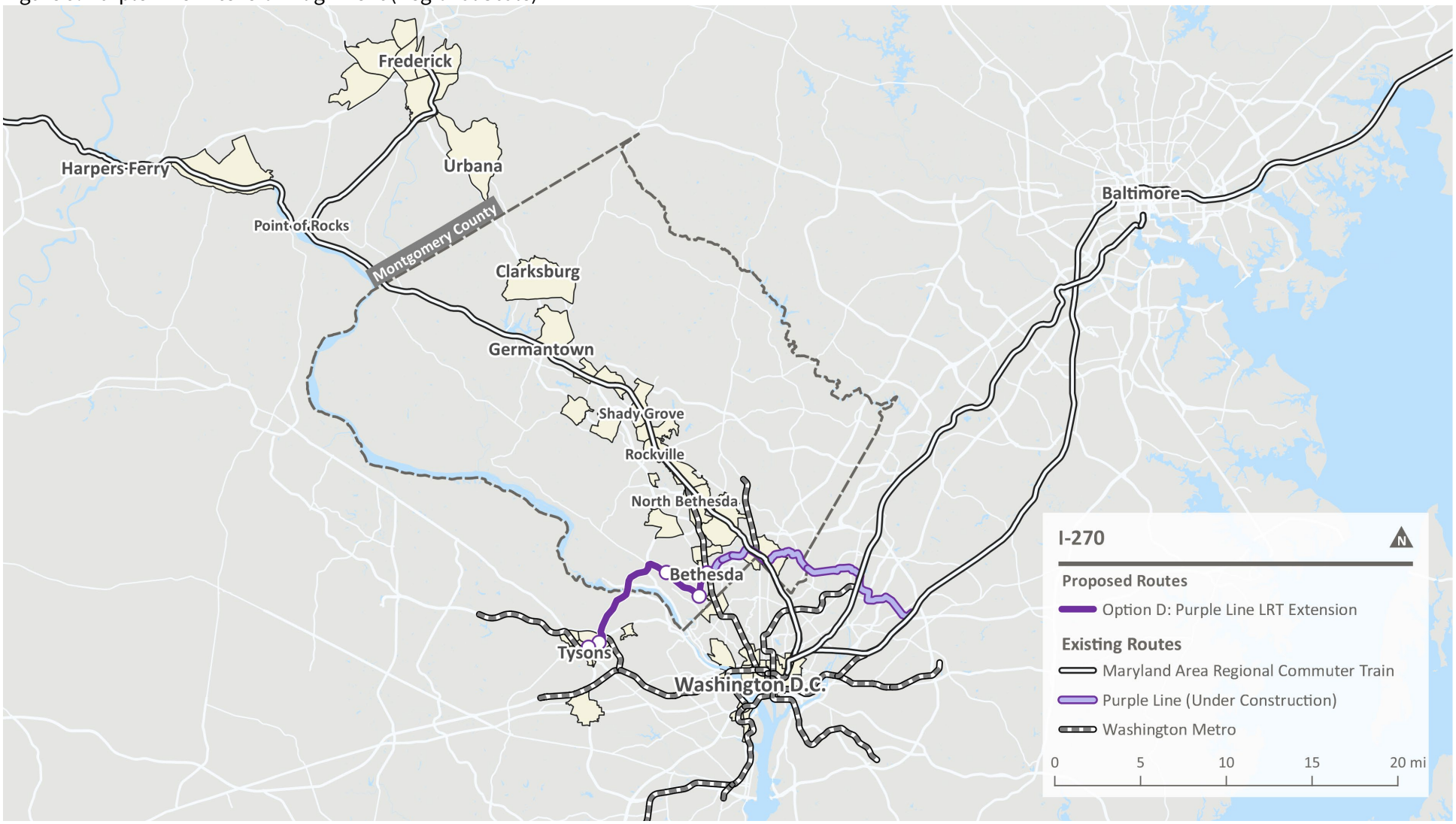
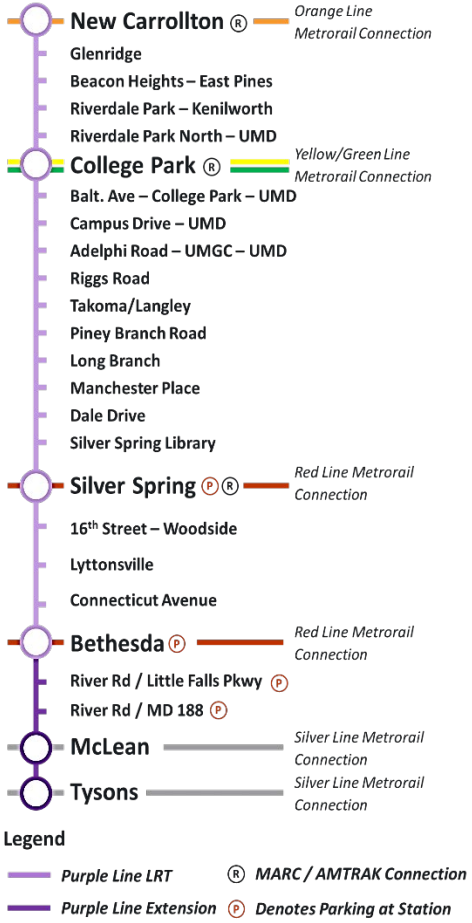


Table 21. Purple Line Extension Miles Traveled and Headways

Day	2-way (mile)	Trips /day[1]	Day /year	Miles /year	Early AM (5-7am)	AM Peak (7-930am)	Mid-day (930-3pm)	PM Peak (3-7pm)	Evening (7-11pm)	Late Night (11pm-1am)
Mon - Thurs	23.2	102	251	593,966	12	6	12	6	12	12
Fri	23.2	85	52	102,544	-	12	12	12	15	15
Sat	23.2	76	62	109,318	-	12	12	12	15	-
Sun/Holiday	23.2	102	251	593,966	12	6	12	6	12	12
Total			365	**805,829**						

[1]Trips per day are based on the frequencies shown on the right side of the table.

Figure 10. Purple Line Extension Illustrative Service Diagram



NEW RAIL CONNECTION TO FREDERICK

Table 22. New Rail Connection to Frederick Assumptions Profile

Assumed Opening Year in RDM and Financial Modeling[14]			Total End to End Run Time	
2035			47 minutes between Downtown Frederick and Shady Grove, as consistent with MDOT's 2020 Monorail Feasibility Study+	
Tested Alignment	The tested alignment is the same as what MDOT assumed in its 2020 Monorail Feasibility Study, which generally follows the alignment of the highway with some service parallel to the CSX Brunswick Line. Stops include Urbana, COMSAT, Germantown, Metropolitan Grove and Shady Grove.			
Frequencies	Frequencies are also consistent with MDOT's 2020 Monorail Feasibility Study. See Table 23 for a full description of frequencies.			
	Unit Rate(s)	**Benchmark Source(s)**	**Unit Rate Application**	**Total Estimated Cost[15]**
Capital Costs: Guideway Related Infrastructure	Monorail, elevated: $130.74 million per mile Light Rail, elevated: $202.02 million per mile	Monorail, elevated: MDOT Monorail Feasibility Study Capital Cost Estimate (excludes vehicles) Light Rail, elevated: Phoenix (AZ) Valley Metro Gillbert Road Extension, Charlotte, NC Lynx Blue Line Extension, Sacramento Blue Line LRT Extension Ph 2, Minneapolis Metro Green Line LRT	27.4 miles (Elevated)	Monorail: $3.5 billion Light Rail: $5.5 billion
Capital Costs: Vehicles	Monorail: $6.40 million per three-section vehicle Light Rail: $9.09 million per five-section light rail vehicle	Monorail: MDOT Monorail Feasibility Study Capital Cost Estimate Light Rail: Average of MTA LRV purchase (Purple Line) and Sound Transit Light Rail purchase	Monorail: 37 three-section vehicles Light Rail: 20 five section vehicles	Monorail: $236.9 million Light Rail: $181.73 million
Operational Costs	Monorail: $18.85 per revenue mile Light Rail: $20.71 per revenue mile	Monorail: Average of two systems that report to 2019 National Transit Database (Seattle and Las Vegas) Light Rail: National average reported to the 2019 National Transit Database, excluding outliers above the 90th percentile and below the 10th percentile.	2,705,914 annual revenue miles	Monorail: $54.1 million Light Rail: $59.4 million

[14] Opening year assumptions do not reflect actual anticipated dates of opening but are required to capture impacts within the model horizon for the comparative assessment and financial modeling. Thus, 2035 is assumed as the opening year of more complex options to allow for ten years of impact, whereas 2030 is assumed as the opening year of bus options.

[15] All costs converted from source year into 2021 dollars. Total costs precede financial and economic dimension analyses, which account for discounting and inflation across a time-horizon.

Figure 11. New Rail Connection to Frederick Alignment (Regional Scale)

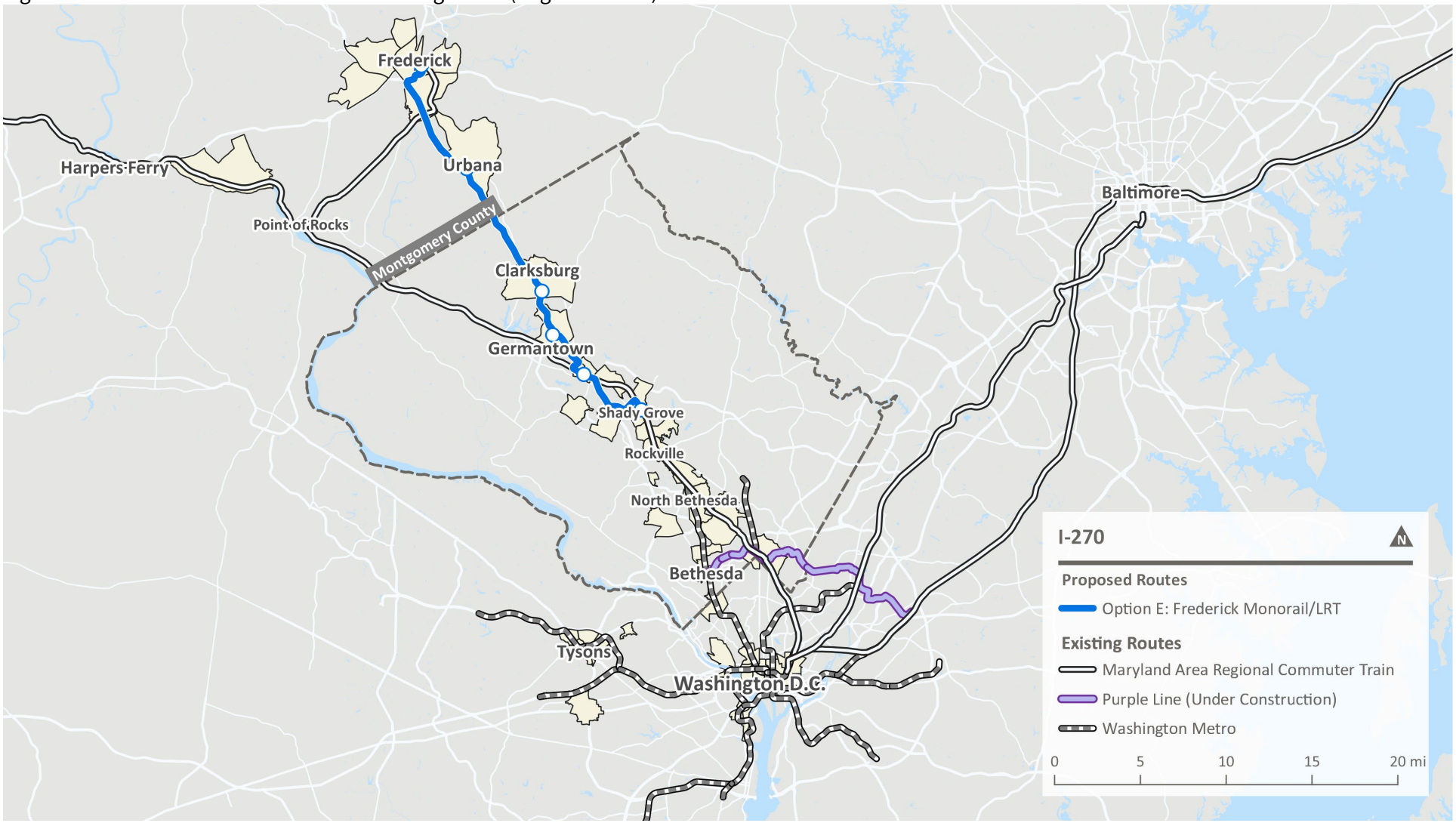
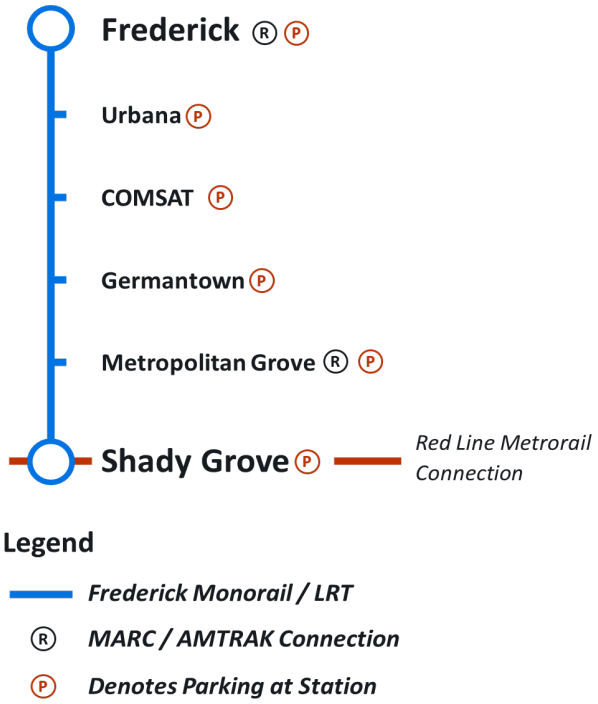


Table 23. New Rail Connection to Frederick Miles Traveled and Headways

Day	2-way (mile)	Trips /day[1]	Day /year	Miles/year	Early AM (5-7am)	AM Peak (7-930am)	Mid-day (930-3pm)	PM Peak (3-7pm)	Evening (7-11pm)	Late Night (11pm-1am)
Mon - Thurs	54.8	160	201	1,762,368	6	6	10	6	10	-
Fri	54.8	164	50	449,360	6	6	10	6	10	15
Sat	54.8	84	52	239,366	-	12	12	12	15	15
Sun/Holiday	54.8	75	62	254,820	-	12	12	12	15	-
Total			365	2,705,914						

[1]Trips per day are based on the frequencies shown on the right side of the table.

Figure 12. New Rail Connection to Frederick Illustrative Service Diagram



MANAGED LANES ENHANCED COMMUTER BUS

Overview: The Enhanced Commuter Bus Option (initially called "Corridor BRT" and sometimes referred to as "Option F") was envisioned to support four different service patterns. The bus primarily runs in the planned managed lanes on I-270 with diversions onto local roads at key locations. A simple diagram of the four tested service patterns follows below in Figure 13. Staff was directed by the Planning Board during briefing #2 to address the needs of the CCT, (which were identified as serving the LSC and connecting Clarksburg and Germantown to the larger transit network) while also accommodating regional needs. This direction was the origin of this option.

The intent of service pattern A is to connect Frederick with the Life Sciences Center. In order to serve communities originally envisioned for CCT service and connect them more efficiently into the LSC, the bus diverts from the highway at Clarksburg Road and travels south on Observation Drive following the master-planned CCT route, including the highway bridge over Dorsey Mill. The bus returns to the highway at Middlebrook Road and diverts off the highway again at Gude Drive to reach the Life Sciences Center.

Service pattern B originates in Germantown at Montgomery College. The bus uses envisioned dedicated bus lanes on MD 118 to connect to the transit center before returning to the highway via the same route. It diverts again at MD 124 to serve Metropolitan Grove, returns to the highway, and then uses I-370 to reach the east side of the Shady Grove Road Metrorail station. The bus then remains off-highway, serving Montgomery College Rockville, Rockville Town Center, and Mt. Vernon Place, and is envisioned to use MD 355 BRT infrastructure to serve these locations. The bus turns into mixed traffic on Wootton Parkway to travel to Park Potomac before re-entering the highway at an assumed interchange on Wootton Parkway. The bus travels south, diverting from the highway to serve Rock Spring and a conceptual stop location at River Road (included for testing purposes only), before traveling into Northern Virginia. Staff solicited input from Fairfax County DOT on ongoing BRT plans, which helped inform routing in Tysons. Service pattern C follows the same routing as B, except that it originates in Montgomery Village, using envisioned dedicated lanes on MD 124. Some doubling back on MD 124 is assumed so connections could be provided to Metropolitan Grove.

Service pattern D is an express service originating in Downtown Frederick with stops at Urbana, Germantown Town Center (with off highway diversions into dedicated lanes on MD 118), Shady Grove Metrorail (via I-370 to the east side of the Metrorail), Rock Spring, a conceptual station at River Road (included for testing purposes only), and Tysons.

Because the option included dedicated bus lanes on Observation Drive as a component of service pattern A, staff altered the MD 355 BRT in the model to have two terminal legs in Clarksburg. Because service pattern A also allowed for a connection between MD 355 and the Life Sciences Center, staff extended the Montgomery College Rockville Veirs Mill BRT CLRP service pattern into the LSC. These decisions were made to maximize the potential of targeted infrastructure.

Following briefing #2, the Planning Board requested that staff de-emphasize this option as master plans typically do not include operational recommendations for things like commuter bus. However, the ultimately proposed network of dedicated bus lanes supports regional commuter bus service by including key connectors at MD 118, MD 124, and Gude Drive/MD 128. These connectors are intended to support local rapid transit service as well.

Table 24. Managed Lanes Enhanced Commuter Bus Assumptions Profile

Assumed Opening Year in RDM and Financial Modeling[16]				Total End to End Run Time
2030				Pattern A – Downtown Frederick to the Life Sciences Center: 70 minutes Pattern B – Montgomery College to Tysons: 79 minutes Pattern C – Montgomery Village to Tysons: 75 minutes Pattern D – Downtown Frederick to Tysons Express: 115 minutes
Tested Alignment	See overview above.			
Frequencies	6-7.5 minute headways during peak hours for locations served by multiple service patterns. See Table 25 and Table 26 for descriptions of frequencies and headways.			
	Unit Rate(s)	**Benchmark Source(s)**	**Unit Rate Application**	**Total Estimated Cost[17]**
Capital Costs: Guideway Related Infrastructure[18]	High: $62.26 million per mile[5] Medium: $40.00 million per mile Low: $6.00 million per mile	High: Average of two high-quality BRT services, including Cleveland Ohio's Healthline (less expensive) as reported in the Eno Center for Transportation's 2020 Capital Construction Database and the MTA's 2017 CCT Environmental Assessment (more expensive) Medium: MCDOT supplied figure for median running BRT Low: MCDOT supplied figure for enhanced local bus	13.2 miles for off-highway infrastructure, excluding costs associated with the managed lanes[19]	High: $819.2 million Medium: $526.3 million Low: $78.9 million
Capital Costs: Vehicles	$1.08 million per high quality articulated bus	Average of the unit cost from two real purchases made by New Jersey Transit and Metrolink (Toronto) as well as the estimated total cost from the 2017 CCT Environmental Assessment divided by the assumed need of 35 buses.	43 high-quality articulated buses	$46.6 million
Operational Costs[3]	High: $13.93 per revenue mile Low: $6.70 per revenue mile	High: a national average of BRT operation costs reported to the 2019 National Transit Database Low: MCDOT requested operations figure based on the US-29 combined mixed traffic/dedicated bus lane BRT service.	3,421,992 annual revenue miles	High: $50.6 million annually Low: $22.9 million annually

[16] Opening year assumptions do not reflect actual anticipated dates of opening but are required to capture impacts within the model horizon for the comparative assessment and financial modeling. Thus, 2035 is assumed as the opening year of more complex options to allow for ten years of impact, whereas 2030 is assumed as the opening year of bus options.

[17] All costs converted from source year into 2021 dollars. Total costs precede financial and economic dimension analyses, which account for discounting and inflation across a time-horizon.

[18] Following the development of assumptions and cost-modeling, the Montgomery County Department of Transportation has requested Planning staff re-evaluate the rates used, and an addendum to this appendix is forthcoming.

[19] 13.2 miles include Snowden Farm Parkway/Stringtown Road; Observation Drive, Seneca Meadows, MD 118, MD 124, and a connection between MD 355 and the Life Sciences Center. Mileage from the original MD 355 BRT alignment on MD 355 is subtracted as the cost is reallocated to Snowden Farm.

Figure 13. Managed Lanes Enhanced Bus Alignment (Regional Scale)

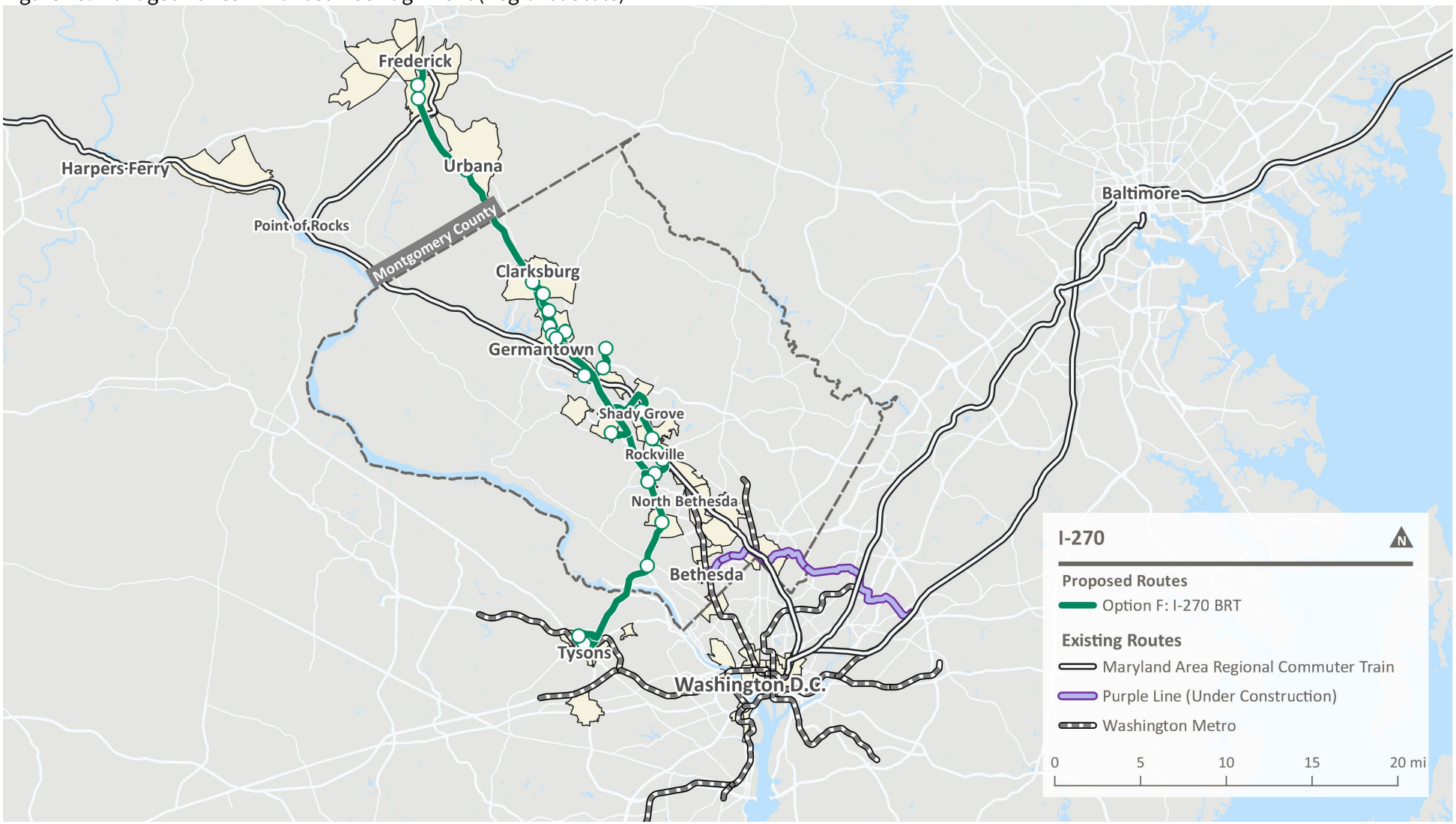


Table 25. Managed Lane Enhanced Commuter Bus Miles Traveled and Headways

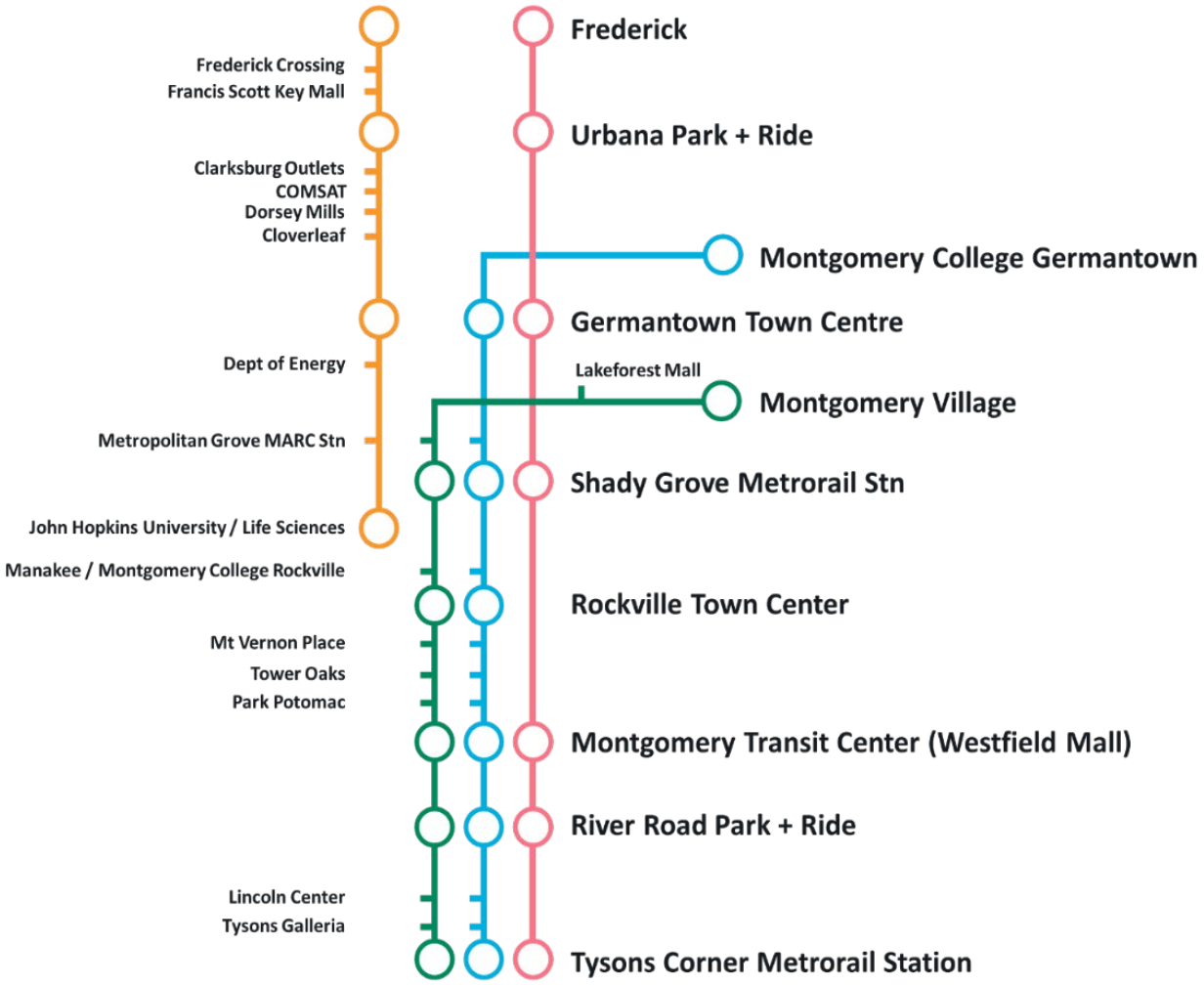
Day	Service Pattern	2-way (mile)	Trips /day[1]	Days /year	Miles/ year	Early AM (5-7am)	AM Peak (7-930am)	Mid-day (930-3pm)	PM Peak (3-7pm)	Evening (7-11pm)	Late Night (11pm-1am)
Mon - Thurs	A - Frederick to Life Sciences Center	57.2	26	201	298,927	60	30	60	30	60	60
	B – Mont. College Germantown to Tysons	64.0	52	201	668,928	30	15	30	15	30	30
	C- Montgomery Village to Tysons	57.8	52	201	604,126	30	15	30	15	30	30
	D - Frederick to Tysons Express	97.8	26	201	511,103	60	30	60	30	60	60
Fri	A - Frederick to Life Sciences Center	57.2	27	50	77,220	60	30	60	30	60	60
	B – Mont. College Germantown to Tysons	64.0	54	50	172,800	30	15	30	15	30	30
	C- Montgomery Village to Tysons	57.8	54	50	156,060	30	15	30	15	30	30
	D - Frederick to Tysons Express	97.8	27	50	132,030	60	30	60	30	60	60
Sat	A - Frederick to Life Sciences Center	57.2	18	52	53,539	-	60	60	60	60	60
	B – Mont. College Germantown to Tysons	64.0	30	52	99,840	-	30	30	30	60	60
	C- Montgomery Village to Tysons	57.8	30	52	90,168	-	30	30	30	60	60
	D - Frederick to Tysons Express	97.8	18	52	91,541	-	60	60	60	60	60
Sun/ Holiday	A - Frederick to Life Sciences Center	57.2	16	62	56,742	-	60	60	60	60	-
	B – Mont. College Germantown to Tysons	64.0	27	62	107,136	-	30	30	30	60	-
	C- Montgomery Village to Tysons	57.8	27	62	96,757	-	30	30	30	60	-
	D - Frederick to Tysons Express	97.8	16	62	97,018	-	60	60	60	60	-
	Total			365	**3,421,992**						

[1]Trips per day are based on the frequencies shown on the right side of the table.

Table 26. Managed Lanes Enhanced Commuter Bus Service Patterns and Headways

Station	Patten A: Downtown Frederick to Life Sciences Center	Pattern B: Montgomery College Germantown to Tysons	Pattern B: Montgomery Village to Tysons	Pattern D: Frederick to Tysons Express	AM Headway (min)	AM Trips / Hr	PM Headway (min)	PM Trips / Hr
Downtown Frederick	A			D	15	4	30	2
Frederick Crossing	A				30	2	60	1
Francis Scott Key Mall	A				30	2	60	1
Urbana Park and Ride	A			D	15	4	30	2
Clarksburg Outlets	A				30	2	60	1
COMSAT	A				30	2	60	1
Dorsey Mills	A				30	2	60	1
Cloverleaf	A				30	2	60	1
Montgomery College Germantown		B			15	4	30	2
Germantown Town Center	A	B		D	7.5	8	15	4
Dept of Energy	A				30	2	60	1
Montgomery Village			C		15	4	30	2
Lakeforest Mall			C		15	4	30	2
Metropolitan Grove Station	A	B	C		6	10	12	5
Shady Grove Metrorail Station		B	C	D	6	10	12	5
Life Science Centre / JHU	A				30	2	60	1
Manakee/Montgomery College Rockville		B	C		7.5	8	15	4
Rockville Town Center		B	C		7.5	8	15	4
Mt Vernon Place		B	C		7.5	8	15	4
Tower Oaks		B	C		7.5	8	15	4
Park Potomac		B	C		7.5	8	15	4
Montgomery Transit Centre (Westfield Mall)		B	C	D	6	10	12	5
River Road Park + Ride		B	C	D	6	10	12	5
Lincoln Centre		B	C		7.5	8	15	4
Tysons Galleria		B	C		7.5	8	15	4
Tysons Metrorail Station		B	C	D	6	10	12	5

Figure 14. Managed Lanes Enhanced Commuter Bus Illustrative Service Diagram



LAND AND RIGHT OF WAY NEEDS

The project team primarily used the Eno Center for Transportation's 2020 Capital Construction Database to source benchmarks for capital construction costs. In some cases, these are supplemented by local resources including Maryland Transit Administration's (MTA) 2018 *MARC Rail Cornerstone Plan*, MTA's 2017 Environmental Assessment for the Corridor Cities Transitway, and the Maryland Department of Transportation's (MDOT) 2020 Monorail Feasibility Study. In many cases, these sources account for right-of-way acquisition, operations and maintenance facilities, as well other capital needs. For example, the Silver Line Phase 1 and 2 benchmarks from Eno, which were used in the initial analysis, include the breakdowns shown in Table 27.

Table 27. Example Capital Cost Allocation within 2020 Capital Construction Database

	Guideway	Stations	Support Facilities	Sitework	Systems	ROW & Land Acquisition	Vehicles	Prof. Services	Contingency/ Finance Charge/ Other
Silver Line Phase 1	23%	13%	3%	9%	11%	2%	7%	31%	0%
Silver Line Phase 2	7%	9%	9%	27%	8%	2%	7%	24%	7%

While the benchmarks used help develop order of magnitude costs for evaluated options, the project team has received questions about right-of-way needs and acquisition costs. The team acknowledges that national benchmarks do not account for variation in land costs and that each benchmark project has its own contextual land acquisition needs. The project team also acknowledges that, per correspondence with the Montgomery County Department of Transportation, the County's own Fiscal Impact Analysis associated with master plans does not account for right-of-way acquisition.

The project team undertook a desktop analysis to develop a high-level assessment of additional land/right-of-way costs associated with the individual options and the Plan's recommended network. The team anticipates updating capital costs identified in with these additional add-ons. Following revisions, this appendix will be updated with new values that account for these costs. As stated above, adding these costs may result in a conservative figure where benchmarks already partially or fully account for land needs.

OPERATIONS AND MAINTENANCE FACILITIES

For the purposes of the Plan's high-level comparative analysis, staff first identified operations and maintenance facility (OMF) needs for each option. The project team acknowledges that there is no clean way of estimating OMF facility needs and that true bottom-up engineering costs would be determined if an option were to advance into facility planning. The project team developed planning-level costs by obtaining tax assessment data from the Maryland State Department of Assessments and Taxation (SDAT), Fairfax County, and using CoStar to assess recent property sales, where relevant and applicable. Table 28 provides the planning-level assumptions and costs associated with OMF facility needs.

Table 28. Operations and Maintenance Facility Land Need Assumptions and Costs

	Enhanced MARC Rail	Red Line Extension	Corridor Cities Transitway	Purple Line Extension	New Frederick Rail Connection	Managed Lanes Enhanced Commuter Bus	Recommended Network
Assumed Land Needs	23 Acres	70 acres	22 acres	9 acres	22 acres	26 acres	Red Line Extension: 70 acres Near-Term Dedicated Bus Lanes: 26 acres
Location	Frederick and Brunswick - Expansion of Existing Yards	Germantown	Gaithersburg - Metropolitan Grove Vicinity	Tysons (Old Courthouse Road/Boone Boulevard Vicinity)	Gaithersburg - Great Seneca Creek Vicinity	Gaithersburg - Metropolitan Grove Vicinity	Red Line Extension: Germantown Near Term Dedicated Bus Lanes: Metropolitan Grove Vicinity
Assumption/ Source	Location: Expansion locations noted in 2018 MARC Rail Cornerstone Plan Size determined by creating a ratio of exiting trainsets to existing OMF acreage and applying the ratio to the new additional vehicle needs	Location: Likely would need to be Dept. of Energy or Montgomery College based on space requirements and existing subdivision patterns Size determined by taking an average of the new Silver Line OMF (95 acres) and the existing Shady Grove OMF (45 acres). Assumes Shady Grove OMF remains operational.	Location and size: 2017 Corridor Cities Transitway EA. Size estimated based on 30 percent drawings and measurement in GIS.	Location determined via high level coordination with partner jurisdiction Size determined by creating a ratio of procured trainsets to under-construction OMF acreage and applying the ratio to the new additional vehicle needs	Location: selected the more expensive of the two options called in 2020 MDOT Monorail Feasibility Study. Size estimated in GIS based on MDOT graphic.	Location: Slight Expansion of 2017 Corridor Cities Transitway EA Location to support additional required vehicles	Combination of both Red Line Extension OMF needs and Managed Lanes Enhanced Commuter Bus Needs
Planning-Level Land Costs for OMF[1]	$19,000,000	$105,000,000	$33,000,000	$36,000,000	$23,000,000	$39,000,000	$144,000,000
Assessment Notes	Assumed agriculture parcel values in Brunswick; in Frederick, adjacent land is a mix of	No recent sales of similar properties. Each hypothetical property is owned by a government	Analysis considered assessed value of land and improvements on all vacant/empty	Multiple sales of properties in this area per CoStar. No property is 9 acres and as such,	All property in proposed location is parkland. No nearby sales of properties	Analysis considered assessed value of land and improvements on all vacant/empty	See notes for Red Line Extension and Managed Lanes Enhanced Commuter Bus.

	industrial and commercial properties. Near to Frederick and on highway.	institution. Assessed value is complicated	properties in location, DOT maintenance facilities, and Montgomery Abandoned Motor Unit property. Due to need to replace facilities, land value increased from $1 million per acre to $1.5 million per acre to be conservative.	consolidation would be required.	render assessed value complicated.	properties in location, DOT maintenance facilities, and Montgomery Abandoned Motor Unit property. Due to need to replace facilities, land value increased from $1 million per acre to $1.5 million per acre to be conservative.	

[1]All costs rounded to the nearest million

RIGHT-OF-WAY AND PROPERTY IMPACTS

Staff undertook an additional analysis to assess land needs associated with the footprint of each option and the recommended network using geographic information systems (GIS), structure imagery, tax data from the State of Maryland and Fairfax County, and CoStar. For bus options, staff created roadway centerlines and created impact areas based on the footprint of options. For at-grade rail options (MARC and the Red Line), staff assumed buffers from the northbound and southbound Brunswick Line tracks—not the property line—based on sourced WMATA engineering specifications. The Red Line impact area assumes 62 additional feet of right-of-way are necessary, as measured from the southbound tracks. The MARC Rail impact area assumes 25 additional feet of right-of-way are necessary, as measured from the northbound track. It is important to note that the existing tracks' distance from CSX Transportation's property line varies (i.e. the tracks are not always completely centered within the private right-of-way).

Table 29. Right-Of-Way and Property Impacts

	Enhanced MARC Rail	Red Line Extension	Corridor Cities Transitway	Purple Line Extension	New Frederick Rail Connection[5]	Managed Lanes Enhanced Commuter Bus[1]	Recommended Network
Structures within impact Area, including structures of value and auxiliary, shed, and garage structures	91 structures	42 structures	33 structures	6 structures	0 structures	24-46 structures[1]	Red Line Extension: 42 structures Recommended Dedicated Bus Lanes: 46 structures[2]
Total Properties Impacted (with and without structure impacts)	300	96	245	82	15	185	Red Line Extension: 96 properties Recommended Dedicated Bus Lanes: 260 properties
Appx. Total of Additional Right-of-Way	20 acres beyond current CSX ROW[3]	21 acres beyond current CSX ROW[3]	114 acres[4]	4 acres, accounting for elevation and tunneling	Appx. 12 acres of air rights on private land; additional easement for columns	48 acres	Red Line Extension: 20 acres beyond current CSX ROW[3] Recommended Dedicated Bus Lanes: 64 acres
Assessed Cost for Additional Right-of-Way and Property/Structure Impacts	$160,000,000	$140,000,000	$39,000,000	$72,000,000	$1,000,000	$16,000,000	$215,000,000

[1]Assumes monorail spacing needs.
[2]For the Enhanced Bus Managed Lanes and Recommended Dedicated Bus Lanes, ranges are reported to account for flexibility in ROW alignment, repurposing, the ability to acquire right-of-way entirely from one side of the road vs. the opposite, etc.
[3]For the MARC option, a 25-foot wide buffer was applied to the northbound track. For WMATA a 62-foot wide buffer from the southbound track; both options assumes use of CSX Transportation's property, which is not accounted for due to the complexity of existing operating agreements between CSX, MTA, and WMATA. This analysis includes land costs only, and use of private ROW is not included as a capital cost.
[4]Includes right-of-way needs for Observation Drive, Observation Drive Extension past Clarksburg Road to Frederick Road per Master Plans, Medical Center Drive Extended (not yet dedicated), ROW through MD Department of Natural Resources Great Seneca Creek area, segments adjacent to the CSX track, and Belward Leg (among other anticipated sliver takings).
[5]Analysis assumes monorail rather than light rail.

Table 30. Total Planning Level Land Costs

Costs	Enhanced MARC Rail	Red Line Extension	Corridor Cities Transitway	Purple Line Extension	New Frederick Rail Connection[5]	Managed Lanes Enhanced Commuter Bus[1]	Recommended Network
Planning-Level Land Costs for OMF	$19,000,000	$105,000,000	$33,000,000	$36,000,000	$23,000,000	$39,000,000	$144,000,000
Assessed Cost for Additional Right-of-Way and Property/Structure Impacts	$160,000,000	$140,000,000	$39,000,000	$72,000,000	$1,000,000	$16,000,000	$215,000,000
Total	**$179,000,000**	**$245,000,000**	**$72,000,000**	**$108,000,000**	**$24,000,000**	**$55,000,000**	**$359,000,000**

Based on the various aspects of capital cost accounted for in utilized benchmarks, the analysis assumes that grade crossings are accounted for in all options (both bus and rail). Of note, the high capital cost benchmark for the CCT—which was included in the initial BRT unit rate developed for the project—includes two grade crossings. Averaging this with a national benchmark—the Cleveland Healthline—reduced the capital cost estimate of the CCT. In other words, this option's capital cost for infrastructure is likely low rather than conservative. Table 31 lists the number of anticipated grade crossings associated with each option, including roadways, environmental features like Seneca Creek, and assumed pedestrian overpasses/underpasses.

Table 31. Anticipated Grade Crossings

	Enhanced MARC Rail	Red Line Extension	Corridor Cities Transitway	Purple Line Extension[1]	New Frederick Rail Connection[1]	Managed Lanes Enhanced Commuter Bus	Recommended Network
Approximate Number Grade Crossings	78	16	2	N/A[1]	Assumed to be entirely elevated	N/A[1]	Red Line Extension: 16 Recommended Dedicated Bus Lanes: 0

[1]Aside from the Purple Line Extension's at-grade segment assumed along River Road, the Purple Line and New Frederick Rail Connections generally run in elevation or are tunneled and are excluded from this table.

NETWORK EVALUATION

Following options analysis, the project team developed a series of network packages for Travel/4 travel demand modeling to better understand how selected transit options—or components of selected transit options—would perform as a larger network. Selected options were retained for inclusion in the network packages based on performance and policy direction.

- **Enhanced MARC Rail**: This option was not advanced into the network package evaluation. While MARC Rail's Brunswick Line service provides an important service, the additional resources necessary to obtain the additional main line track were not warranted based on performance, as compared with other options. Additionally, Montgomery Planning has only modest plans to grow densities near existing stations beyond mid-county. The Plan recommends continuing to absorb right-of-way for MARC expansion if and when possible, but de-emphasizes this option.

- **Red Line Extension:** While up-front costs are resource intensive and the option is challenging to implement, the Red Line Extension option performed well—relative to other options—at increasing regional and county trips. It also performed well at reducing VMT and is forecast to remove more VMT from roadways than the under-construction Purple Line between Bethesda and New Carrollton. The option is also forecast to increase the average number of jobs accessible for EFAs by over six percent and would be one of the less expensive options to operate. The option was retained for further evaluation.

- **Corridor Cities Transitway:** The Corridor Cities Transitway has been promised to Mid-county and Upcounty communities for decades. The transitway performed well in the 2045 forecast year and, relative to other options, is projected to add the greatest number of county transit trips (although regional benefits are more limited). However, its performance is dependent on the high frequency service programmed into the model. Existing conditions modeling work projected more limited gains were this option to be implemented today, which suggests the option's future performance in 2045 is dependent on realizing forecasted growth. Per the project's dynamic land use modeling, this appears reasonable. While the option is not without risk and had a relatively poor benefit to cost comparative index value, it was retained for further evaluation in the network package scenarios.

- **Purple Line Extension:** Based on cost, performance, and the sheer number of alignment alternatives that could be considered for a Purple Line Extension (beyond what was studied by Corridor Forward), the Purple Line was not retained for further evaluation in the network package scenarios. The Plan recommends that further study of travel demand is necessary to determine if and to where an extension may be warranted.

- **New Rail Connection to Frederick:** There is significant merit to developing a more direct rail connection between Downtown Frederick and Montgomery County's rapid transit network. The option reduced the greatest number of daily VMT, edging out the Red Line, but the majority of the daily reduced VMT are from trips that originate in Frederick. While the Red Line and the New Rail Connection to Frederick generate approximately the same number of new regional transit trips, the Red Line Extension generated a greater share of Montgomery County transit trips. Considering initial costs were excessive despite minimal right-of-way acquisition costs (assuming a monorail mode), the option was not advanced. The Plan recommends county support of a more direct transit connection with Frederick, but suggests that it would be more appropriate for other jurisdictions to champion such a project.

- **Managed Lanes Enhanced Commuter Bus:** This option performed well, generating the greatest number of regional and county transit trips across all options—likely because of the long geographic span of service and high service frequencies assumed. However, VMT reductions lag behind the Red Line Extension and the New Rail Connection to Frederick. Based on the implementation analysis, it is likely easier to implement this option—assuming the managed lanes project advances. This option had the second highest cost benefit comparative index value, following the Red Line Extension.

Beyond the evaluation, policy also shaped the network packages. The Planning Board directed staff to consider the value of and alternatives to the CCT following the second board briefing on December 12, 2020. Following a public meeting in the summer of 2021, Council sent a memorandum, dated July 23, 2021, to Montgomery County Department of Transportation Director Chris Conklin requesting MCDOT work to consider how new transit routes can take

advantage of the managed lanes. The memorandum requests MCDOT to directly coordinate with Montgomery Planning on Option F (now referred to in the Plan and appendices as the "Managed Lanes Enhanced Commuter Bus" option).

In summary, based on performance and policy, staff retained the Red Line Extension and components of the CCT and Managed Lanes Enhanced Commuter Bus options in all network packages for further evaluation. Because staff anticipated questions about the feasibility of the Red Line Extension, each network package was also modeled *without* the Red Line Extension. Results, detailed under the "Recommended Package Without the Red Line" section demonstrate why pursuit of the Red Line Extension remains crucial despite implementation challenges.

Table 32 below describes the evaluated network packages. These packages fulfill both local and regional needs. The Red Line Extension and Managed Lanes Enhanced Commuter Bus option both generated regional and county transit trips. Both options connect to more locally-oriented rapid transit infrastructure, either the master-planned CCT or refined variants:

- Network package one includes the master-planned CCT.
- Network package two re-envisions service to CCT communities by connecting Observation Drive with the MD 355 BRT, programming it and Snowden Farm Parkway in the model as alternating terminal service legs of the MD 355 BRT, and realigning Phase 1 of the CCT to Gude Drive in the south and Montgomery Village in the north. Staff reprogrammed the Veirs Mill BRT in the model, pulling it up along MD 355 and through to the Life Sciences Center on Gude Drive. The modeled service ultimately traverses around the Great Seneca vicinity—serving stop locations proximate to locations originally envisioned for CCT service—and terminates in Montgomery Village.
- Network Package Three provides more modest local rapid transit enhancements. The Life Sciences Center is served by extending the Veirs Mill Transitway via MD 355 BRT infrastructure and additional infrastructure on Gude Drive and connecting roadways. Observation Drive is added as an additional terminal leg of the MD 355 BRT. Because local transit infrastructure is reduced, this network scenario added an additional commuter bus line (service pattern A) between Frederick and the Life Sciences Center beyond the two service patterns provided in network packages one and two.

All packages consolidate Red Line Extension Service, MARC Rail service (formerly at Metropolitan Grove), and rapid transit stops into one node at MD 124/Fairgrounds.

Table 32. Description of Network Packages[1, 2, 3]

Description	Network Package 1	Network Package 2	Network Package 3
Red Line Extension to Germantown	Included	Included	Included
Corridor Cities Tranistway/Mid-County and Upcounty BRT Transit	Includes with the CCT's Master-Planned Alignment	Phase II of the Master-Planned CCT removed; Observation Drive added as a terminal leg of the MD 355 BRT; Phase I of the Master-Planned CCT realigned to connect to Veirs Mill BRT and Montgomery Village. Both grade crossings are eliminated.	Observation Drive added as a terminal leg of the MD 355 BRT; dedicated bus lanes also added to connect the Life Sciences Center to Rockville and the Veirs Mill BRT.
Managed Lanes Enhanced Commuter Bus	Frederick – Tysons Express Service Pattern (D) Montgomery Village – Tysons Service Pattern (C)	Frederick – Tysons Express Service Pattern (D) Montgomery Village – Tysons Service Pattern (C)	Frederick – Tysons Express Service Pattern (D) Montgomery Village – Tysons Service Pattern (C) Frederick – Life Sciences Service Pattern (A)

[1]The Network Package analysis removes the originally tested stop at River Road.
[2]The Network Package analysis does not include an evaluation of the Manekin West Connector, which is ultimately included in recommended network package.
[3]The Network Package analysis was undertaken for the forecast year only—existing conditions modeling outputs are not available for the network packages.

Results of network package modeling can be found in the description of each performance dimension, see Table 3 Table 6 and Table 8.

Network package performance is generally comparable across network packages 1 and 2, with package 1 performing well generally, and package 2 providing greater benefits to equity focus communities. While the network packages were not modeled in existing conditions, results from the initial analysis suggests that the performance of the CCT in 2045 is predicated on the county achieving is forecasted land use growth, whereas network package 2 better integrates service to existing communities in addition to serving CCT communities. From a cost perspective, network package three offered the best value for resources expended based its cost benefit comparative index, with network package two offering the second best comparative index. From an implementation perspective neither network package 2 nor 3 require new interchanges over the I-270 at Dorsey Mill Road and Fields Road/King Farm Boulevard. These two networks also use MD 355 infrastructure as a north-south spine rather than create a north-south parallel roadway on the west side of the highway that is not programmed with stops. Network package two makes use of the CCT's original concept design drawings (30-35 percent drawings) by retaining infrastructure along some segments of the originally planned CCT alignment. Network package 2 best served equity focus communities by improving local and regional transit access to Montgomery Village, and by creating the potential for a one-seat ride between the Life Sciences Center and EFAs like Wheaton and Twinbrook via Rockville Town Center.

RECOMMENDED NETWORK RATIONALE

The recommended network is not fully reflective of any of the modeled options or packages; however, its infrastructure most closely aligns with Network Package 2. During its July briefing, the Planning Board directed staff to de-emphasize highway running bus service. In order to comply with this direction and still support the potential for efficient off-highway diversions to points of demand as well as support the primary purpose of enhancing local connectivity, the Plan recommends a series of dedicated bus lanes infrastructure, referred to in the Plan as Corridor Connectors, that can be programmed with a number of different service patterns. Table 33 details the difference between service and infrastructure.

Table 33. Infrastructure and Service

Dedicated Transit Lane Infrastructure	Transit Service Patterns
• **Definition:** The physical components of a transit system, including dedicated or separated bus lanes, express bus lanes, and queue jumps. • **Responsible Agency:** Montgomery Planning master-plans right-of-way widths to ensure infrastructure accommodates transit, as well as other modes. • **How it is Planned:** Montgomery Planning considers existing and planned population and employment density, equity needs, the potential to stimulate economic development, and environmental benefits. Montgomery Planning plans infrastructure to support existing and future quality of life.	• **Definition:** How buses are routed and scheduled to use provided infrastructure. • **Responsible Agencies:** MCDOT and/or MTA develop and implement service patterns • **How it is Planned:** The agencies above develop service patterns that account for anticipated demand at the time of implementation, operational costs of services, and the opportunities and constraints of existing infrastructure.

The Germantown, Lakeforest & Montgomery Village, and Life Sciences connectors proposed in the Plan each support commuter bus service and local rapid transit service. Enhanced commuter bus service running in the managed lanes can divert from the highway into dedicated lanes on these connectors to reach points of local demand. When paired with additional north-south connectors (Manekin West Connector, Milestone/COMSAT East Clarksburg Connector, and Great Seneca Connector) the numerous service patterns could be considered, including but not limited to:

- An extension of the Veirs Mill BRT into the Life Sciences Center
- MD 355 BRT service patterns with differing northern termini in the vicinities of Manekin, COMSAT, and the outlets via Snowden Farm
- An extension of the Veirs Mill BRT to Kentlands
- A one-seat ride connection between the Life Sciences Center and Montgomery Village
- A one-seat ride connection between the Clarksburg Outlets and the Life Sciences Center

The proposed infrastructure network offers the greatest potential to reduce implementation costs for service to CCT communities by removing grade separated interchanges, offers better value for money as compared to the original CCT by proposing dedicated bus lane infrastructure that can serve multiple purposes, and offers the strongest transit links to EFAs by better integrating Montgomery Village into the larger rapid transit network and by creating the potential for a one seat ride to the Life Sciences Center from points south in Twinbrook and Wheaton.

NETWORK PACKAGES WITHOUT THE RED LINE

Through the individual option analysis, the Red Line extension demonstrated high benefits relative to the other options, but also high costs. As the Red Line extension was incorporated into the network package analysis, questions remained both about its feasibility and the potential benefits of the proposed transit network should the Red Line extension not be implemented. As a result, a complementary analysis was conducted to evaluate the benefits of the network packages without inclusion of the Red Line extension. The proposed transit network is a combination of Network Package 2 and Network Package 3, with minor additions based on policy direction.

The number of new transit trips in the region is a key metric applied to evaluate the individual transit options and network packages. In 2045, total network packages would generate between approximately 17,000 and 21,000 new daily transit trips. The supplemental analysis reveals that a significant portion of the new daily transit trips are dependent on the Red Line extension. Without the Red Line extension, the number of new transit riders would fall from by 43% (Network Package 1) to 59% (Network Package 3).

Table 34. New Transit Trips with and without the Red Line Extension (2045)

New Transit Trips	Network Package 1	Network Package 2	Network Package 3
Total Network Package	21,362	20,656	17,283
Network Package without the Red Line	12,131	11,350	7,109
Difference	9,231	9,306	10,174

Like new transit trips, vehicle miles traveled (VMT) is a metric used to evaluate the individual transit options and network packages. In 2045, the total network packages would reduce daily VMT by approximately 283,000 to 294,000 miles. The supplemental analysis reveals that a significant portion of the VMT reduction is dependent on the Red Line extension. Without the Red Line extension, the daily VMT reduction would fall by 65% (Network Packages 1 and 2) to 70% (Network Package 3).

Table 35. VMT Reductions with and without the Red Line Extension (2045)

VMT Reductions	Network Package 1	Network Package 2	Network Package 3
Total Network Package	283,196	284,997	293,670
Network Package without the Red Line	98,328	100,398	88,748
Difference	184,868	184,599	204,922

Context may aid understanding. Per the Final Environmental Impact statement for the Purple Line Light Rail project (currently under construction), the Purple Line is anticipated to reduce daily VMT by 129,828 miles. When modeled independently in the first phase of the project, the Red Line Extension was modeled to reduce regional VMT by approximately 157,400 daily miles. Because the Red Line accounts for approximately 65-70 percent of each network package's respective daily VMT reduction, and because it removes more miles from the roadway compared to existing under construction projects, it remains a compelling ambitious project.

APPENDIX 3 ADDENDUM. REVISED COSTS

Following collaboration with stakeholders, including the Montgomery County Department of Transportation (MCDOT) and the Washington Metropolitan Area Transit Authority (WMATA), the project team performed additional work related to the costs of options and network packages for bus and heavy rail. This addendum provides additional information, background, and updates related to the project's costing work.

Master and functional plans typically undergo a fiscal impact analysis during their approval processes. The fiscal impact analysis generally applies unit costs to elements of a plan to develop a ballpark cost estimates, were a plan to be fully realized. Typically, the fiscal impact analysis does not account for land acquisition for right-of-way and assumes right-of-way will be obtained through development.

It is atypical for master and functional plans to delve into the level of financial detail included for Corridor Forward. Additionally, Corridor Forward's planning process also considered and documents potential land costs at a planning level. Corridor Forward employs a benchmarking approach in its cost analysis, using national and local data to inform planning-level cost estimates used for the purposes of comparison. The Plan's estimates are intended to represent ballpark figures to allow relative comparison. Developing bottom-up engineering cost estimates would have significantly exceeded resources allocated to the project, and bottom-up engineering is typically undertaken only once a policy direction is solidified to ensure resources are used effectively.

Relative to one another, the comparative financial performance of the three network packages remains unchanged with the addendum to Appendix 3. Network Package 2, which is most similar to the Plan's recommended network of the three tested packages, continues to offer strong potential. While more expensive than package 3, it offers the potential for more robust service than package 3 and remains less expensive than package 1, which includes the Corridor Cities Transitway. This addendum does not change the Plan's recommendations.

OPERATIONS COSTS – BACKGROUND ON THE NATIONAL TRANSIT DATABASE AND BENCHMARKING APPROACH

The project team used the Federal Transit Administration's (FTA) 2019 National Transit Database (NTD) to source operations costs for the purposes of benchmarking the studied options. The NTD functions as the nation's primary source for information and statistics on passenger transit systems operating in the United States. Beneficiaries and recipients of federal grants must report to the NTD per statute, and approximately 850 transit providers currently report to the NTD, including both MCDOT and WMATA.

The project team used two inputs, *Total Operating Expenses* and *Vehicle Revenue Miles,* to develop unit rates signifying operational costs per revenue mile across the different modes studied. The project team then compared these unit rates to the rates of local systems that report to the NTD to determine whether use of a local reference or whether a national average unit rate was more appropriate. For monorail and light rail modes with no currently operating local references and few available national references, staff made use of representative systems by selecting relevant systems for monorail/automated guideway systems and removing outliers above the 90th and below the 10th percentile.

Based on feedback received from relevant agencies, this addendum only focuses on operation costs for bus and heavy rail modes as these are components of the recommended network. Operational cost revisions are limited to these modes.

Agencies responsible for reporting to the NTD have some discretion regarding reporting, rendering it challenging to discretely break out bus modes. For example, WMATA operates the Metroway bus rapid transit service; however, in 2019 and 2020, the agency did not break out reporting for this service under the NTD's Bus Rapid Transit category. To aid operator's discretion, the NTD provides the following definitions of bus services in their glossary[1]:

- **Bus (NTD Code: MB)** - A transit mode comprised of rubber-tired passenger vehicles operating on fixed routes and schedules over roadways. Vehicles are powered by diesel, gasoline, battery or alternative fuel engines contained within the vehicle.

- **Commuter Bus (NTD Code: CB)** - Local fixed-route bus transportation primarily connecting outlying areas with a central city. Characterized by a motorcoach (aka over-the-road bus), multiple trip tickets, multiple stops in outlying areas, limited stops in the central city, and at least five miles of closed-door service.

- **Bus Rapid Transit (NTD Code: RB) -** Fixed-route bus systems that operate at least 50 percent of the service on fixed guideway. These systems also have defined passenger stations, traffic signal priority or preemption, short headway bidirectional services for a substantial part of weekdays and weekend days; low-floor vehicles or level-platform boarding, and separate branding of the service. Agencies typically use off-board fare collection as well. This is often a lower-cost alternative to light rail.

Heavy rail is defined as follows:

- **Heavy Rail (NTD Code: HR)** - A transit mode that is an electric railway with the capacity for a heavy volume of traffic. It is characterized by high speed and rapid acceleration passenger rail cars operating singly or in multi-car trains on fixed rails; separate rights-of-way from which all other vehicular and foot traffic are excluded; sophisticated signaling, and high platform loading.

Tables 1-4 provide national averages, medians, and local references (as available) by reporting mode.

[1] Online retrieval reference date November 15, 2021

Table 1 – Bus (MB) Operation Costs per Revenue Mile References

	Average	Median	Local Reference 1	Local Reference 2	Local Reference 3	Local Reference 4	Local Reference 5	Local Reference 6	Local Reference 7	Local Reference 8	Local Reference 9	Local Reference 10
Reported 2019 Dollars	$6.12	$5.46	$16.03	$9.20	$8.51	$10.01	$3.83	$8.21	$7.93	$7.17	$12.27	$9.66
Inflated 2021 Dollars[1]	$6.49	$5.80	$17.01	$9.76	$9.02	$10.62	$4.06	$8.71	$8.41	$7.61	$13.02	$10.24
Local Reference System Operator			Maryland Transit Admini-stration (MTA)	Ride On, Montg. County Transit (MCDOT)	Fairfax Connector Bus System	City of Alexandria	Loudoun County Transit	Arlington Transit	County of Howard	TransIT Services of Frederick County	City of Baltimore	City of Fairfax CUE Bus

[1]Converted 2019 to 2021 dollars using a 3 percent inflation rate, compounded annually.

Table 2 – Commuter Bus (CB) Operation Costs per Revenue Mile References

	Average	Median	Local Reference 1	Local Reference 2	Local Reference 3
Reported 2019 Dollars	$5.10	$4.35	$9.79	$9.16	$6.56
Inflated 2021 Dollars[1]	$5.41	$4.62	$10.39	$9.72	$6.96
Local Reference System Operator			Maryland Transit Administration (MTA)	Potomac and Rappahannock Transportation Commission	Loudon County Transit

[1]Converted 2019 to 2021 dollars using a 3 percent inflation rate, compounded annually.

Table 3 – Bus Rapid Transit (RB) Operation Costs per Revenue Mile References

	Average	Median	Local Reference 1[2]
Reported 2019 Dollars	$13.93	$13.45	$10.20
Inflated 2021 Dollars[1]	$14.78	$14.27	$10.82
Local Reference System Operator			Greater Richmond Transit Company

[1]Converted 2019 to 2021 dollars using a 3 percent inflation rate, compounded annually.
[2]Only one local reference across MD, VA, and DC reported using the RB code (Bus Rapid Transit) to the 2019 National Transit Database. WMATA's Metroway, a Bus Rapid Transit Service running primarily in dedicated guideway, is included in WMATA's bus reporting (NTD Code: MB).

Table 4 – Heavy Rail (HR) Operation Costs per Revenue Mile References

	National Average	National Median	Local Reference 1	Local Reference 2
Reported 2019 Dollars	$16.93	$13.19	$13.07	$17.79
Inflated 2021 Dollars[1]	$17.97	$14.00	$13.87	$18.87
Local Reference System Operator			Washington Metropolitan Area Transit Authority (WMATA)	Maryland Transit Administration (MTA)

[1]Converted 2019 to 2021 dollars using a 3 percent inflation rate, compounded annually.

OPERATIONS COSTS – REVISED OPERATIONS COSTS AND REFERENCES

During stakeholder coordination, MCDOT requested Montgomery Planning update the cost analysis with revised operational costs based on professional judgment and experience with other ongoing work. The project team created the Summary Unit Cost Comparison (Table 5) to better understand the request and with additional consideration of national and local benchmarking data.

Table 5 – Summary Unit Cost Comparison Table

Costs in 2019 Dollars/Revenue Mile	Bus	Commuter Bus	Bus Rapid Transit	Metrorail
Originally Used Operations Unit Rate	No Local Bus Tested – Column for Comparative Reference	$13.93 – originally, no distinction was made between operations in managed lanes and dedicated lanes		$13.07
National Transit Database Average Operations Unit Rate	$6.12	$5.10	$13.93	$16.93
National Transit Database Median Operations Unit Rate	$5.46	$4.35	$13.45	$13.19
National Transit Database Local Reference Operations Unit Rate	$16.03 (MTA) $10.01 (Alexandria DASH) $9.20 (MCDOT RideOn) $8.51 (Fairfax Connector) $8.21 (Arlington ART) $7.17 (Frederick TransIT)	$9.79 (MTA) $9.16 (PRTC) $6.56 (Loudon County)	$10.20 (GRTC)	$13.07 (WMATA) $17.79 (MTA)
Agency Partner's Recommended Unit Rate	No Local Bus Tested – Column for Comparative Reference	$4.50	$6.70	$13.07 (no change)

Planning staff has provided a range of potential costs for Managed Lanes Enhanced Commuter Bus and the network packages based on coordination with MCDOT. These updates demonstrate revised financial and economic outlooks in the event lower operational unit rates are attainable. **Based on a review of local and national NTD data, Montgomery Planning suggests that the mid-range assumptions may be the best indicator of potential operational costs.** Tables 6 and 7 provide the revised costs and descriptions of the revised costing assumptions for the Corridor Cities Transitway and the Managed Lanes Enhanced Commuter Bus options, respectively. Tables 6, 7 and 8 provide the revised costing assumptions for the tested network packages.

Staff also coordinated with WMATA regarding operational and capital benchmarks. During coordination, WMATA indicated that in other studies of system expansion, a $20.58 per revenue mile unit rate was employed for the year 2040. The project team confirmed that the $13.07 per revenue mile unit rate initially used for Corridor Forward resulted in a 2040 unit rate of $24.80 when inflated, which is more conservative than WMATA's figure. The project team considered applying an inflation cap to only the Red Line option to align with WMATA's figures; however, to maintain a consistent financial modeling approach across options staff proposed maintaining the initial unit rate to WMATA, and the agency concurred with this approach.

Table 6 – Operations Cost Changes for Corridor Cities Transitway, Phases 1 and 2

CCT Phases 1 + 2	Mode	Annual Revenue VMT (miles)	Op Cost ($ / revenue mile)	Reference	Annual Op Cost ($M, 2019 USD)	Annual Op Cost ($M, 2021 USD)[1]
1. Initial Assumptions (High)	Bus Rapid Transit	1,692,520	$13.93	2019 NTD Avg. Bus Rapid Transit	**$23.6**	**$25.0**
2. Planning's Revised Assumptions (Mid)	Bus Rapid Transit	1,692,520	$9.20	RideOn 2019 NTD	**$15.6**	**$16.5**
3. MCDOT-Recommended Assumptions (Low)	Bus Rapid Transit	1,692,520	$6.70	MCDOT Recommendation	**$11.3**	**$12.0**

[1]3 percent inflation rate compounded annually assumed for 2019 to 2021 dollar conversion.

Of note, the 2017 Environmental Assessment for the Corridor Cities Transitway estimates annual operating costs to be $23.5 million in 2014 dollars. This suggests that, at the tested frequencies, high end assumptions for the option may be more appropriate than Planning's revised assumptions or the MCDOT-recommended assumptions.

Table 7 – Operations Cost Changes for Managed Lanes Enhanced Commuter Bus

Managed Lanes Enhanced Commuter Bus	Mode	Annual Revenue VMT (miles)	Op Cost ($ / revenue mile)	Reference	Annual Op Cost ($M, 2019 USD)	Annual Op Cost ($M, 2021 USD)[1]
1. Initial Assumptions (High)	Bus Rapid Transit	**3,421,992**	$13.93	2019 NTD Avg. Bus Rapid Transit	**$47.7**	**$50.6**
2. Planning's Revised Assumptions (Mid)	**Total**	**3,421,992**			**$33.0**	**$35.0**
	Commuter Bus	2,614,435	$9.79	MTA Commuter Bus 2019 NTD	$25.6	$27.2
	Bus Rapid Transit	807,557	$9.20	RideOn 2019 NTD	$7.4	$7.9
3. MCDOT-Recommended Assumptions (Low)	**Total**	**3,421,992**[2]			**$17.2**	**$18.2**
	Commuter Bus	2,614,435	$4.50	MCDOT Recommendation	$11.8	$12.5
	Bus Rapid Transit	807,557	$6.70	MCDOT Recommendation	$5.4	$5.7

[1]3 percent inflation rate compounded annually assumed for 2019-2021 dollar conversion

[2]Total annual VMT represents totality of Managed Lanes Enhanced Commuter Bus option, including extension of Veirs Mill Transitway into the Life Sciences Center.

The operating costs for the Managed Lanes Enhanced Commuter Bus are split between the commuter bus and bus rapid transit categories. Where the route runs in the managed lanes along I-270, commuter bus operating unit rates are assumed. Where the route operates on local streets recommended for dedicated lanes, bus rapid transit operating costs are assumed. These costs are then applied to the annual mileage associated with on and off-highway service.

Table 8 – Operations Cost Changes for Network Package 1

Network Package 1	Mode	Annual Revenue VMT (miles)	Op Cost ($ / revenue mile)	Source	Annual Op Cost ($M, 2019 USD)	Annual Op Cost ($M, 2021 USD) [1]
1. Initial Assumptions (High)					**$58.9**	**$62.5**
Red Line Metro Extension	Metro	809,799	$13.07	WMATA 2019 NTD	**$10.6**	**$11.2**
CCT Phases 1 + 2	Bus Rapid Transit	1,692,520	$13.93	2019 NTD Avg. Bus Rapid Transit	**$23.6**	**$25.0**
Managed Lanes Enhanced Commuter Bus (Services C & D)	Bus Rapid Transit	1,778,802	$13.93	2019 NTD Avg. Bus Rapid Transit	**$24.8**	**$26.3**
2. Revised Assumptions (Mid)					**$43.4**	**$46.0**
Red Line Metro Extension	Metro	809,799	$13.07	WMATA 2019 NTD	**$10.6**	**$11.2**
CCT Phases 1 + 2	Bus Rapid Transit	1,692,520	$9.20	RideOn 2019 NTD	**$15.6**	**$16.5**
Managed Lanes Enhanced Commuter Bus (Services C & D)	Total	1,778,802			**$17.2**	**$18.3**
	Commuter Bus	1,475,513	$9.79	MTA Commuter Bus 2019 NTD	$14.4	$15.3
	Bus Rapid Transit	303,289	$9.20	RideOn 2019 NTD	$2.8	$3.0
3. MCDOT-Recommended Assumptions (Low)					**$30.6**	**$32.5**
Red Line Metro Extension	Metro	809,799	$13.07	WMATA 2019 NTD	**$10.6**	**$11.2**
CCT Phases 1 + 2	Bus Rapid Transit	1,692,520	$6.70	MCDOT Recommendation	**$11.3**	**$12.0**
Managed Lanes Enhanced Commuter Bus (Services C & D)	Total	1,778,802			**$8.7**	**$9.2**
	Commuter Bus	1,475,513	$4.50	MCDOT Recommendation	$6.6	$7.0
	Bus Rapid Transit	303,289	$6.70	MCDOT Recommendation	$2.0	$2.2

[1] 3 percent inflation rate compounded annually assumed for 2019 to 2021 dollar conversion.

Table 9 – Operations Cost Changes for Network Package 2

Network Package 2	Mode	Annual Revenue VMT (miles)	Op Cost ($ / revenue mile)	Source	Annual Op Cost ($M, 2019 USD)	Annual Op Cost ($M, 2021 USD)[1]
1. Initial Assumptions (High)					**$55.0**	**$58.3**
Red Line Metro Extension	Metro	809,799	$13.07	WMATA 2019 NTD	$10.6	$11.2
MD355 BRT Extra Leg (Incremental)[2]	Bus Rapid Transit	-	$13.93	2019 NTD Avg. Bus Rapid Transit	$0.0	$0.0
Corridor Connectors	Bus Rapid Transit	1,407,648	$13.93	2019 NTD Avg. Bus Rapid Transit	$19.6	$20.8
Managed Lanes Enhanced Commuter Bus (Services C & D)	Bus Rapid Transit	1,778,802	$13.93	2019 NTD Avg. Bus Rapid Transit	$24.8	$26.3
2. Revised Assumptions (Mid)					**$40.8**	**$43.3**
Red Line Metro Extension	Metro	809,799	$13.07	WMATA 2019 NTD	**$10.6**	**$11.2**
MD355 BRT Extra Leg (Incremental)[2]	Bus Rapid Transit	-	$9.20	RideOn 2019 NTD	**$0.0**	**$0.0**
Corridor Connectors	Bus Rapid Transit	1,407,648	$9.20	RideOn 2019 NTD	**$13.0**	**$13.7**
Managed Lanes Enhanced Commuter Bus (Services C & D)	Total	1,778,802			**$17.2**	**$18.3**
	Commuter Bus	1,475,513	$9.79	MTA Commuter Bus 2019 NTD	$14.4	$15.3
	Bus Rapid Transit	303,289	$9.20	RideOn 2019 NTD	$2.8	$3.0
3. MCDOT-Recommended Assumptions (Low)					**$28.7**	**$30.4**
Red Line Metro Extension	Metro	809,799	$13.07	WMATA 2019 NTD	**$10.6**	**$11.2**
MD355 BRT Extra Leg (Incremental)[2]	Bus Rapid Transit	-	$6.70	MCDOT Recommendation	**$0.0**	**$0.0**
Corridor Connectors	Bus Rapid Transit	1,407,648	$6.70	MCDOT Recommendation	**$9.4**	**$10.0**
Managed Lanes Enhanced Commuter Bus (Services C & D)	Total	1,778,802			**$8.7**	**$9.2**
	Commuter Bus	1,475,513	$4.50	MCDOT Recommendation	$6.6	$7.0
	Bus Rapid Transit	303,289	$6.70	MCDOT Recommendation	$2.0	$2.2

[1] 3 percent inflation rate compounded annually assumed for 2019 to 2021 dollar conversion.

[2] The alternating leg service pattern for MD 355 BRT was deemed to have incremental operational costs as realignment of route to Observation Drive every other bus would simply replace every other trip along Snowden Farm Parkway, which is a longer segment. As such, the nominal difference in operational costs was not accounted for in this evaluation.

Table 10 – Operations Cost Changes for Network Package 3

Network Package 3	Mode	Annual Revenue VMT (miles)	Op Cost ($ / revenue mile)	Source	Annual Op Cost ($M, 2019 USD)	Annual Op Cost ($M, 2021 USD)[1]
1. Initial Assumptions (High)					**$43.6**	**$46.3**
Red Line Metro Extension	Metro	809,799	$13.07	WMATA 2019 NTD	**$10.6**	**$11.2**
MD355 BRT Extra Leg (Incremental)[2]	Bus Rapid Transit	-	$13.93	2019 NTD Avg. Bus Rapid Transit	**$0.0**	**$0.0**
Veirs Mill BRT[3]	Bus Rapid Transit	108,058	$13.93	2019 NTD Avg. Bus Rapid Transit	**$1.5**	**$1.6**
Managed Lanes Enhanced Commuter Bus (Services A, C and D)	Bus Rapid Transit	2,265,231	$13.93	2019 NTD Avg. Bus Rapid Transit	**$31.6**	**$33.5**
2. Revised Assumptions (Mid)					**$33.5**	**$35.5**
Red Line Metro Extension	Metro	809,799	$13.07	WMATA 2019 NTD	**$10.6**	**$11.2**
MD355 BRT Extra Leg (Incremental)[2]	Bus Rapid Transit	-	$9.20	RideOn 2019 NTD	**$0.0**	**$0.0**
Veirs Mill BRT[3]	Bus Rapid Transit	108,058	$9.20	RideOn 2019 NTD	**$1.0**	**$1.1**
Managed Lanes Enhanced Commuter Bus (Services A, C and D)	Total	2,265,231			**$21.9**	**$23.3**
	Commuter Bus	1,842,488	$9.79	MTA Commuter Bus 2019 NTD	$18.0	$19.1
	Bus Rapid Transit	422,742	$9.20	RideOn 2019 NTD	$3.9	$4.1
3. MCDOT-Recommended Assumptions (Low)					**$22.4**	**$23.8**
Red Line Metro Extension	Metro	809,799	$13.07	WMATA 2019 NTD	**$10.6**	**$11.2**
MD355 BRT Extra Leg (Incremental)[2]	Bus Rapid Transit	-	$6.70	MCDOT Recommendation	**$0.0**	**$0.0**
Veirs Mill BRT[3]	Bus Rapid Transit	108,058	$6.70	MCDOT Recommendation	**$0.7**	**$0.8**
Managed Lanes Enhanced Commuter Bus (Services A, C and D)	Total	2,265,231			**$11.1**	**$11.8**
	Commuter Bus	1,842,488			$8.3	$8.8
	Bus Rapid Transit	422,742	$4.50	MCDOT Recommendation	$2.8	$3.0

[1]3 percent inflation rate compounded annually assumed for 2019 to 2021 dollar conversion.

[2]The alternating leg service pattern for MD 355 BRT was deemed to have incremental operational costs as realignment of route to Observation Drive every other bus would simply replace every other trip along Snowden Farm Parkway, which is a longer segment. As such, the nominal difference in operational costs was not accounted for in this evaluation.

[3]The analysis assumes existing incremental increase in Veirs Mill BRT operations, extending the service from Montgomery College into the Life Sciences Center

CAPITAL COSTS – BACKGROUND ON BENCHMARKING APPROACH AND INITIAL SOURCES

The project team used benchmarks to help establish high-level estimates as bottom-up engineering costs for project elements were not available. Simply put, a bottom-up approach for capital cost estimation refers to starting with a known product and building a total cost based on the numerous specific components of the product. Costs are then summed to develop a total estimate. By contrast, benchmarking uses similar projects' metrics quantities to inform estimates. Because bottom-up engineering costs were not available[2], the project team employed a benchmarking estimation approach using various local and national sources. Stakeholders have requested re-examination of bus and heavy rail capital costs. As such, the tables in this appendix focus only on options related to these modes. Table 11 provides the initial capital construction unit rates associated with the two modes and their sources.

Table 11 – Capital Cost Unit Rates Employed in the Initial Analysis

	Bus Rapid Transit	**Heavy Rail**
Infrastructure Costs: Vehicles	$1.08 M/articulated bus (source: average of NJ Transit, Metrolinx purchases, supplemented with CCT EA)	$2.75 M/Metrorail car (source: WMATA Metro 8,000 series purchase)
Infrastructure Costs: Guideway & Facilities	$62.26 M/mi (source: average of Institute for Transportation and Development Policy BRT Guide reporting for Cleveland Healthline; 2017 CCT EA)	At-Grade: $220.1 M/mi Elevated: $223.3 M/mi (source: average of Eno Capital Cost database reporting for WMATA, BART and Miami Dade projects)

No updates were requested related to vehicle cost and purchase; however, updates were requested for the guideway and facilities cost unit rates. The initial rates for guideways and facilities were sourced from local and national benchmarks.

For the bus-rapid-transit type infrastructure, the initial analysis assumed $62.26 million/mile of infrastructure based on an average cost between the Institute for Transportation and Development Policy's BRT Guide reporting for the Cleveland Healthline and the 2017 Environmental Assessment for the Corridor Cities Transitway. The Healthline is a BRT service running in 6.8 miles of dedicated lanes. Buses have two-door boarding and run partially along the curb and partially in median depending on the segment. Buses are generally separated from traffic. The per mile cost of the Healthline, which includes associated infrastructure, was approximately $38.48 million (2021 dollars). The CCT, an option studied by Corridor Forward, is a 17-mile BRT service with two phases. A 2017 Environmental Assessment for Phase 1 of the service anticipates capital costs to be $698 million, including all infrastructure, in 2016 dollars, for Phase 1 of the project (the first 9 miles). When converted to 2021 dollars and averaged with the Healthline, the unit rate for BRT service came to $64.2 million per mile; however, a $62.3 million per mile figure was employed in the analysis due to reporting error in the initial evaluation's spreadsheet workbook. Note that initial BRT cost benchmarks account for infrastructure, stations, professional services, right-of-way acquisition, operations and maintenance facilities, etc.

[2]The project team did not develop bottom-up engineering estimates for each transit option as doing so would significantly exceed allotted resources. The use of public resources on bottom-up engineering is more appropriate when there is generally accepted direction by decisionmakers on what transit option(s) are the most desirable. Corridor Forward's purpose is to solidify decisionmaker policy direction on corridor-serving transit options by through higher-level comparative analysis.

For heavy rail, the project team sourced information from the Eno Center for Transportation's Capital Construction Database. The 2020 database reports capital costs for rail modes. Where information is available, allocation of capital costs is reported as percentages, but even when not reported, the reported costs are assumed to account for guideway, stations, support facilities, sitework, systems, right-of-way and land acquisition, vehicles, professional services, and contingency. As such, it is important to note that vehicle costs are therefore likely double-counted in the analyses of heavy rail in initial reporting. The project team's initial approach separates costs for rail by grade. Table 12 breaks out the sources used to develop initial unit rates for heavy rail infrastructure.

Table 12 – Initial Capital Cost Sources for Heavy Rail Benchmarks

	At-Grade	Elevated
Eno Center for Transportation 2020 Capital Construction Database Sources	WMATA Silver Line, Phase 1 WMATA Silver Line, Phase 2 Bay Area Rapid Transit (BART) Warm Springs Extension	Bay Area Rapid Transit (BART) Coliseum-Oakland Airport Line Miami Dade Airport Link Metrorail Extension
Average Cost/Mile (millions)	At-Grade: $220.1 M/mi	Elevated: $223.3 M/mi

One of the benefits of using an average of multiple benchmarks (as available) relates to the contextual variance of capital costs. Each project included as a benchmark has its own unique engineering challenges and needs, as well as market contexts. Where available, benchmarks from high-cost markets like San Francisco are used as the Washington, DC Metropolitan Region is generally considered to be an expensive construction market.

CAPITAL COSTS – REVISED CAPITAL COSTS AND REFERENCES

Montgomery Planning coordinated with the MCDOT and WMATA regarding costing assumptions. MCDOT recommended updates be provided for Bus Rapid Transit, supplying its own figures based on experience with recent implementation. MCDOT also recommended that the Silver Line Phase 1, the most expensive benchmark used to create the unit rate shown in Table 12, be used as the sole input to estimate heavy rail. At the time of this writing, the project team has not received requests from WMATA to adjust figures during coordination. Table 13 provides MCDOT's recommended updated capital cost unit rates. No changes were requested for vehicle costs. Note that the new requested unit rate does not distinguish between elevated and at-grade running service. In other words, a single unit rate is applied rather than differentiating between at-grade and elevated service. In practice, this may be conservative as the Silver Line Phase 1 includes at-grade, elevated, and tunneled components.

Table 13 – Updated Low-End Unit Rates Requested for the Revised Analysis

	Bus Rapid Transit	**Heavy Rail**
Infrastructure Costs: Vehicles	$1.08 M/articulated bus (retained)	$2.75 M/Metrorail car (retained)
Infrastructure Costs: Guideway & Facilities	Enhanced Local Bus Services: $6M/mi Median Running BRT: $40 M/mi (source: MCDOT supplied figures)	$264.4 M/mi (source: Eno Capital Cost database, see Silver Line Phase 1)

Table 14 (next page) applies these unit rates to the mileage assumed for the revised routes.

Table 14 – Revised Capital Cost Inputs

Option or Network Package	Unit Rate ($M, 2019 dollars)	Unit Rate Source	Mileage Application[1]	Total Capital Cost Input ($M, 2019 dollars)
Red Line Metro Extension	$264.4	Eno 2020 Capital Construction Database – Silver Line Phase 1 Only	8.2	**$2,168.1**
CCT Phases 1 + 2[2]	$84.7	2017 CCT Environmental Assessment (MTA)	17.0	**$1,440.7**
Managed Lanes Enhanced Commuter Bus: Corridor Connectors (Germantown, Montgomery Village & Life Sciences) & Addt. BRT Infrastructure	$6.0 (low) $40.0 (mid)	MCDOT Recommended	13.2	**$79.2 (low)** **$528.0 (mid)**
Network Package 1				**$3,633.4 (low)** **$3,772.8 (mid)**
Red Line Metro Extension	$264.4	Eno 2020 Capital Construction Database – Silver Line Phase 1 Only	8.2	$2,168.1
CCT Phases 1 + 2[2]	$84.7	2017 CCT Environmental Assessment (MTA)	17.0	$1,440.7
Managed Lanes Enhanced Commuter Bus – Off Highway Segments Only	$6.0 (low) $40.0 (mid)	MCDOT Recommended	4.1	$24.6 (low) $164.0 (mid)
Network Package 2				**$2,258.7 (low)** **$2,772.1 (mid)**
Red Line Metro Extension	$264.4	Eno 2020 Capital Construction Database – Silver Line Phase 1 Only	8.2	$2,168.1
Corridor Connectors: Germantown, Life Sciences, Montgomery Village & Great Seneca, COMSAT/Clarksburg East	$6.0 (low) $40.0 (mid)	MCDOT Recommended	15.1	$90.6 (low) $604.0 (mid)
Network Package 3				**$2,229.3 (low)** **$2,576.1 (mid)**
Red Line Metro Extension	$264.4	Eno 2020 Capital Construction Database – Silver Line Phase 1 Only	8.2	$2,168.1
Corridor Connectors: Germantown, Life Sciences, Montgomery Village & COMSAT/Clarksburg East	$6.0 (low) $40.0 (mid)	MCDOT Recommended	10.2	$61.2 (low) $408.0 (mid)

[1]Mileage assumption was slightly extended for the Red Line Extension between the initial options analysis and the network package study

[2]Corridor Cities Transitway capital cost inputs taken for phase 1 from MTA produced 2017 Environmental Assessment ($698M/9 miles inflated to 2021 dollars resulting in a $84.7 M/mile unit rate).

Table 15 provides a summary of the capital costs of revised options, adding in potential additional land costs. As previously stated, the capital cost unit rates were initially built from sources that factored in land costs and vehicle costs; however, the new MCDOT recommended unit rates do not. For a conservative approach, the project team applied additional potential land costs provided in Appendix 3 to develop total potential costs, converting this to 2021 dollars. These land costs account for right-of-way and operations and maintenance needs at a planning-level. While this potentially results in accounting for these costs doubly by two different methodologies, the variability of land costs cannot be easily accounted for in a benchmarking approach. As such, the approach is conservative.

Table 15 – Revised Capital Cost Inputs with Additional Land Costs

Option or Network Package	Unit Rate Developed Capital Costs		Potential Land Costs Additional Land Costs ($ millions, 2021)	Total ($ millions, 2021)
	$ millions, 2019	$ millions, 2021		
Red Line Metro Extension	$2,168	$2,300	$245	$2,545
CCT Stage 1 + 2	$1,441	$1,528	$72	$1,600
Managed Lanes Enhanced Commuter Bus Mid	$528	$560	$55	$615
Managed Lanes Enhanced Commuter Bus Low	$79	$84	$55	$139
Network Package 1 Mid	$3,773	$4,003	$251	$4,254
Network Package 1 Low	$3,633	$3,855	$251	$4,106
Network Package 2 Mid	$2,772	$2,941	$359	$3,300
Network Package 2 Low	$2,259	$2,396	$359	$2,755
Network Package 3 Mid	$2,576	$2,733	$234	$2,967
Network Package 3 Low	$2,229	$2,365	$234	$2,599

SUMMARY OF REVISIONS AND ANALYSIS

Table 16, as well as Figures 1 and 2 (next page), provide a summary of initial and revised operating and capital expenses across options, demonstrating a range of potential costs. Montgomery Planning suggests that the mid-range assumptions may be the best indicator of potential costs. Note that these are flat costs: they do not reflect the time value of money or financing the project across multiple years or multiple years of operation, as was undertaken for the initial analysis.

The comparative financial performance of the three network packages remains unchanged. Network Package 3 continues to be the least expensive option and has higher comparative cost-to-benefit index values associated with the presented ranges as the services are the least robust and cheapest to implement. Application of only local data for the CCT's capital side increased the gap between Network Packages 1 and 2, and the infrastructure associated with Network Package 2 continues to offer a better cost to benefit comparative index than Network Package 1.

Table 16 – Summary of Initial and Revised Capital and Operating Cost Ranges

	Annual Operating Costs ($ millions, 2021)		Capital Costs ($ millions, 2021)	
	Mid-Range Assumption	**Range of Results**	**Mid-Range Assumption**	**Range of Results**
Red Line Extension	$11	N/A[1]	$2,545	$1,719-2,545
CCT Stage 1 + 2	$17	$12-25	$1,600	$1,059-1,600
Managed Lanes Enhanced Commuter Bus	$35	$18-51	$615	$139-819
Network Package 1	$46	$33-63	$4,106	$3,121-4,254
Network Package 2	$43	$30-58	$2,755	$2,745-3,300
Network Package 3	$36	$24-46	$2,599	$2,440-2,967

[1]Based on general concurrence from stakeholders, only one unit cost was analyzed for the Red Line Extension, so there is no cost range.

Figure 1. Estimated Operating Costs (Millions)

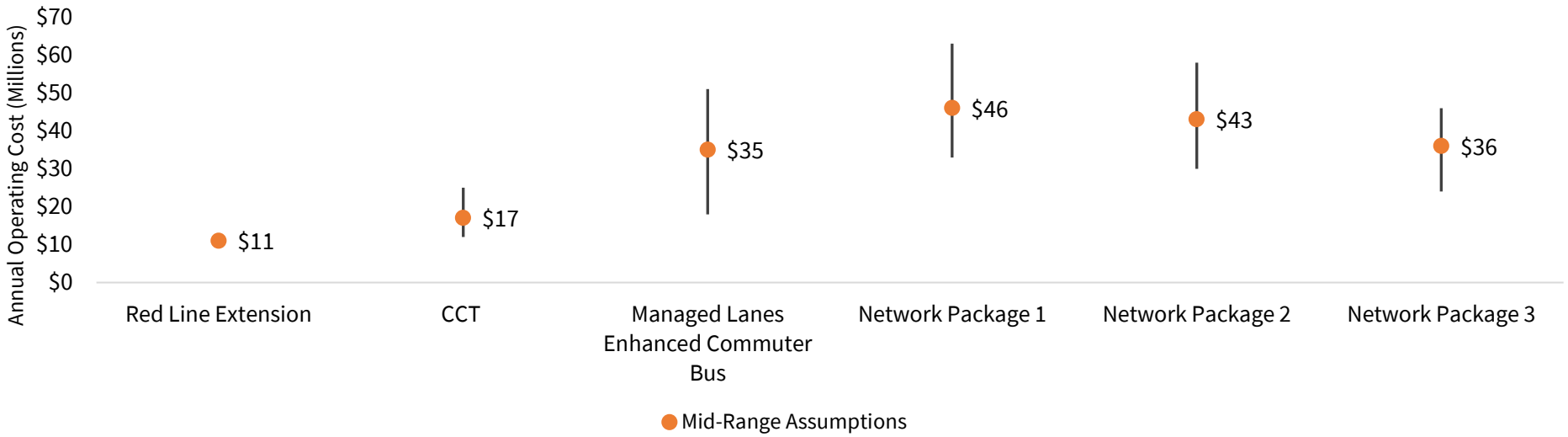
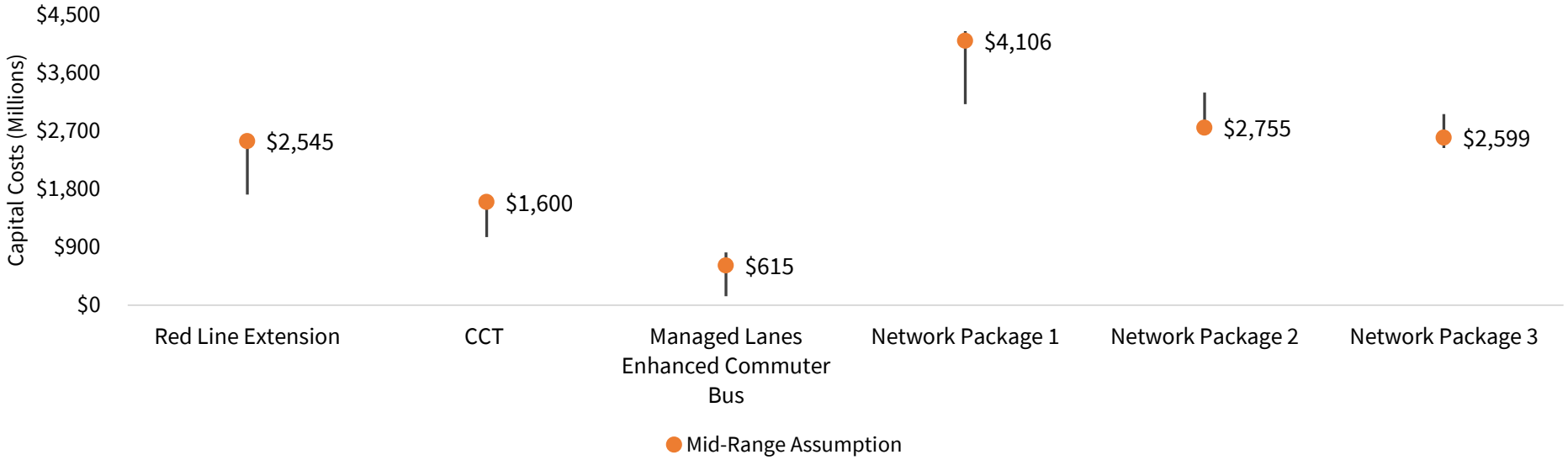


Figure 2. Estimated Capital Costs (Millions)



APPENDIX 3 ADDENDUM. MARC & RED LINE COMPARISON

Corridor Forward includes a proposed transit network comprised of dedicated bus lanes in the near term and a long-term vision of a Red Line Extension. In addition to the recommended transit network, the Plan includes supporting recommendations, which include both strategies to enhance the benefits of the proposed transit network and enhance connections to neighboring jurisdictions. Two of the supporting recommendations focus on MARC rail, including support for increased frequency and service span along the Brunswick Line and new stations at White Flint and Shady Grove.

Testimony from several members of the public, advocacy groups, and public agencies questioned elevating the Red Line Extension as part of the proposed transit network while not prioritizing enhancements to MARC rail. This appendix provides an in-depth comparison of the analysis findings for the two transit options and is a supplement to the content provided in Appendix 3. As demonstrated in the tables and charts below, the Red Line extension consistently outperforms enhancements to MARC rail.

OVERVIEW OF TRANSIT OPTIONS

The two transit options include different types of improvements. The enhanced MARC Rail option increases transit service along the Brunswick Line, increasing the number of trains during the peak period and adding new stations at White Flint and Shady Grove. In contrast, the Red Line extension would extend the Red Line eight miles north of Shady Grove along the CSX tracks, providing three new stations: Gaithersburg, MD 124/Fairgrounds, and Germantown Town Center.

SERVICE FREQUENCY

Even with the proposed improvements to MARC, the frequency of MARC Rail is far lower than that of the Red Line extension (which is assumed to have the same frequencies as the rest of the Red Line). As noted in Table 1, MARC trains would come 4 times an hour during the peak period (every 15 minutes), while Red Line trains would arrive 10 times an hour (every 6 minutes). Midday, train service on MARC would be hourly, while the Red Line would come 5 times an hour (every 12 minutes).

Table 1. Service Frequency

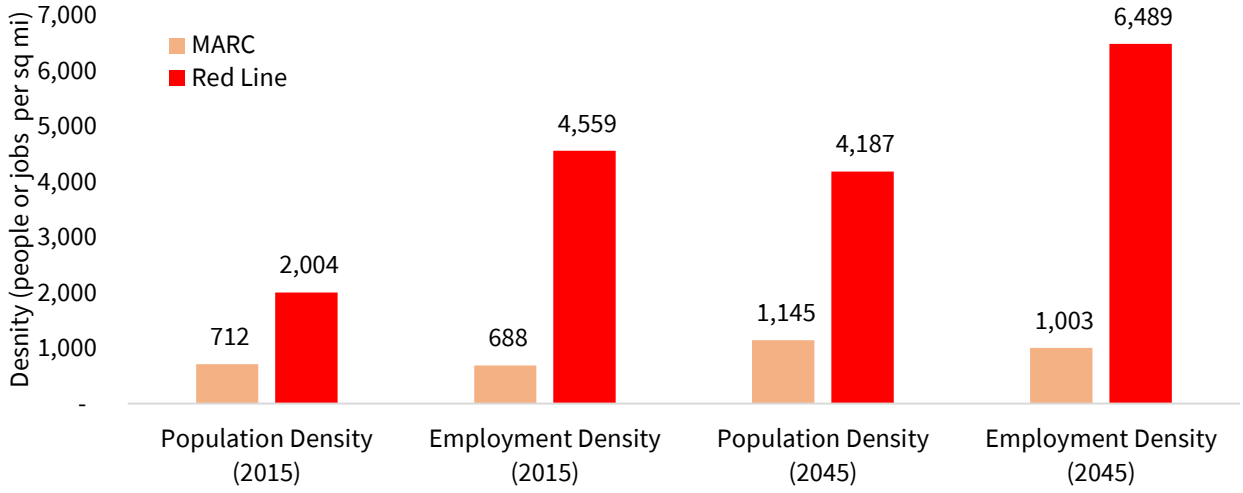
Frequency	Enhanced MARC	Red Line Extension
Peak Period Trains/Hour	4	10
Midday Trains/Hour	1	5

SURROUNDING AREA LAND USE

While the Red Line extension would parallel MARC service for a portion of the corridor, the routes have different alignments for the majority of their service in Montgomery County. Figure 1 depicts the average density within a half mile of existing Montgomery County stations for the MARC Brunswick

Line and the west branch of the Red Line (based on the land use forecasts in the Metropolitan Washington Council of Governments regional travel demand model). Population and employment density along the Red Line exceeds density along the MARC Brunswick Line both in 2015 and 2045. This demonstrates a higher potential for transit use along the Red Line, as well as an alignment between transit investments and planned growth.

Figure 1. Average Density within Half Mile of Existing Montgomery County Stations



Note: Red Line only includes Montgomery County stations on west branch between Shady Grove and Bethesda.

RIDERSHIP

Forecasted ridership on the Red Line exceeds that of the enhanced MARC Rail. While the Red Line extension would result in over 20,000 new riders, including 11,750 from other transit modes and 8,310 new transit riders, improvements to MARC are anticipated attract 11,860 new MARC riders, including 8,030 from other transit modes and 3,830 new transit riders.

Table 2. Ridership for Each Transit Option (2045)

Ridership Measure	**Enhanced MARC**	**Red Line Extension**
Total New Riders	**11,860**	**20,060**
Switched from Another Transit Mode	8,030	11,750
New to Transit	3,830	8,310

Enhancing MARC service would impact other modes. Because the Brunswick Line offers some redundancy with segments of the Red Line, Metro service could lose as many as 7,600 trips in 2045 if MARC was to be improved without concurrent transit enhancements to other modes. On the other hand, if the county and/or state were to pursue the studied Red Line Extension, the existing MARC service would potentially lose riders.

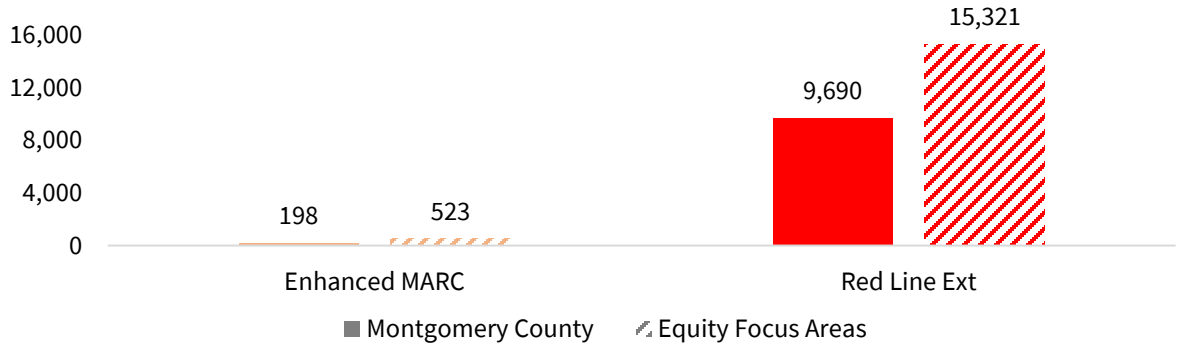
JOB ACCESSIBILITY

Job accessibility measures the number of jobs that can be reached from a certain location within a given travel time and mode. For Corridor Forward, job access was evaluated for transit trips within a 45-minute travel shed. In 2045, the transit job accessibility for the average Montgomery County resident will be 211,000 jobs. This is higher in Equity Focus Areas (EFAs; 225,000 jobs) relative to non-EFAs (203,000 jobs), representing a relative advantage in job accessibility for EFA residents.

Depicted in Figure 2, improvements to MARC Rail would improve job accessibility by about 200 jobs for the average Montgomery County resident and approximately 520 jobs for the average resident of an EFA. In contrast, the Red Line extension would result in an increase in job accessibility of 9,690 jobs for the average Montgomery County resident and approximately, 15,320 new jobs for EFA residents. This advantage for the Red Line is for three reasons:

1) The level of access is enhanced by the number of stations associated with each option. There are only eight MARC stations between Germantown and Union Station on the MARC line (including the added master-planned Shady Grove and White Flint), whereas there would be 19 stations between Germantown and Union Station.
2) The Red Line extension provides a connection to job centers within Montgomery County, such as Bethesda, and
3) While both MARC Rail and the Red Line connect Montgomery County residents to Washington, DC, the Red Line connects to Dupont Circle and District neighborhoods with a higher density of jobs than Capitol Hill (where the Brunswick Line terminates).

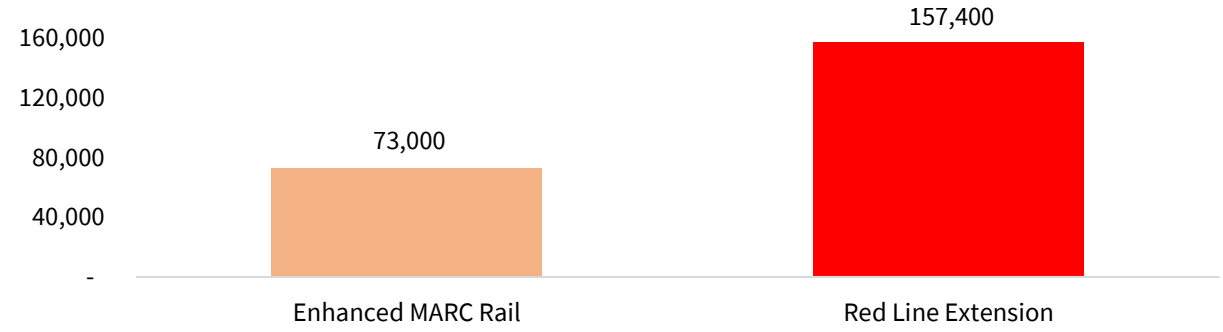
Figure 2. New Jobs Accessible by Transit within 45 Minutes (2045)



VMT REDUCTION

Vehicle miles traveled (VMT) measures the total distance of automobile travel. Based on the analysis, Montgomery County will experience 22,515,000 daily VMT in 2045. While improvements to MARC Rail would reduce VMT by 73,000 miles daily, the Red Line extension would reduce VMT by twice as many miles – 157,400 miles (Figure 3). The VMT reduction associated with EFAs 380% higher for the Red Line extension than for enhanced MARC Rail (26,600 miles for the Red Line compared to 5,500 miles for enhanced MARC Rail).

Figure 3. VMT Reduction (2045)



COSTS

The total cost for each transit option varies given the differing capital and operating costs as well as the land acquisition needs. The estimated cost for enhanced MARC Rail is $1.73 billion, compared to $2.36 billion for the Red Line extension. While the costs for the Red Line extension exceed that for MARC Rail by over $600 million, the extent of the benefits of the Red Line extension demonstrate that it is a more worthwhile investment. For example, the cost per transit rider is 24% higher for enhanced MARC than the Red Line extension and the cost per VMT reduced is 58% higher for enhanced MARC than the Red Line extension.

IMPLEMENTATION

Table 3 summarizes some implementation considerations across the two transit options. While enhanced MARC Rail is anticipated to require 45 miles of new track, the extension of the Red Line spans just 8 miles. The footprint of the Red Line extension exceeds that of a third new track for MARC rail (62' compared to 25'), which results in more impacted structures and right-of-way needs per mile of improvement for the Red Line. Improvements to MARC Rail are anticipated to require 78 grade crossings, compared to 16 for the Red Line extension, and anticipated historic and environmental impacts for enhanced MARC Rail exceed that for the Red Line extension.

Table 3. Implementation Considerations

Indicator[1]	Enhanced MARC Rail	Red Line Extension
Distance of New Guideway	~45 miles	~8 mile
Approximate Footprint	25' along NB tracks	62' along SB tracks
Anticipated Additional Right-Of-Way	20 acres	21 acres
Anticipated Impacts to Structures	91 structures	42 structures
Anticipated Grade Crossings	78 grade crossings	16 grade crossings
Anticipated Historic Impact[2]	High	Medium
Anticipated Environmental Impacts[2]	High	Low

Notes:

1. Based on high-level desktop analysis. This analysis is based on studied alignments. Further studies could result in alignments that reduce or increase impacts and costs.
2. Assumes a 200-foot buffer from studied alignment

APPENDIX 4. ILLUSTRATIVE CROSS-SECTIONS

While median-running transit offers the best opportunity to operate a bus without impacts from traffic, in some locations curb-running transit may be preferable. Section needs vary significantly based on context, as utilities, mature trees, and adjacent connecting active zone facilities can impact the most desirable and/or practical design. Engineered sections will be designed during the facility planning process or determined through the development review process for new development adjacent to the relevant roadway(s).

While Complete Streets classifications have not yet been officially applied to all county roadways by changes to county code or an amendment to the 2018 *Master Plan of Highways and Transitways*, the illustrative sections included in this Appendix reference the county's Complete Streets Design Guide to inform development. The sections divide the roadway into two sections:

- **Active Zone:** Includes roadway elements between the curb and the property line. It contains all active transportation uses (pedestrians and usually bicyclists) and includes a maintenance buffer, a frontage zone, sidewalks or sidepaths, separated bike lanes, and several types of buffers. For more information, see the County's Complete Streets Design Guidelines.
- **Street Zone:** includes roadway elements between the curbs, including travel lanes, transitway lanes, a median, on-street parking, and on-street bike lanes

Dedicated bus lanes are assumed to be 13 feet or 12 feet in constrained sections. Dedicated bus lane buffer widths may vary. Along wider roadways, buffers with six-foot wide medians (or wider) are preferred to provide pedestrians ADA-compliant crossing refuges; however, in locations where it is preferrable to maintain a tight cross-section to reduce crossing distances, two-foot wide buffers may be appropriate. In locations where left turn lanes are necessary, 16-18-foot wide center medians have the potential to support both turning needs and pedestrian refuges, while smaller 12-foot-wide medians do not support pedestrian safety.

Consistent with the county's Vision Zero Policy and the intent of the Complete Streets Design Guidelines, prioritizing safety for a roadway's most vulnerable users is paramount. For this reason, ultimate section designs should account for adequate pedestrian refuges across wider roadway sections, as well as appropriate buffers from traffic that protect non-motorists, many of whom are walking, biking, or rolling to transit. While the illustrative sections below depict separate facilities for bicyclists and pedestrians, on some roadway types, a sidepath with shared space for these modes may be recommended.

This appendix includes nine illustrative cross-sections:

1. 100-foot ROW: Two Lanes with Median-Running Transit
2. 100-foot ROW: Two Lanes with Curbside-Running Transit
3. 115-foot ROW: Four Lanes with Median-Running Transit
4. 115-foot ROW: Four Lanes with Curbside-Running Transit
5. 120-foot ROW: Two Lanes with Median-Running Transit

6. 120-foot ROW: Two Lanes with Curbside-Running Transit
7. 140-foot ROW: Four Lanes with Median-Running Transit
8. 140-foot ROW: Four Lanes with Curbside-Running Transit
9. 150-foot ROW: Four Lanes with Median-Running Transit

Figure 1. Illustrative 100-foot ROW: Two Lanes with Median-Running Transit

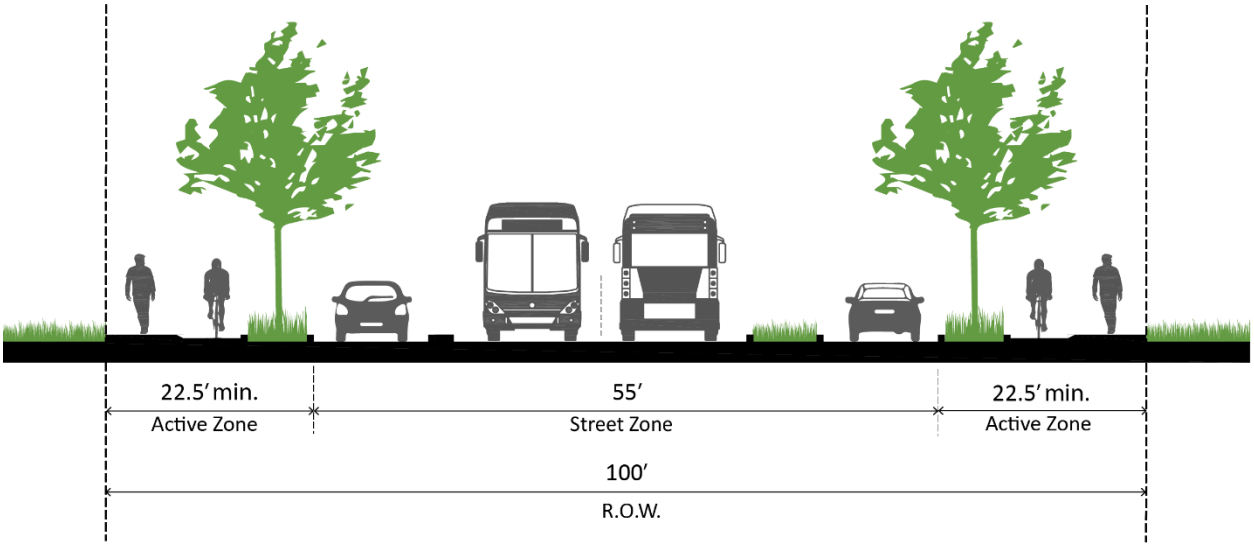


Figure 2. Illustrative 100-foot ROW: Two Lanes with Curbside-Running Transit

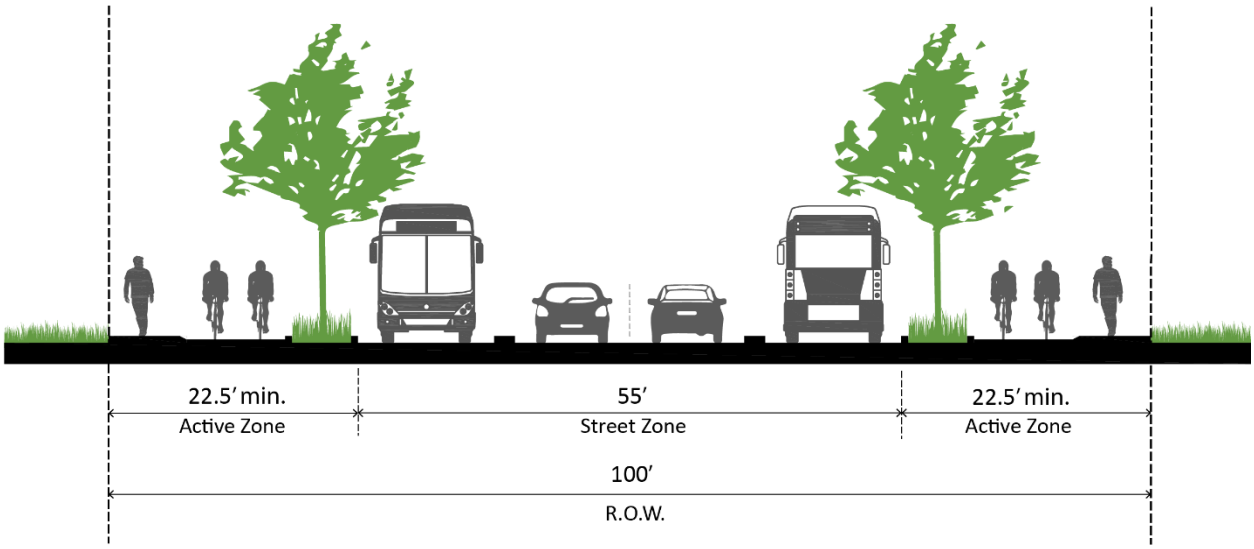


Figure 3. Illustrative 115-foot ROW: Four Lanes with Median-Running Transit

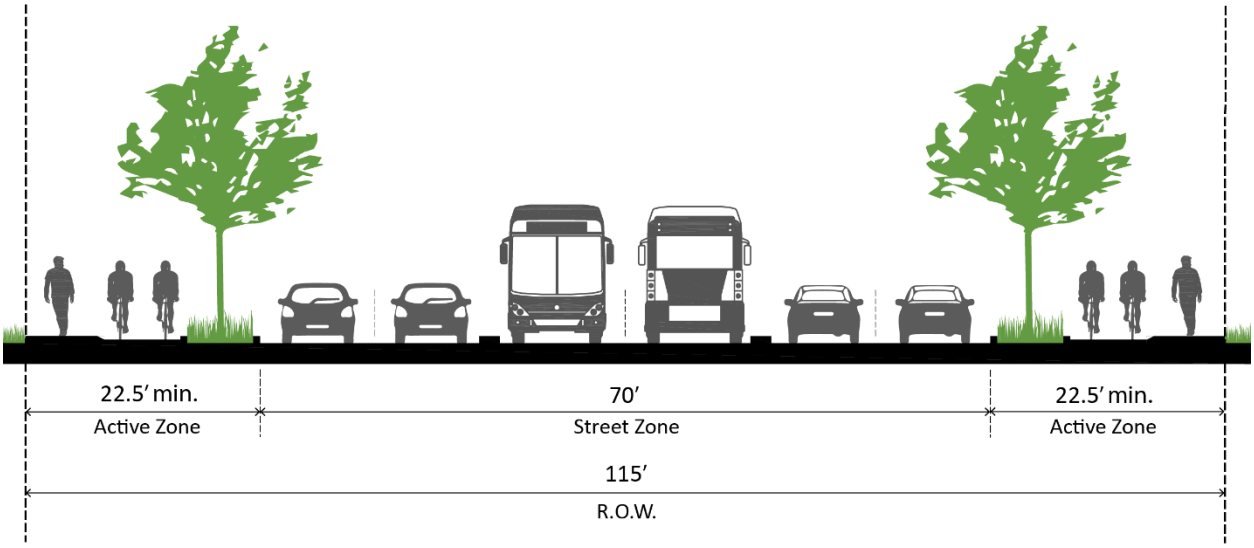


Figure 4. Illustrative 115-foot ROW: Four Lanes with Curbside-Running Transit

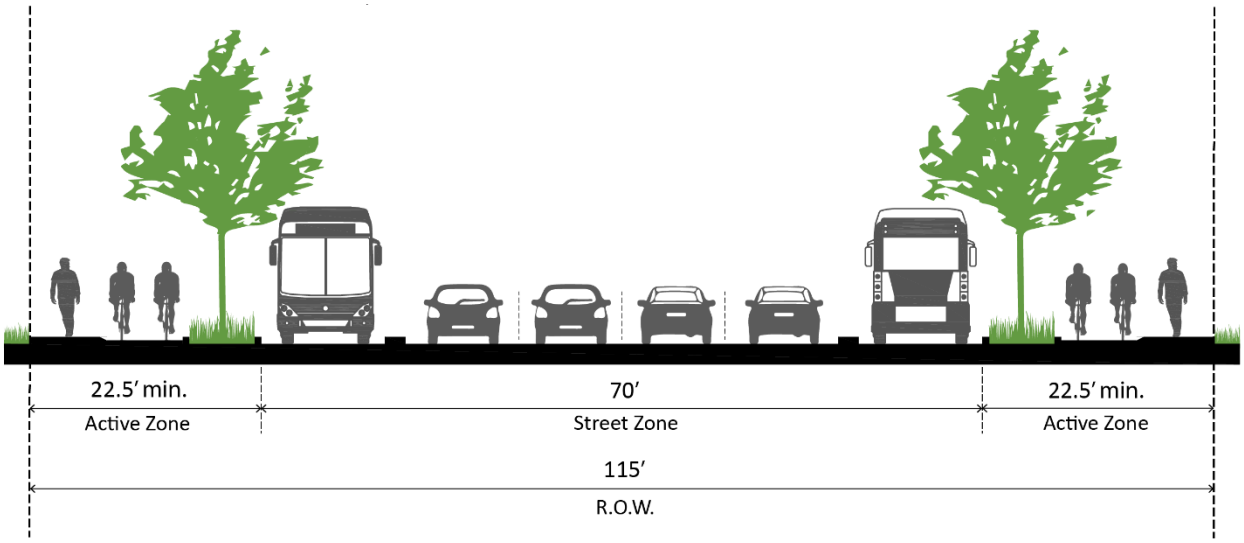


Figure 5. Illustrative 120-foot ROW: Two Lanes with Median-Running Transit

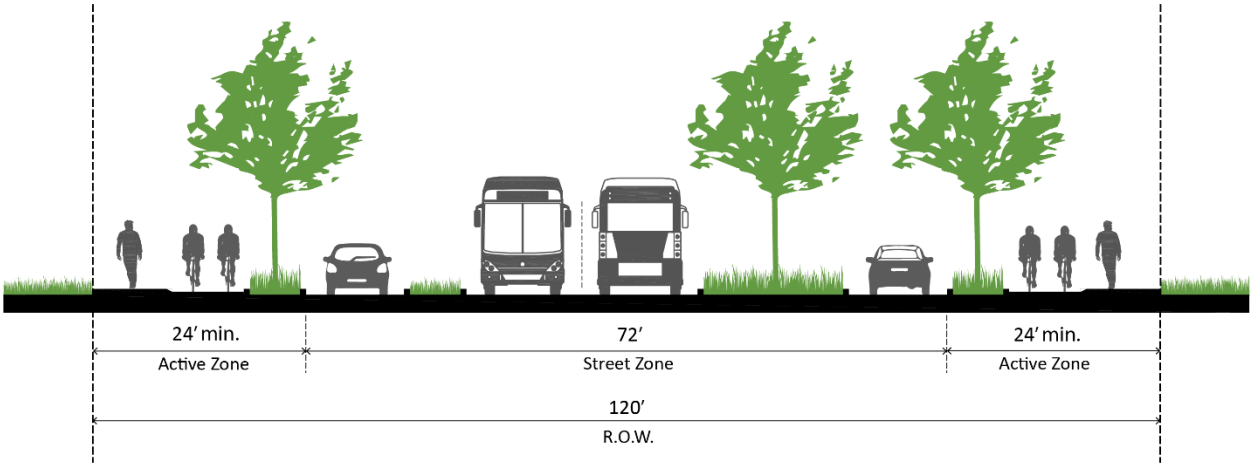


Figure 6. Illustrative 120-foot ROW: Two Lanes with Curbside-Running Transit

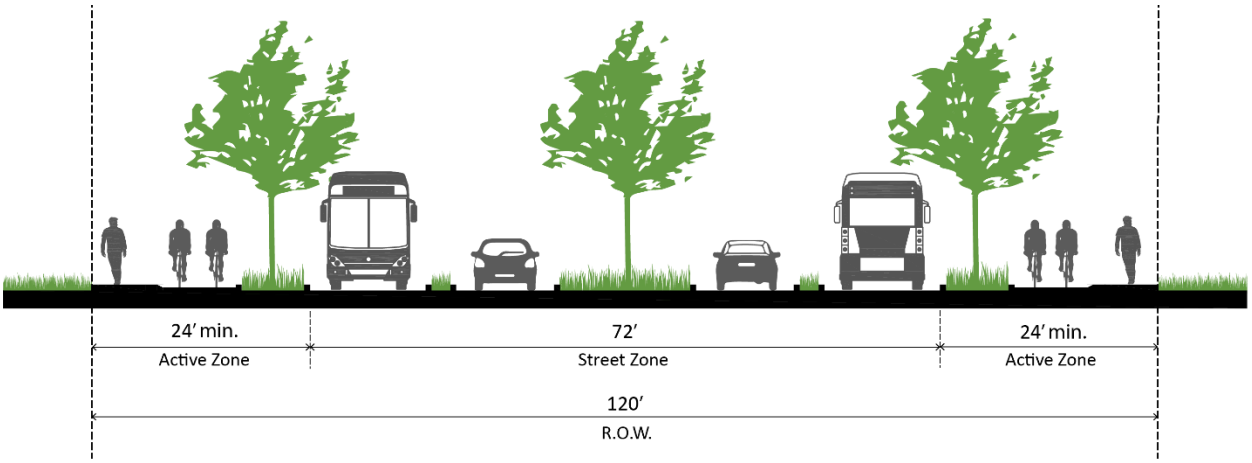


Figure 7. Illustrative 140-foot ROW: Four Lanes with Median-Running Transit

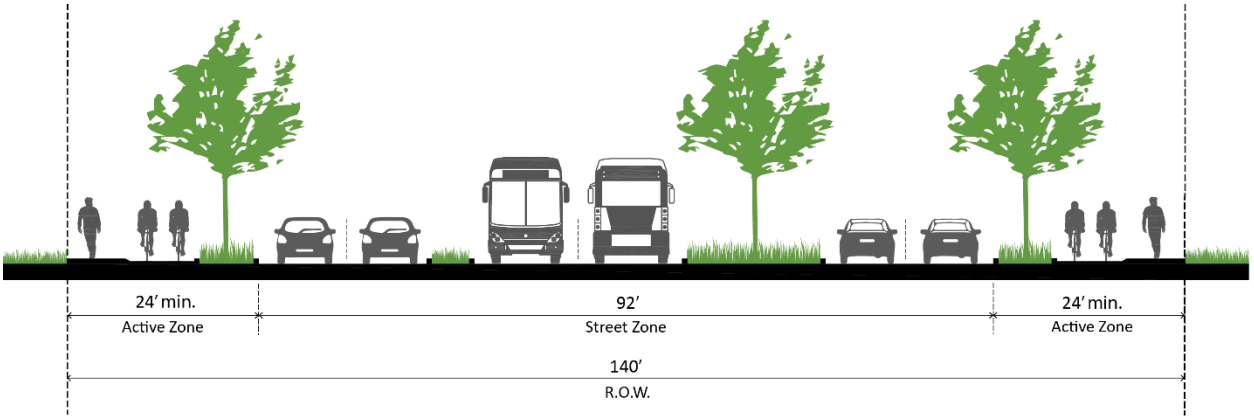


Figure 8. Illustrative 140-foot ROW: Four Lanes with Curbside-Running Transit

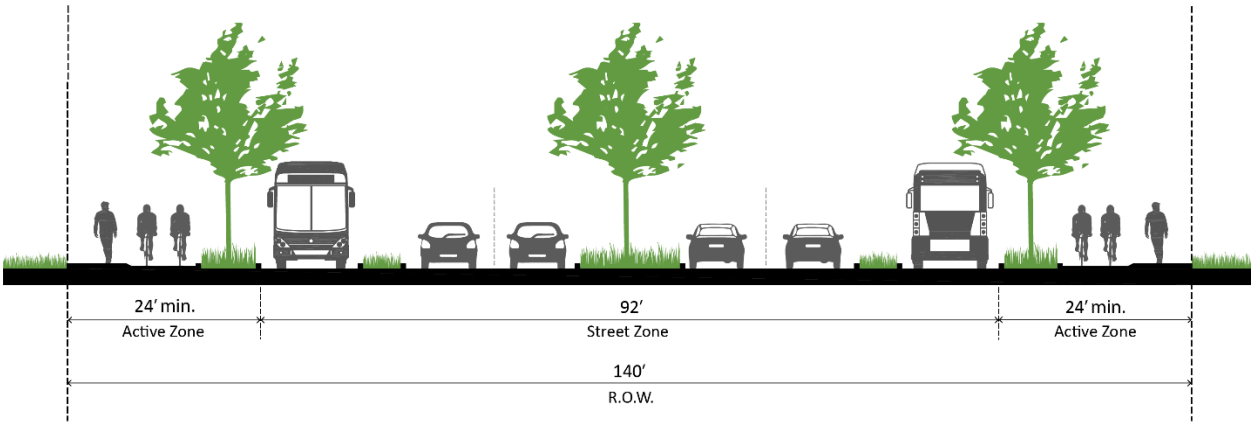
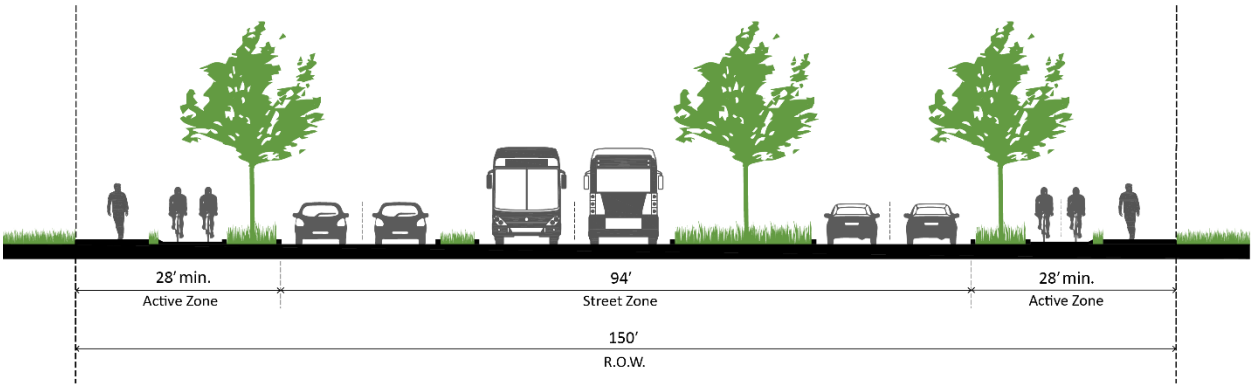


Figure 9. Illustrative 150-foot ROW: Four Lanes with Median-Running Transit



APPENDIX 5: CARBON FOOTPRINT ANALYSIS

Since 2010, the Planning Board has included a carbon footprint analysis and recommendations to reduce vehicle miles traveled (VMT) and greenhouse gas (GHG) emissions in each of the county's master plans to satisfy the requirement of Montgomery County Code Chapter 33A, Section 33A-14. Specifically, the law requires that the Planning Board must:

(a) Assess the Plan's potential impact on greenhouse gas emissions in the County, including a Carbon Footprint Analysis;
(b) Consider ways to reduce vehicle miles traveled in the County;
(c) Consider options that would minimize greenhouse gas emissions; and
(d) Consider the impact of the plan on racial equity and social justice in the County (as defined in Section 2-64A).

In addition, Montgomery County completed its Climate Action Plan in June 2021, committing to cut greenhouse gas emissions by 80 percent by 2027 and 100 percent by 2035. he Climate Action Plan details the effects of a changing climate on Montgomery County and includes strategies to reduce GHG emissions and climate-related risks to the County's residents, businesses, and the built and natural environment. The Climate Action Plan focuses on seven pillars to reduce greenhouse gas emissions and climate change impacts: clean energy; buildings; transportation; carbon sequestration; climate adaptation; climate governance; and public engagement, partnerships, and education.

WHAT IS CARBON FOOTPRINT?

Carbon footprint is the amount of carbon dioxide including "direct emissions, such as those that result from fossil-fuel combustion in manufacturing, heating, and transportation, as well as emissions required to produce the electricity associated with goods and services consumed. In addition, the carbon footprint concept also often includes the emissions of other greenhouse gases, such as methane, nitrous oxide, or chlorofluorocarbons (CFCs). [A] carbon footprint is usually expressed as a measure of weight, as in tons of CO2 or CO2 equivalent per year".[1]

CARBON FOOTPRINT ANALYSIS

A typical carbon footprint analysis measures only the direct emissions generated by fossil fuel consumption for transportation, manufacturing, and building energy use. Some functional master plans, such as the 2018 *Bicycle Master Plan* and 2013 *Countywide Transit Corridors Functional Master Plan*, have used a modified approach focused exclusively on changes in VMT in the carbon footprint analysis, since those plans did not include specific land use recommendations (such as zoning) that would generate data on projected square feet of non-residential development or numbers of

[1] https://www.britannica.com/science/carbon-footprint

residential units. Corridor Forward: The I-270 Transit Plan (Corridor Forward) employs a similar approach to those functional master plans.

RESULTS

The results of the VMT analysis are included in **Table 1**, which includes the daily totals for four different geographies: the entire metropolitan Washington region, Montgomery County, Equity Focus Areas (EFAs) within Montgomery County, and the areas of Montgomery County not designated as an EFA (non-EFAs). The analysis was conducted for several scenarios, including an existing condition, a future "no build" baseline condition, the six transit options selected for detailed study, and the three transit network packages (which are a combination of the transit options, with some modifications).

The carbon footprint analysis, included in **Table 2**, is built off the VMT analysis. For each scenario, a factor was applied to the VMT results to calculate each type of emissions (CO_2 emissions, hydrocarbons, etc.). As a result, the relationship between each scenario is the same for the VMT and carbon footprint analysis. For ease of explanation, only the VMT analysis results are described below. However, the findings and relationship between each scenario is the same for the VMT and carbon footprint analysis.

Consistent with the anticipated population and employment growth in the region and Montgomery County between 2015 and 2045, VMT is anticipated to rise in the coming decades. Each of the transit options and networks evaluated would reduce VMT from the "no build" baseline, but that reduction is relatively small. At the regional level, VMT reductions do not exceed 0.2%, and reductions within Montgomery County do not exceed 1% of "no build" VMT.

VMT reductions for the network packages exceed the VMT reductions for the individual options, indicating that a combination of transit options is more effective at reducing emissions than a singular transit project. The recommended transit network includes elements from Network Package 2 and Network Package 3, discussed in greater detail in Appendix 3 – Metrics and Performance.

EQUITY ANALYSIS

In addition to understanding emissions regionwide and countywide, an additional analysis was conducted to evaluate the how VMT reductions are distributed across the county, specifically between EFAs and non-EFAs. Approximately one quarter of the county's population lives in EFAs, yet in all scenarios, about a third of trips are generated by EFAs.

This overrepresentation of VMT associated with EFAs represents a disparity – residents of EFAs experience more VMT (and the resulting emissions) per capita than non-EFAs. This disparity is because EFAs – in addition to hosting a concentration of low-income households, people of color, and residents with limited English proficiency – also represent some of the county's job centers, such as Wheaton, Rockville, and Silver Spring. This disparity does not mean that people living in EFAs generate more VMT, but instead that the mix of uses present in EFAs generate more VMT. Residents of EFAs do not drive more than residents elsewhere in the county, but EFAs tend to be areas of greater

activity, and therefore the VMT in those areas are disproportionately high relative to other parts of the county (see Appendix 6 – Equity Assessment for additional information).

Similar to the regionwide and countywide results, the greatest VMT reductions in EFAs are associated with the network packages. However, it is important to note that for all scenarios, non-EFAs experience a greater reduction in VMT than EFAs (as a percent of "no build" VMT), indicating that the existing emissions disparity will not be mitigated by the recommended transit network. In addition to the provision of new transit infrastructure and service, other interventions could be considered to evaluate how VMT and disparities can be reduced, such as lane repurposing, parking management, travel pricing, and travel demand management strategies.

Table 1. Daily Vehicle Miles Traveled

Region											
	Existing (2015)	**No Build (2045)**	**Enhanced MARC**	**Red Line Ext**	**CCT**	**Purple Line Ext**	**Rail to Frederick**	**Enhanced Commuter Bus**	**Network Package 1**	**Network Package 2**	**Network Package 3**
Value	178,017,268	218,640,994	218,567,959	218,483,583	218,611,629	218,596,499	218,481,570	218,530,978	218,357,797	218,355,996	218,347,324
Change from No Build	-	-	-73,035	-157,410	-29,365	-44,495	-159,424	-110,016	-283,196	-284,997	-293,670
% Change	-	-	-0.04%	-0.09%	-0.02%	-0.02%	-0.09%	-0.06%	-0.16%	-0.16%	-0.16%
Montgomery County											
	Existing (2015)	**No Build (2045)**	**Enhanced MARC**	**Red Line Ext**	**CCT**	**Purple Line Ext**	**Rail to Frederick**	**Enhanced Commuter Bus**	**Network Package 1**	**Network Package 2**	**Network Package 3**
Value	19,445,335	22,515,296	22,482,035	22,431,609	22,491,971	22,503,393	22,462,035	22,468,730	22,368,362	22,365,431	22,377,158
Change from No Build	-	-	-33,261	-83,687	-23,325	-11,903	-53,261	-46,566	-146,934	-149,865	-138,138
% Change	-	-	-0.17%	-0.43%	-0.12%	-0.06%	-0.27%	-0.24%	-0.76%	-0.77%	-0.71%
Montgomery County - Equity Focus Area											
	Existing (2015)	**No Build (2045)**	**Enhanced MARC**	**Red Line Ext**	**CCT**	**Purple Line Ext**	**Rail to Frederick**	**Enhanced Commuter Bus**	**Network Package 1**	**Network Package 2**	**Network Package 3**
Value	6,556,666	7,622,522	7,616,998	7,595,923	7,618,222	7,620,587	7,610,288	7,611,713	7,586,231	7,581,613	7,585,779
Change from No Build	-	-	-5,524	-26,600	-4,300	-1,936	-12,235	-10,810	-36,291	-40,910	-36,744
% Change	-	-	-0.08%	-0.41%	-0.07%	-0.03%	-0.19%	-0.16%	-0.55%	-0.62%	-0.56%
Montgomery County - Non-Equity Focus Area											
	Existing (2015)	**No Build (2045)**	**Enhanced MARC**	**Red Line Ext**	**CCT**	**Purple Line Ext**	**Rail to Frederick**	**Enhanced Commuter Bus**	**Network Package 1**	**Network Package 2**	**Network Package 3**
Value	12,888,668	14,892,774	14,865,037	14,835,687	14,873,749	14,882,806	14,851,748	14,857,017	14,782,131	14,783,818	14,791,379
Change from No Build	-	-	-27,737	-57,087	-19,025	-9,967	-41,026	-35,757	-110,643	-108,956	-101,395
% Change	-	-	-0.22%	-0.44%	-0.15%	-0.08%	-0.32%	-0.28%	-0.86%	-0.85%	-0.79%

Table 2. Emissions Associated with Daily Vehicle Miles Traveled (kilograms)

Region											
	Existing (2015)	**No Build (2045)**	**Enhanced MARC**	**Red Line Ext**	**CCT**	**Purple Line Ext**	**Rail to Frederick**	**Enhanced Commuter Bus**	**Network Package 1**	**Network Package 2**	**Network Package 3**
CO_2 Emissions	71,918,976	88,330,961	88,301,455	88,267,368	88,319,098	88,312,985	88,266,554	88,286,515	88,216,550	88,215,823	88,212,319
Hydrocarbons	107,344	131,841	131,796	131,746	131,823	131,814	131,744	131,774	131,670	131,669	131,663
Exhaust Carbon Monoxide	1,086,795	1,334,803	1,334,357	1,333,842	1,334,624	1,334,532	1,333,830	1,334,132	1,333,074	1,333,063	1,333,010
Exhaust Nitrogen Oxides	244,774	300,631	300,531	300,415	300,591	300,570	300,412	300,480	300,242	300,239	300,228
Exhaust PM2.5	7,121	8,746	8,743	8,739	8,744	8,744	8,739	8,741	8,734	8,734	8,734
Breakwear PM2.5	712	875	874	874	874	874	874	874	873	873	873
Tirewear PM2.5	356	437	437	437	437	437	437	437	437	437	437
Montgomery County											
	Existing (2015)	**No Build (2045)**	**Enhanced MARC**	**Red Line Ext**	**CCT**	**Purple Line Ext**	**Rail to Frederick**	**Enhanced Commuter Bus**	**Network Package 1**	**Network Package 2**	**Network Package 3**
CO_2 Emissions	7,855,915	9,096,180	9,082,742	9,062,370	9,086,756	9,091,371	9,074,662	9,077,367	9,036,818	9,035,634	9,040,372
Hydrocarbons	11,726	13,577	13,557	13,526	13,563	13,570	13,545	13,549	13,488	13,486	13,493
Exhaust Carbon Monoxide	118,714	137,456	137,253	136,945	137,313	137,383	137,131	137,172	136,559	136,541	136,613
Exhaust Nitrogen Oxides	26,737	30,959	30,913	30,843	30,926	30,942	30,885	30,895	30,756	30,752	30,769
Exhaust PM2.5	778	901	899	897	900	900	898	899	895	895	895
Breakwear PM2.5	78	90	90	90	90	90	90	90	89	89	90
Tirewear PM2.5	39	45	45	45	45	45	45	45	45	45	45

Table 2. Emissions Associated with Daily Vehicle Miles Traveled (kilograms) - Continued

Montgomery County - Equity Focus Areas											
	Existing (2015)	**No Build (2045)**	**Enhanced MARC**	**Red Line Ext**	**CCT**	**Purple Line Ext**	**Rail to Frederick**	**Enhanced Commuter Bus**	**Network Package 1**	**Network Package 2**	**Network Package 3**
CO_2 Emissions	2,648,893	3,079,499	3,077,267	3,068,753	3,077,762	3,078,717	3,074,556	3,075,132	3,064,837	3,062,972	3,064,655
Hydrocarbons	3,954	4,596	4,593	4,580	4,594	4,595	4,589	4,590	4,574	4,572	4,574
Exhaust Carbon Monoxide	40,028	46,535	46,502	46,373	46,509	46,524	46,461	46,470	46,314	46,286	46,311
Exhaust Nitrogen Oxides	9,015	10,481	10,473	10,444	10,475	10,478	10,464	10,466	10,431	10,425	10,430
Exhaust PM2.5	262	305	305	304	305	305	304	304	303	303	303
Breakwear PM2.5	26	30	30	30	30	30	30	30	30	30	30
Tirewear PM2.5	13	15	15	15	15	15	15	15	15	15	15
Montgomery County - Non-Equity Focus Areas											
	Existing (2015)	**No Build (2045)**	**Enhanced MARC**	**Red Line Ext**	**CCT**	**Purple Line Ext**	**Rail to Frederick**	**Enhanced Commuter Bus**	**Network Package 1**	**Network Package 2**	**Network Package 3**
CO_2 Emissions	5,207,022	6,016,681	6,005,475	5,993,617	6,008,994	6,012,654	6,000,106	6,002,235	5,971,981	5,972,662	5,975,717
Hydrocarbons	7,772	8,980	8,964	8,946	8,969	8,974	8,956	8,959	8,914	8,915	8,919
Exhaust Carbon Monoxide	78,685	90,920	90,751	90,572	90,804	90,860	90,670	90,702	90,245	90,255	90,301
Exhaust Nitrogen Oxides	17,722	20,478	20,439	20,399	20,451	20,464	20,421	20,428	20,325	20,328	20,338
Exhaust PM2.5	516	596	595	593	595	595	594	594	591	591	592
Breakwear PM2.5	52	60	59	59	59	60	59	59	59	59	59
Tirewear PM2.5	26	30	30	30	30	30	30	30	30	30	30

APPENDIX 6: EQUITY FOCUS AREA ANALYSIS

In 2019, the Montgomery County Council passed Bill 27-19 to establish a racial equity and social justice program. The bill amends the County Code Chapter 33A, Section 33A-14, requiring the Planning Board to "consider the impact of the plan on racial equity and social justice in the County, as defined in Section 2-64A." Per the County Code, racial equity and social justice are defined as "changes in policy, practice, and allocation of county resources so that race or social justice constructs do not predict one's success, while also improving opportunities and outcomes for all people."

In addition, the development of Corridor Forward coincided with an update to the county's general plan, known as *Thrive Montgomery 2050*, which provides broad policy guidance and a framework for decisions about land use, transportation, and related issues under local government influence. The policies and practices in the Planning Board Draft of *Thrive Montgomery 2050* seek to achieve three overarching objectives: economic competitiveness, racial and social equity, and environmental resilience. The policy guidance and overarching objectives of the Planning Board Draft of *Thrive Montgomery 2050* informed the development of Corridor Forward.

EQUITY ANALYSIS

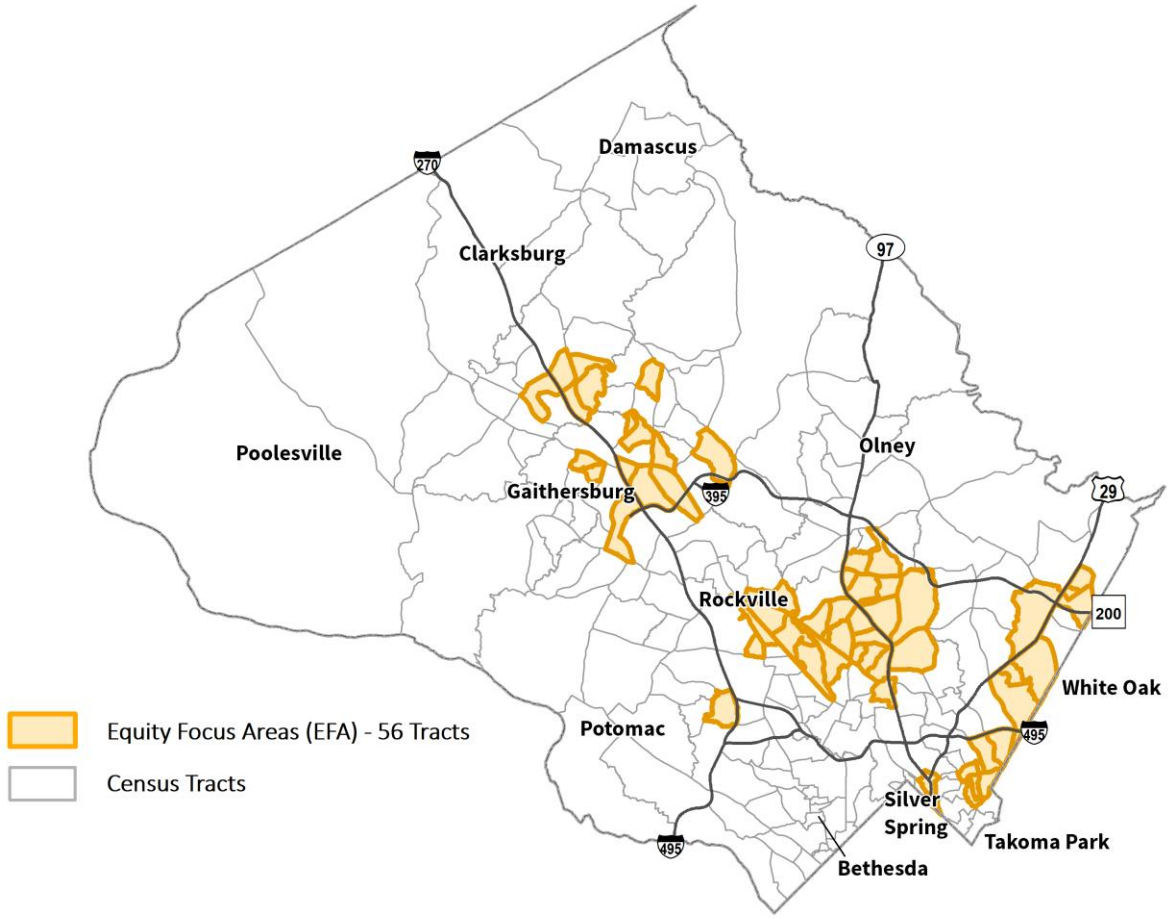
A technical analysis of transit options underpins the Corridor Forward planning process and recommendations. Several metrics were calculated for the six transit options advanced for detailed studied. This section disaggregates several of those metrics to understand if and how Equity Focus Areas differed from more affluent parts of Montgomery County. The analysis is based on a model run for the year 2045.

EQUITY FOCUS AREAS

To aid the Montgomery Planning in evaluating and advancing racial equity and social justice, staff identified Equity Focus Areas (EFAs). EFAs are parts of Montgomery County – displayed in **Figure 1 –** that are characterized by high concentrations of lower-income people of color, who may also speak English less than very well. About 276,000 people (26 percent of county's population) live in EFAs. These areas are primarily found along the I-270 corridor, the US 29 corridor, the MD 97 corridor, and the eastern portion of Downcounty.

According to an initial analysis, the population in EFAs, compared to the county overall, is younger, has a lower educational attainment level, and is more likely to be Hispanic. The annual income of one-third of the households in these areas is under $50,000, and these residents are more likely to pay 35 percent or more of their income on housing costs. Households in EFAs are also less likely to be in owner-occupied housing and are less likely to own a personal vehicle, and the median housing value is two-thirds of the value countywide.

Figure 1. Equity Focus Areas



NEW TRANSIT TRIPS

In 2045, about 270,000 transit trips will be taken daily in Montgomery County. Roughly 100,000 of these transit trips come from EFAs (37 percent) relative to 170,000 from non-EFAs. Given that 26 percent of the county's population lives in EFAs, the proportion of ridership in EFAs indicates an overrepresentation of transit activity in EFAs. This is likely for multiple reasons: many EFAs are along the county's premium transit routes, specifically along the two branches of Metrorail's Red Line (to Glenmont and Shady Grove), and households in EFAs are more likely to rely on transit as a result of their lower rate of vehicle ownership (11.3 percent compared to 6.4 percent for non-EFAs).

Each evaluated transit option adds new transit trips, between roughly 1,500 and 7,000 (**Table 1**). The Red Line extension adds the greatest absolute number of new transit trips to and from EFAs as well as the greatest portion of new trips coming to or from EFAs (37 percent).

Table 1. New Daily Transit Trips (2045)

New Transit Trips	Enhanced MARC	Red Line Ext	CCT	Purple Line Ext	Rail to Frederick	Enhanced Commuter Bus
Montgomery County	1,976	5,099	7,058	1,520	3,649	5,876
Equity Focus Areas	399	1,864	1,424	141	1,066	1,403
Non-Equity Focus Areas	1,577	3,234	5,634	1,379	2,583	4,473

VEHICLE MILES TRAVELED

Vehicle miles traveled (VMT) measures the total distance of automobile travel. Based on the analysis, Montgomery County will experience 22,515,000 daily VMT in 2045. This is comprised of approximately 7,623,000 miles associated with EFAs and 14,892,000 associated with non-EFAs. The proportion of VMT in EFAs (34 percent) exceeds the proportion of the population in EFAs (26 percent), representing a disparity in air quality. This disparity is because EFAs – in addition to hosting a concentration of low-income households, people of color, and residents with limited English proficiency – also represent some of the county's job centers, such as Wheaton, Rockville, and Silver Spring. This disparity does not mean that people living in EFAs generate more VMT, but instead that the mix of uses present in EFAs generate more VMT.

All of the transit options would reduce VMT by between approximately 11,900 and 83,700 miles daily (as shown in **Table 2**). The Red Line extension would result in the greatest reduction in VMT in EFAs, as well as the highest proportion of VMT reduction in EFAS (32 percent).

Table 2. Daily Vehicle Miles Traveled (2045)

VMT Reduction	Enhanced MARC	Red Line Ext	CCT	Purple Line Ext	Rail to Frederick	Enhanced Commuter Bus
Montgomery County	33,261	83,687	23,325	11,903	53,261	46,566
Equity Focus Areas	5,524	26,600	4,300	1,936	12,235	10,810
Non-Equity Focus Areas	27,737	57,087	19,025	9,967	41,026	35,757

Additional analysis related to transit options' VMT is included in the Carbon Footprint Analysis Appendix.

VEHICLE HOURS OF TRAVEL

Vehicle hours traveled (VHT) represents the total duration of automobile travel. Based on the analysis, Montgomery County travelers will experience roughly 774,000 daily VHT in 2045. Of this total, approximately 265,000 VHT occur in EFAs, and 509,000 are associated with non-EFAs. Similar to the results for VMT, the proportion of VHT in EFAs (34 percent) exceeds the proportion of the population in EFAs. Both VMT and VHT are associated with emissions. In addition, high VHT can be associated with congestion (which results in higher emissions than free-flow travel).

As depicted in **Table 3**, all the transit options would result in a reduction in VHT. The VHT reduction is greatest for the Red Line extension, both in terms of the absolute reduction of hours in EFAs as well as the portion of VHT reduction for EFAs (32 percent).

Table 3. Daily Vehicle Hours Traveled (2045)

VHT Reduction	Enhanced MARC	Red Line Ext	CCT	Purple Line Ext	Rail to Frederick	Enhanced Commuter Bus
Montgomery County	1,269	3,083	822	524	1,887	1,650
Equity Focus Areas	199	992	151	85	433	384
Non-Equity Focus Areas	1,070	2,091	671	439	1,453	1,265

JOB ACCESS

Job accessibility measures the number of jobs that can be reached from a certain location within a given travel time and mode. For Corridor Forward, job access was evaluated for transit trips within a 45-minute travel shed. In 2045, the transit job accessibility for the average Montgomery County resident will be 211,000 jobs. This is higher in EFAs (225,000 jobs) relative to non-EFAs (203,000 jobs), representing a relative advantage in job accessibility for EFA residents. As discussed relative to new transit trips, this is partially because many EFAs are along the county's premium transit routes, like along the two branches of Metrorail's Red Line.

As depicted in **Table 4**, all of the transit options improve job accessibility in Montgomery County and for Non-EFAs in Montgomery County. However, while job accessibility increases for almost all transit options in EFAS, extending the Purple Line reduces average job accessibility for EFA residents. It is important to note that this equity analysis solely focuses on EFAs in Montgomery County. The benefit to low-income communities or people of color outside of the county is not accounted for.

Job accessibility gains are greatest for the Red Line extension, for EFAs as well as for the county overall. This is because the Red Line extension provides a one-seat ride to Washington, DC, the region's largest job center.

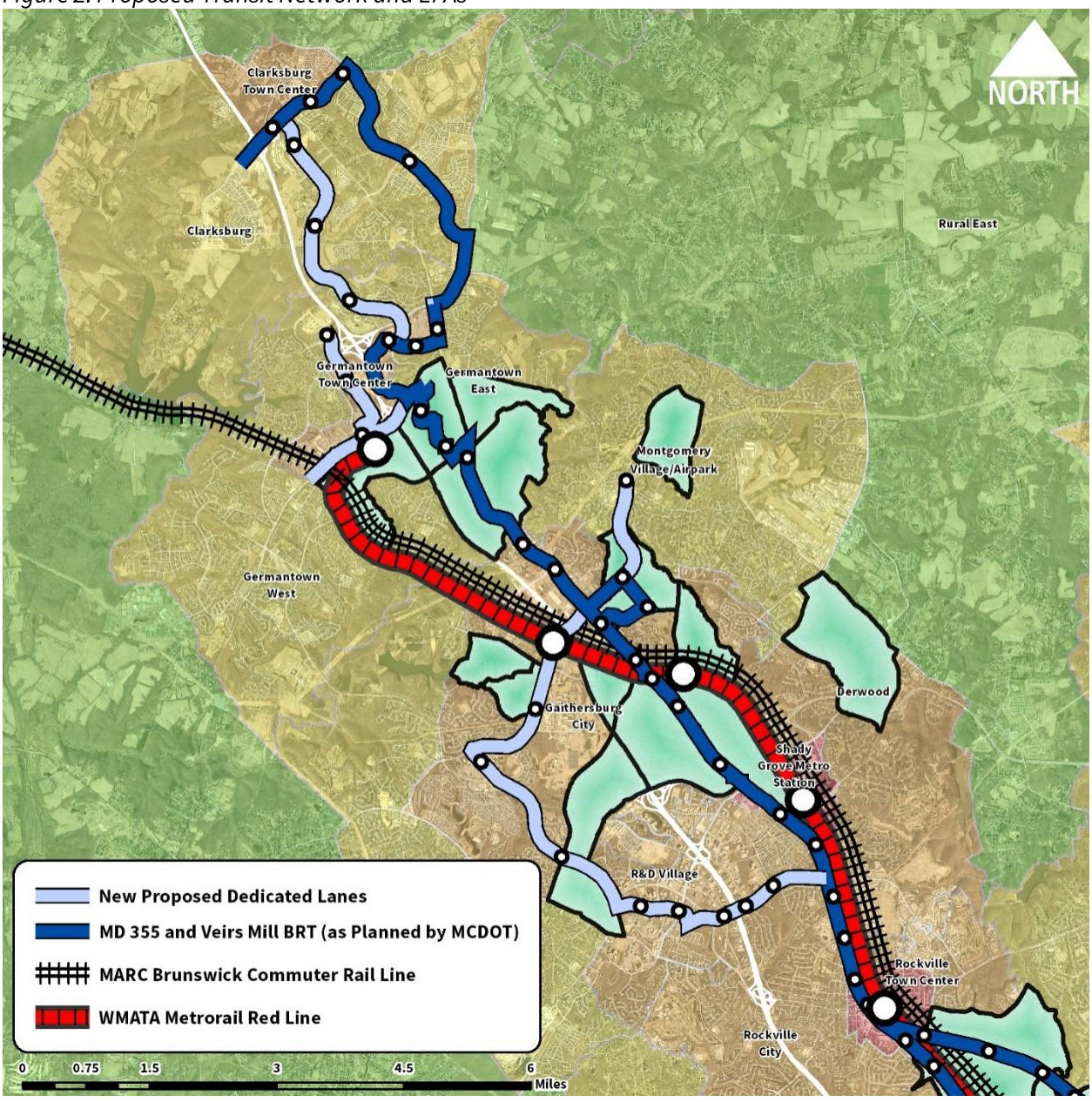
Table 4. Job Accessibility by Transit within 45 Minutes (2045)

Job Accessibility	Enhanced MARC	Red Line Ext	CCT	Purple Line Ext	Rail to Frederick	Enhanced Commuter Bus
Montgomery County	198	9,690	2,613	1,541	3,419	4,428
Equity Focus Areas	523	15,321	2,128	-1,184	3,463	3,664
Non-Equity Focus Areas	17	6,547	2,883	3,062	3,395	4,855

TRANSIT INVESTMENTS IN EQUITY FOCUS AREAS

Corridor Forward's foundational recommendation is to build out a network of dedicated bus lanes and an extension of the Red Line to Germantown. As shown in **Figure 2** (next page), this transit network would provide premium transit infrastructure to EFAs not currently served by rail or bus rapid transit. Several EFAs along MD 355 and Veirs Mill Road would gain improved transit service through those planned investments. The dedicated bus lanes included in the proposed transit network would improve transit connectivity and infrastructure in the Life Sciences Center, Montgomery Village, Germantown, and City of Gaithersburg. The Red Line extension would provide a one-seat ride to Washington, DC for EFAs in Germantown and City of Gaithersburg.

Figure 2. Proposed Transit Network and EFAs



SUPPORTING A MULTIMODAL FUTURE

Several recommendations and actions focus on expanding alternatives to driving along the I-270 corridor. Promoting and enhancing transit, walking, and bicycling can result in a decrease in vehicle travel, which in turn reduces carbon emissions and improves air quality. Given the disproportionate emissions burden borne by residents of EFAs, reductions in vehicle travel supports racial equity and social justice. These recommendations fall in several categories: providing new or improved infrastructure for transit, prioritizing transit investments over vehicle investments, supporting bicycle and pedestrian connectivity and access, and connecting to adjacent jurisdictions, as well as existing and planned transit.

GENTRIFICATION, DISPLACEMENT, AND AFFORDABLE HOUSING

Corridor Forward is not a land use plan. However, one recommendation focuses on changes to the planned land use along the corridor, with a focus on transit-oriented development and mitigating displacement risk. Increased density in proximity to new transit stations as well as dedicated efforts to create affordable housing and preserve existing business supports racial equity and social justice by allowing a more diverse cross-section of residents to stay or move to communities in close proximity to premium transit.

In addition, while Montgomery County continues to expand its affordable and attainable housing options, some households find Montgomery County to be too expensive for their families and, as a result, choose to live in other jurisdictions. As part of the plan's outreach, staff rode RideOn Route 101 during the morning commute period. Multiple southbound passengers indicated that they lived in Frederick County, but commuted to Montgomery County by transit (transferring onto Route 101 at Lakeforest Mall). Based on the existing and anticipated growth in travel demand between the two jurisdictions, the Plan includes a recommendation to strength transit connections between Montgomery and Frederick Counties.

APPENDIX 7: COMMUNITY OUTREACH

INTRODUCTION

The Montgomery County Council added Corridor Forward: The I-270 Transit Plan to the Montgomery County Planning Department (Montgomery Planning) work program in spring 2019. Montgomery Planning initiated pre-planning work in fall 2019 and launched the plan in spring 2020. At the initiation of the Plan, Montgomery Planning developed a communications strategy to identify stakeholders, consider strategies to educate stakeholders, and inform stakeholders of key deliverables.

Following the development of the Communications Plan, Planning staff began to meet with jurisdictional and agency partners, representative citizen groups, and advocates, as discussed in greater detail in the interagency and stakeholder coordination section of this Appendix. In addition to engaging these stakeholders, Planning staff also initiated community outreach in an effort to inform, educate and solicit feedback from the general public, both through a kick-off meeting as well as through online content. While Planning staff initially envisioned in-person outreach, due to the COVID-19 pandemic, outreach was largely limited to virtual meetings and online content.

INTERAGENCY AND STAKEHOLDER COORDINATION

Planning staff met with agency partners, representative citizen groups, and advocates throughout the development of the Plan, holding over 60 meetings between winter 2020 and fall 2021, with many of the stakeholders listed below.

JURISDICTIONS

- City of Frederick
- City of Gaithersburg Mayor and Council
- City of Gaithersburg Staff
- City of Rockville Mayor and Council
- City of Rockville Planning Commission
- City of Rockville Staff
- City of Rockville Traffic and Transportation Commission
- Fairfax County
- Frederick County

TRANSPORTATION AGENCIES AND ORGANIZATIONS

- Maryland Department of Transportation - Maryland Transit Administration
- Maryland Department of Transportation - State Highway Administration
- Metropolitan Washington Council of Governments (MWCOG)
- Montgomery County Department of Transportation
- Montgomery County Transportation Management Districts
- Northern Virginia Transportation Commission
- Washington Metropolitan Area Transit Authority (WMATA)

OTHER STAKEHOLDERS

- Coalition for Smarter Growth
- Community Action Boards
- Gaithersburg-Germantown Chamber of Commerce
- Greater Washington Partnership
- Great Seneca Science Corridor (GSSC) Implementation Advisory Committee
- High Road Foundation
- Housing Opportunities Commission Montgomery County
- Maryland Building Industries Association
- Montgomery County Agricultural Center
- Montgomery Parks
- NAIOP - Commercial Real Estate Development Association
- Universities at Shady Grove

COMMUNITY MEETINGS

SEPTEMBER 30, 2020: COMMUNITY KICK-OFF MEETING

Montgomery Planning held a community kick-off meeting on September 30, 2020. Due to the ongoing COVID-19 pandemic, the meeting was held virtually on Microsoft Teams Live. During the meeting, Planning staff provided an overview of Corridor Forward, its scope and schedule, and the results of the transit values questionnaire as of the meeting date (described in more detail below). Following the presentation, staff facilitated a panel discussion with representatives from Montgomery Planning, Montgomery County Department of Transportation, Maryland Department of Transportation Maryland Transit Administration, and the Coalition for Smarter Growth. Over 180 people registered for the event, and over 80 participated in the virtual meeting. As of this writing, the recorded video of the event, which is posted on the Plan's website, has been viewed 113 times.

JULY 20, 2021: COMMUNITY PRESENTATION

Montgomery Planning held a second virtual community meeting on July 20, 2021. During the meeting, Planning staff provided an overview of the work completed since the community kick-off meeting and also discussed the six transit options retained for detailed analysis and evaluation, which were identified in the initial stage of the plan. Planning staff also described the evaluation metrics that would inform the prioritization of transit options and outlined how responses from the Transit Values Questionnaire informed the development of these metrics. The meeting was also held via Microsoft Teams. As of this writing, the recorded video of the event, which is posted on the Plan's website, has been viewed 76 times.

OCTOBER 20, 2021: COMMUNITY PRESENTATION ON PRELIMINARY RECOMMENDATIONS

Montgomery Planning held a third virtual meeting on October 20, 2021. During the meeting, Planning staff presented preliminary recommendations, including a recommended transit network, to serve communities and employment centers along the I-270 corridor. Over 95 people registered for the event. As of this writing, the recorded video of the event, which is posted on the Plan's website, has been viewed 30 times.

EDUCATIONAL MATERIALS

In addition to the interagency and stakeholder coordination, as well as virtual community meetings, Planning staff also completed several outreach initiatives to educate and inform stakeholders and the community of the Plan. These initiatives are discussed in greater detail below.

VIDEOS

Staff developed five brief videos, which were hosted on the project website, to educate the public about transit planning and Corridor Forward. These videos provided the public with a foundational understanding of the project and transit planning terms and concepts:

- **Introducing Corridor Forward.** This video provided an overview of Corridor Forward, summarized the Plan's purpose and the existing transit options that were evaluated as part of the Plan.
- **What is Transit?** This video introduced and summarized several transit modes, including bus, bus rapid transit (BRT), light rail transit, subway or heavy rail transit, commuter rail, and monorail.
- **Why is Transit Important?** This video outlined the environmental, equity, and economic benefits of transit and tied these benefits back to *Thrive Montgomery 2050*.
- **How is Transit Funded?** This video defined capital and operating costs and described how fares typically cover only a portion of transit's operating costs. It outlined tradeoffs in transit planning associated with determining a service's mode, frequency, and fares.
- **How Do We Plan for Transit?** This video explained the role of existing and future demand in determining transit planning priorities and discussed the tradeoffs between access and efficiency, regional and local service, and transfers and "one-seat" rides. It concluded with a brief discussion of the role of economic development in transit planning.

WEB MAP

Staff published an interactive web map that displayed information on where people live and work, how they travel to work, and the travel options available to them along the I-270 corridor. The map allowed users to review these metrics for communities and employment centers located along the corridor in Montgomery County, Frederick County, the District of Columbia, Fairfax County, Alexandria, and Arlington. The map highlighted some of the transportation challenges and opportunities along the I-270 corridor: that job accessibility is far greater by car than by transit, and that many commuters in the region commute more than 45 minutes to work.

INFOGRAPHIC

Staff developed an infographic highlighting how transit advances the county's environmental, equity, and economic values, as well as benefits community health. The infographic, included as an attachment to this Appendix, included statistics from local and national research to quantify transit's role in supporting these values and made the case that transit is a beneficial and necessary part of the county's future.

TRANSIT VALUES QUESTIONNAIRE

Outreach for the Plan began with a Transit Values Questionnaire, to understand travelers' values and priorities for transit along the I-270 corridor. The online questionnaire was publicized through social

media, the Plan's e-newsletter, during targeted meetings with stakeholders (such as a coordinated meeting of the Transportation Management Districts), and during the September 30, 2020 community kick-off meeting.

NON-VIRTUAL ENGAGEMENT TO PROMOTE TRANSIT VALUES QUESTIONNAIRE

Due to the COVID-19 pandemic, the opportunity for in-person outreach was limited. Planning staff leveraged the online resources noted above to promote the plan, educate stakeholders, and encourage participation – specifically through bus signage and mailers.

BUS SIGNAGE

Planning staff worked with the Montgomery County Department of Transportation to purchase in-bus advertising for routes that run along and in the proximity of the I-270 corridor. The advertising, which was provided in both English and Spanish, direct bus riders to the online Transit Values Questionnaire. The purpose of this outreach strategy was to better understand the priorities and challenges faced by current transit users. In addition, it provided broad exposure to Corridor Forward for transit users in the study area.

Figure 1: Image of Bus Signage

MAILERS

Staff developed targeted mailer postcards that direct recipients to the online transit values questionnaire. The mailers were primarily in English and Spanish, but also included directions in Amharic, Vietnamese, Korean, French, Chinese, and Hindi on how to access translated versions of the online questionnaire. Target communities were identified with the assistance of the Research and Strategic Projects Division's work on Equity Focus Areas.

RESULTS OF TRANSIT VALUES QUESTIONNAIRE

- Total responses received: 282
- Overview of responses:
    - The majority of residents live and work in Montgomery County (62 percent), and most live and work near the I-270 corridor (62 percent).

- Nearly all respondents have access to a personal vehicle (95 percent), which is slightly higher than the county as a whole (93 percent, per the American Community Survey).
- Respondents care more about transit options that provide travel times equal to or better than driving (62 percent) rather than options that relieve congestion (31 percent).
- Respondents want a balance between convenient access (50 percent) and short travel times between major stops (43 percent).
- Respondents' highest priorities include realizing near-term benefits, serving existing centers, and serving existing equity needs. Respondents' lower priorities include realizing long-term benefits, serving areas designated for growth, grappling with potential displacement.
- Balance economic, environmental, and equity benefits to the greatest extent possible.

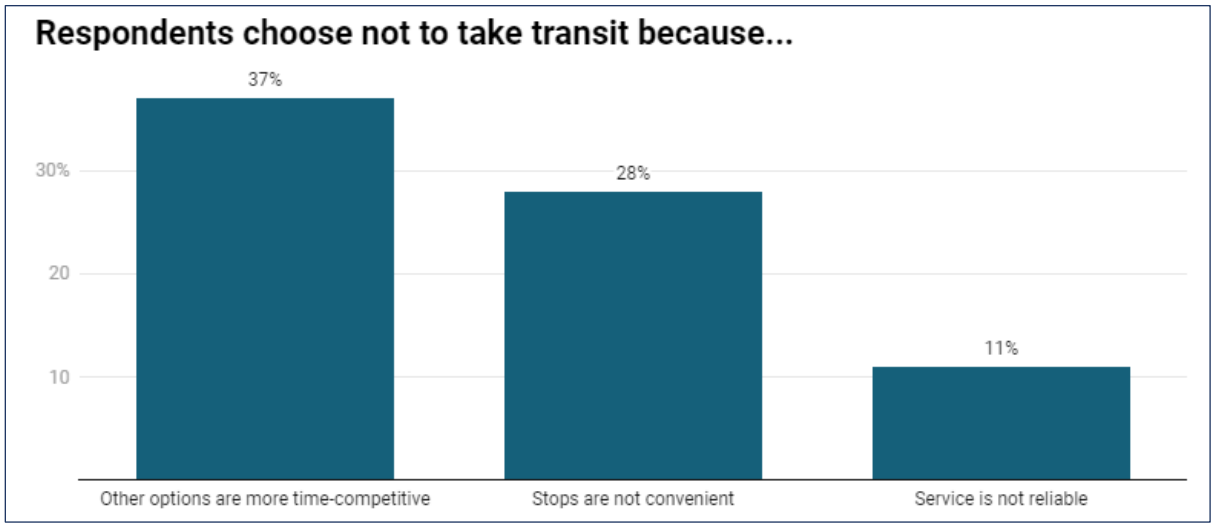


Figure 2: Transit Values Questionnaire

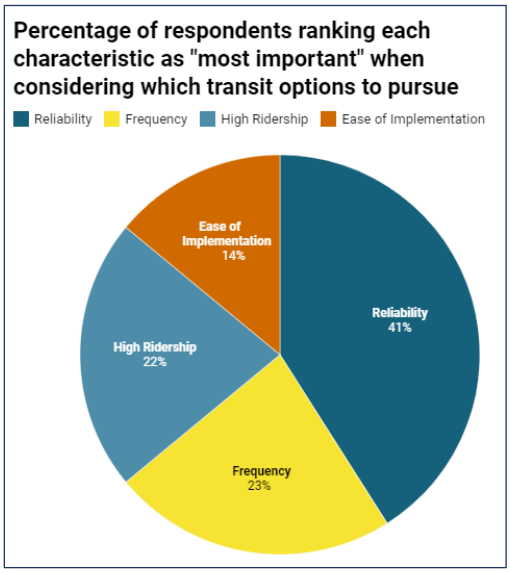


Figure 3: Transit Values Questionnaire

TRANSIT STORY CAMPAIGN

Figure 4: Graphic for Transit Stories Social Media Campaign

In addition to the Transit Values Questionnaire, Planning staff also launched an engagement campaign to gain qualitative feedback and individual narratives about the role, benefits, and challenges of transit serving the I-270 corridor. Montgomery Planning posted a series of tweets to prompt responses about individuals' "transit stories," such as where and why they take transit and the challenges of the existing system. People who do not use social media were invited to participate through a webpage on the Plan website. In addition to the social media effort, staff engaged several nonprofit and community organizations to identify members of the public to interview about how and why they use transit. The stories received include the following:

- *I live near the US 29 corridor and the 270 corridor could use transit as Georgia Avenue should have Ride On.*
- *My wife & I live in Aspen Hill. We bought a house here in 2008 because the area was much more affordable than other parts of Montgomery County, it was reasonably close to amenities (e.g., shopping, restaurants, Rock Creek Park, Strathmore, etc.), and it was roughly halfway between our two workplaces (I work in Howard County, and she works in Gaithersburg). Unfortunately, public transportation isn't really feasible for either of us to get to work. My wife could probably*

*take a series of buses, but the commute time would be way too long to be practical. This is especially true when one have kids, and we have both had occasions when we had to leave work early to pick up a sick child from school or daycare. In the past, I carpooled with a friend/coworker who lived in Rockville, but he moved to Howard County to be closer to work. At the moment, my wife & I are both working remotely most of the time, and I expect we will continue to do so as much as we possibly can in the future. We have used the Metro to go downtown on weekends, but we don't do that very often anymore because we both find the trip can make us somewhat motion-sick. It often seems the train conductors are constantly speeding up & slowing down the trains, rather than just running at a constant speed. My wife is European & generally loves public transportation, but we both notice that trains run much more smoothly when we visit her hometown in Germany. Yes, back when I went to meetings via transit (now the mtgs are all virtual), I used to try to plan my schedule so I could take the Ride-On *rather* than drive. Why? On Ride-On, I could catch up on Twitter, do a Sudoku, or read a book --- none of these are available to me while driving. (Besides, driving in traffic sucks.) When I got to my destination, I didn't have to look for a place to park & got a little exercise walking a couple of blocks to my meeting. Yes, I had to plan to leave a bit earlier, but the "trip" part was more fun!*

- *Before covid, I drove to my job in Baltimore from SS along 95 and then 200 opened up, thank goodness. That shortened the trip a bit but then started getting congested. And now drivers are speeding, tailgating, and lane-hopping worse than ever. MARC train is ok but trip is long and I still have to get from home to station, and then from station to work. I have a friend who uses one of those buses subsidized by govt employer; goes from SS to her job downtown. She loved it until employer switched contractors; driver not as good, bus not as nice. I suppose it was a matter of cost. For non-work travel, I use my car and Lyft or Uber. Public transit seems slightly out control. Riders floss their teeth, put their feet on the seats. Years ago, a Metrorail worker told a seated customer--slouched down low-- to remove his feet from the pole that standing riders have to hold onto. She was serious; the fellow gave her a dirty look but cooperated. I rarely see Metro workers on the subway, or they're just traveling, not looking for civility violations. And maybe that's not their job. I take transit because our car culture is inequitable, highly inefficient, and detrimental to the planet. By designing our communities around motor vehicles, we disenfranchise those who don't have the resources to own and maintain a vehicle. This puts a stark burden on poor folks who then have very limited reach in terms of the opportunities they can access. They won't be able to get jobs outside of a small radius and getting to crucial appointments might be difficult etc. I experienced this in my late teens and throughout college. Whenever I lived somewhere with a lackluster transit system, my life was so much more stressful. Growing up, I wanted to drive as soon as possible. But, now I see how public transit is necessary for an equitable community so I'm choosing to forgo owning a car. Hopefully, with enough committed users, there will be ample funding to develop the transit system our community deserves. A car shouldn't be a necessity for someone to live a reasonably convenient life. Cars are congesting our planet and we use way too much space for parking. If we invest in transit instead, we'll have a lot more space for infrastructure instead of so much of it going to parking and highways.*
- *I have the privilege of choosing between driving or taking transit. There is discussion contrasting personal vehicle trips with transit trips, but I'm not seeing pedestrian routes emphasized with the transit planning. Just because a transit stop is technically within a 20 minute walk of a destination doesn't mean I'm going to choose to make that walk if it feels dangerous and*

uncomfortable; I will drive instead. It does not take much time traveling around Montgomery County to realize the majority of routes are designed exclusively for personal vehicle travel. I believe transit planning needs to take into account improved pedestrian routes near transit stops to maximize their utility.

- *Ride On should be free for all seniors ae 55 and older not 65 as Ride On should operate on Georgia Avenue not WMATA as the 270355 corridor I am not affected as I do and not live there as I am retired.*
- *I live in Montgomery Village and work in DC. During the pandemic I've worked mostly from home and would drive into the office (H St NW and Pennsylvania). Compared to taking the metro where I could decompress, driving became stressful. I could drive the 30 Mike's in 35-40 minutes leaving between 7-8am. On the way home, traffic was already slow going on GW parkway before the Legion bridge by 2:30pm!! It can take. Toll lanes are not helpful for the masses nor will help widespread traffic congestion if people like me will not pay for tolls. We also need to reduce emissions on roads and investing in public transportation. I will go back to using public transit, driving to metro station. It is expensive, $17 per day to ride both ways and park which is not much savings from parking garage rates in DC. My fervent wish is for express metro trains to allow quicker trips during rush hour. Perhaps this would increase riders commuting by car because they'd rather be in their own vehicle than on the metro for equal/more time. For example if express trains during am and pm rush hour could hit half the stops or just designated hubs like other cities do. Overall I think metro needs to be affordable and efficient as possible to entice more drivers to take metro or bus or combination. My husband was working in Alexandra and it would've taken him 1 1/2 hours to get there between metro, bus, walk so he drives, solo everyday to save 40 minutes of his time. He hates sitting in 495/270 traffic but public transportation doesn't serve him well.*
- *Given that we're three people sharing one car -- we use walking and taking the bus a lot. Sometimes we need a Zipcar, but transit serves our needs most of the time. Thanks for Ride-On!*

RIDING THE BUS

Planning staff also rode the Route 101 bus from Lakeforest Mall to Medical Center Metro during the morning commute on July 14, 2021 to speak directly with transit riders about their travel choices.

GENERAL TAKEAWAYS FROM THE BUS RIDE INCLUDE:

1. Because the bus is less expensive than Metro (and is currently free), many riders with the option between the two are choosing to travel by bus. This emphasizes the need for choices between modes.
2. While an extension of the Redline may be very beneficial, many riders may prefer a limited stop bus, if it is less expensive that rail.

PASSENGER ANECDOTES:

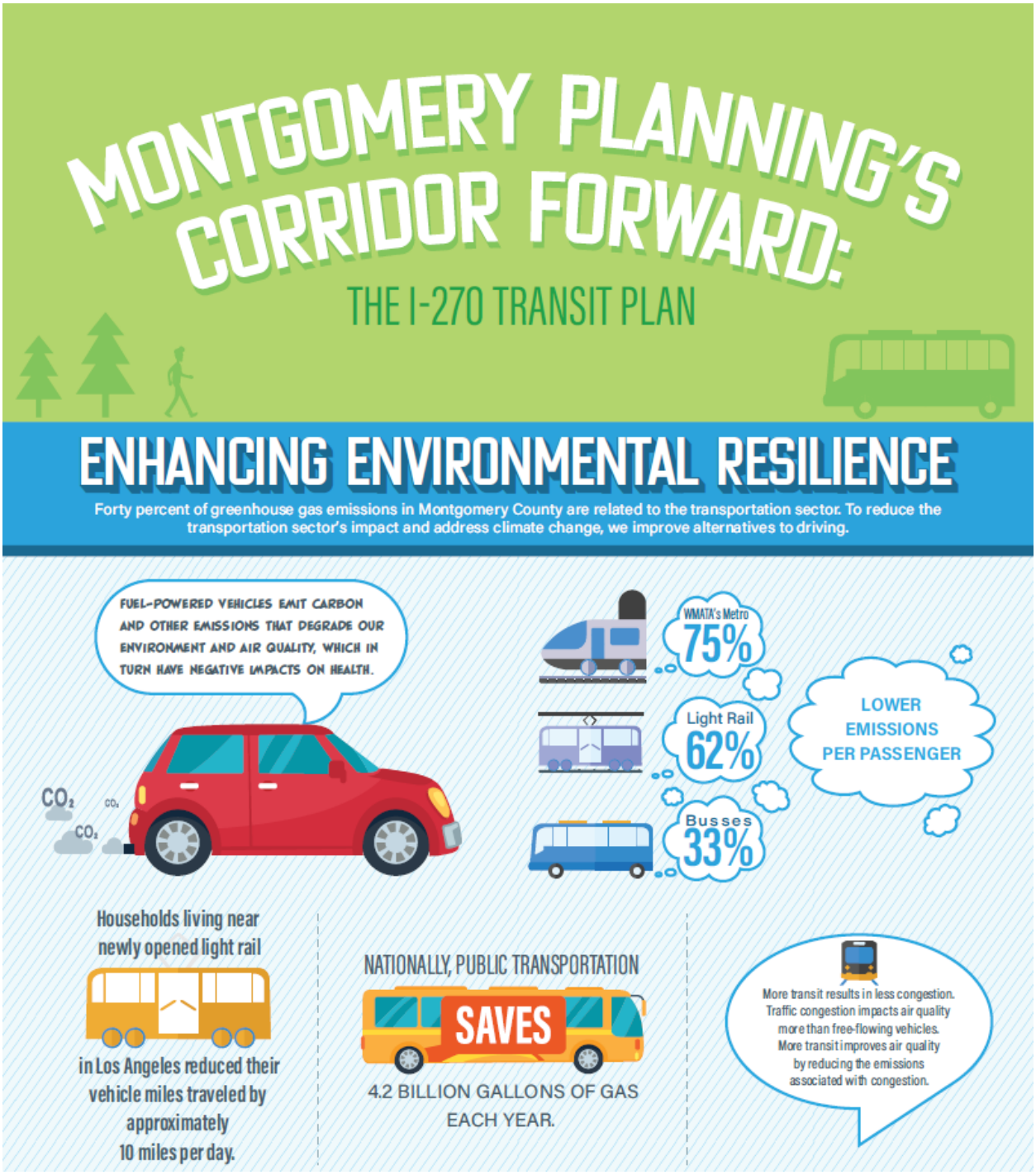
1. Passenger commutes to DC every day to clean homes. She takes the same bus each day, transferring to Metro at Medical Center station. Primarily a Spanish speaker.

2. Passenger commutes from Germantown and transfers buses at Lakeforest Mall. She takes the bus because she owns a car and does not drive. Primarily a Spanish speaker.
3. Passenger takes the bus to NIH. She owns a car, and sometimes chooses to drive instead of taking transit. She takes the bus because it's convenient, but she is a bit worried about COVID-19 once the bus becomes more crowded.
4. Passenger takes the bus to their job at NIH. While he could take either the bus or the train, he often takes the bus as it takes about the same amount of time and is less expensive. He does not own a car, but he is thinking of buying one.
5. Passenger does not have a car and doesn't drive. She sometimes takes the bus and sometimes takes Metro to her job at NIH. While the train is quicker, the bus is less expensive, and the fare is predictable (don't need to keep track of peak vs. off peak, and what time of day she is traveling). The turnstiles and escalators at the Metro make her uncomfortable, and she appreciates that the bus is not too crowded and doesn't require interacting with too many other people.
6. Passenger takes a bus from her home in Frederick to Lakeforest Transit Center and then transfers to the Route 101 to continue to her destination in Bethesda. Her travel time is approximately two hours in the morning, and two hours in the evening. She generally chooses to ride the bus rather than Metro because the bus is less expensive. While the bus not as frequent (especially with COVID-19), if provides a beneficial connection.
7. Passenger takes MARC Rail from West Virginia to Rockville and then transfers to the Route 101 bus to continues to his destination at NIH. (Passenger declined to discuss further.)
8. Passenger takes bus from White Flint to NIH. The passenger prefers to take the Route 101 bus, rather than Metrorail from White Flint to Medical Center because the bus stop is closer to his home than the Metrorail Station (the walk to Metrorail is five minutes longer). The passenger finds the bus is reliable and travels quickly to his destination. While the passenger has a car, he travels to work by transit rather than driving, to leave the family car with his spouse and children.

DRIVER NOTES

1. The driver emphasized the need for dedicated bus lanes. While the roads are not very congested right now (summer 2021), they were very congested in 2019.
2. Because there is little congestion, his route has a long layover before turning around. In 2019, that layover was very short.
3. In 2019, his bus was very full – standing room only. The bus did not run in 2020, and it has limited ridership in 2021.
4. Many people taking this route transfer to the bus from points north of Lakeforest Mall, such as Frederick and Germantown.

ATTACHMENT: INFOGRAPHIC



STRENGTHENING COMMUNITY EQUITY

Owning a car is expensive – between buying and maintaining a vehicle, insurance, gas, tolls and parking, the cost can be a burden. Transit provides a more affordable alternative.

IN URBAN AREAS, TRAVELING BY TRANSIT COSTS 25% TO 50% OF TRAVELING BY AUTO

CHOOSING TRANSIT OVER DRIVING CAN SAVE AN AVERAGE HOUSEHOLD $10,000 PER YEAR.

HOUSEHOLD TRANSPORTATION COSTS DECLINE IN REGIONS WITH HIGH TRANSIT USE.

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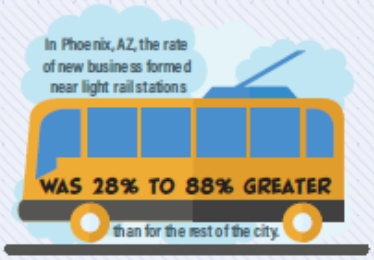
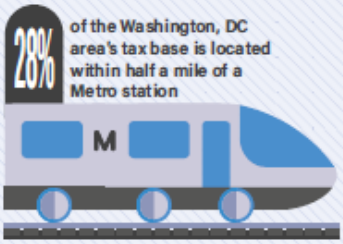
The pollution and negative health effects of transportation are more likely to impact communities of color. In 12 northeast states, the emissions exposure for Latino and African American residents are 75% and 61% higher, respectively, than they are for white residents. More sustainable transportation options, such as transit, can help reduce these disparities.

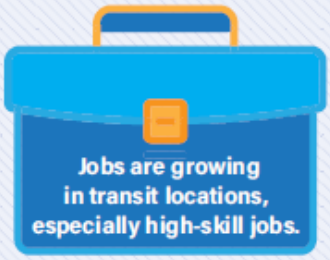
PROMOTING ECONOMIC HEALTH

Because high-quality transit can move large numbers of people to job centers, transit investments can strengthen existing jobs centers and provide a foundation for new job centers.

EVERY $1 BILLION SPENT ON TRANSIT GENERATES $3.6 BILLION IN ADDED SALES VOLUME AND $82 MILLION IN LOCAL SALES TAX AND PROPERTY TAX REVENUE.








PROVIDING HEALTH AND SAFETY
Transit benefits community health by promoting an active lifestyle.
Each percentage point increase in frequent transit use within a jurisdiction results in a 0.5 percentage point decrease in obesity.
Traveling by transit can be safer than traveling by private vehicle.
Transit passengers have about 1/10 the fatality rate of car occupants.
Transit users average about three times as much walking as people who rely on cars, achieving over 20 daily minutes of moderate activity.
ABOUT THE CORRIDOR FORWARD PLAN
The plan will involve community engagement and a detailed evaluation of potential projects, resulting in a prioritized list of transit projects.
For more information, contact Patrick Reed, Corridor Forward Plan project manager, at 301-495-4538 or patrick.reed@montgomeryplanning.org.
Stay informed and subscribe to the Corridor Forward: The I-270 Transit Plan eLetter.
CORRIDOR FORWARD
I-270 Transit Plan
Montgomery Planning
MONTGOMERYPLANNING.ORG

APPENDIX 8. REGIONAL TRAVEL PATTERNS SUMMARY

Corridor Forward identified and evaluated transit options serving communities along the I-270 corridor. In order to conduct this assessment, it was first important to understand travel demand and existing transit along the corridor.

Table 1 summarizes commute trips to Activity Centers along the corridor based on the Metropolitan Washington Council of Governments (MWCOG) regional travel demand model. Activity Centers, defined by MWCOG, are locations that will accommodate the majority of the region's future growth include existing urban centers, priority growth areas, traditional towns, and transit hubs. The majority of trips to Montgomery County Activity Centers originate in Montgomery County. Attachment 1 includes a map of the MWCOG Activity Centers.

Table 1. Commute Trips to Corridor Forward Activity Centers

Activity Center (AC)	Jurisdiction	Commute Trips to Activity Center (AC)	Commute Trips from Montgomery County to AC	% Commute Trips from Montgomery County to AC	Commute Trips from within 2 miles of I-270 in Montgomery County to AC
Bethesda	Montgomery	42,100	16,700	40%	6,600
Clarksburg	Montgomery	2,200	1,500	68%	1,200
Gaithersburg Kentlands	Montgomery	7,200	5,300	74%	3,600
Gaithersburg Central	Montgomery	9,200	6,300	68%	4,200
Gaithersburg Metropolitan Grove	Montgomery	5,400	3,900	72%	2,700
Germantown	Montgomery	16,700	11,000	66%	8,100
Grosvenor	Montgomery	800	600	75%	300
Kensington	Montgomery	6,300	3,400	54%	1,000
Life Sciences Center-Crown Farm	Montgomery	21,800	14,000	64%	9,000
NIH	Montgomery	20,300	9,200	45%	4,000
Rock Spring	Montgomery	17,000	8,400	49%	4,500
Rockville King Farm-Shady Grove	Montgomery	7,600	5,200	68%	3,200
Rockville Montgomery College	Montgomery	5,400	3,600	67%	2,100
Rockville Tower Oaks	Montgomery	2,200	1,500	68%	800
Rockville Town Center	Montgomery	17,100	10,500	61%	6,000
Rockville Twinbrook	Montgomery	19,300	11,000	57%	5,400
Silver Spring	Montgomery	25,500	9,700	38%	2,200
White Flint	Montgomery	22,800	12,300	54%	5,800
Courthouse	Arlington	21,200	1,800	8%	800
Crystal City	Arlington	54,700	4,300	8%	1,800

Table 1. Commute Trips to Corridor Forward Activity Centers (continued)

Activity Center (AC)	Jurisdiction	Commute Trips to Activity Center (AC)	Commute Trips from Montgomery County to AC	% Commute Trips from Montgomery County to AC	Commute Trips from within 2 miles of I-270 in Montgomery County to AC
Pentagon	Arlington	18,600	1,400	8%	600
Pentagon City	Arlington	14,900	1,200	8%	500
Rosslyn	Arlington	42,600	3,900	9%	1,600
Capitol Hill	DC	46,000	8,300	18%	2,800
Downtown DC	DC	129,000	26,300	20%	9,300
Dupont	DC	56,700	13,000	23%	4,900
Farragut Square	DC	245,600	52,500	21%	19,300
Friendship Heights	DC	17,000	5,400	32%	1,900
Georgetown	DC	24,900	4,700	19%	1,800
Monumental Core	DC	84,800	15,500	18%	5,500
NoMa	DC	68,700	13,900	20%	4,500
West End	DC	85,700	18,300	21%	6,900
Dunn Loring-Merrifield	Fairfax	45,500	2,400	5%	1,100
McLean	Fairfax	5,600	500	9%	200
Tysons Central 123	Fairfax	58,700	4,700	8%	2,200
Tysons Central 7	Fairfax	19,400	1,500	8%	700
Tysons East	Fairfax	12,900	1,000	8%	500
Tysons West	Fairfax	15,500	1,200	8%	600
Brunswick	Frederick	900	20	2%	10
Downtown Frederick	Frederick	15,000	500	3%	300
East Frederick Rising	Frederick	4,900	200	4%	100
Fort Detrick	Frederick	8,300	200	2%	100
Francis Scott Key Mall	Frederick	16,500	700	4%	400
Golden Mile	Frederick	4,600	100	2%	100
Jefferson Tech Park	Frederick	500	10	2%	10
Urbana	Frederick	2,100	200	10%	100

Notes: Yellow highlighted cells represent Activity Centers in Montgomery County. Cells in the four rightmost columns are in shades of green. The darker the green, the higher the value relative to other values in the same column.

Table 2 summarizes commute trips by mode and job accessibility to Activity Centers along the I-270 corridor. Within Montgomery County, the portion of commute trips made by transit is generally less than 30 percent with exceptions in Bethesda (45 percent), NIH (41 percent), and Silver Spring (45 percent). Transit rates are higher for Activity Centers in Arlington and Washington, DC, and lower in Frederick and Fairfax Counties.

For all Activity Centers, the number of residents within a 45-minute drive far exceeds number of residents within a 45-minute transit trip. Within Montgomery County, transit access is generally less than 20 percent of auto access, with exceptions for Bethesda (25 percent) and Silver Spring (33 percent). Similar to transit rates, job access by transit is a higher portion of job access by transit for Activity Centers in Arlington and Washington, DC, and lower in Frederick and Fairfax Counties.

Table 2. Commute Trips by Mode and Job Accessibility

Activity Center	Jurisdiction	Commute Trips by Mode		Job Accessibility		
		Commute Trips to Activity Center	% Transit to Activity Center	Residents within a 45-Minute Drive	Residents within a 45-Minute Transit Trip	% Transit Access as % of Auto Access
Bethesda	Montgomery	42,100	45%	2,755,000	692,200	25%
Clarksburg	Montgomery	2,200	4%	2,000,500	11,300	1%
Gaithersburg Central	Montgomery	9,200	15%	2,609,500	124,900	5%
Gaithersburg Kentlands	Montgomery	7,200	12%	2,384,800	104,900	4%
Gaithersburg Metropolitan Grove	Montgomery	5,400	13%	2,431,800	98,800	4%
Germantown	Montgomery	16,700	12%	2,185,900	124,800	6%
Grosvenor	Montgomery	800	15%	2,932,200	514,500	18%
Kensington	Montgomery	6,300	15%	2,767,800	432,100	16%
Life Sciences Center-Crown Farm	Montgomery	21,800	16%	2,769,800	150,600	5%
NIH	Montgomery	20,300	41%	2,782,900	553,600	20%
Rock Spring	Montgomery	17,000	17%	3,008,200	93,500	3%
Rockville King Farm-Shady Grove	Montgomery	7,600	17%	2,962,500	309,400	10%
Rockville Montgomery College	Montgomery	5,400	13%	2,814,900	175,800	6%
Rockville Tower Oaks	Montgomery	2,200	9%	3,132,400	67,300	2%
Rockville Town Center	Montgomery	17,100	22%	2,727,300	492,100	18%
Rockville Twinbrook	Montgomery	19,300	22%	2,718,100	520,300	19%
Silver Spring	Montgomery	25,500	45%	2,948,700	965,200	33%
White Flint	Montgomery	22,800	24%	2,874,700	522,300	18%
Courthouse	Arlington	21,200	47%	3,000,000	981,900	33%
Crystal City	Arlington	54,700	50%	2,976,000	767,400	26%

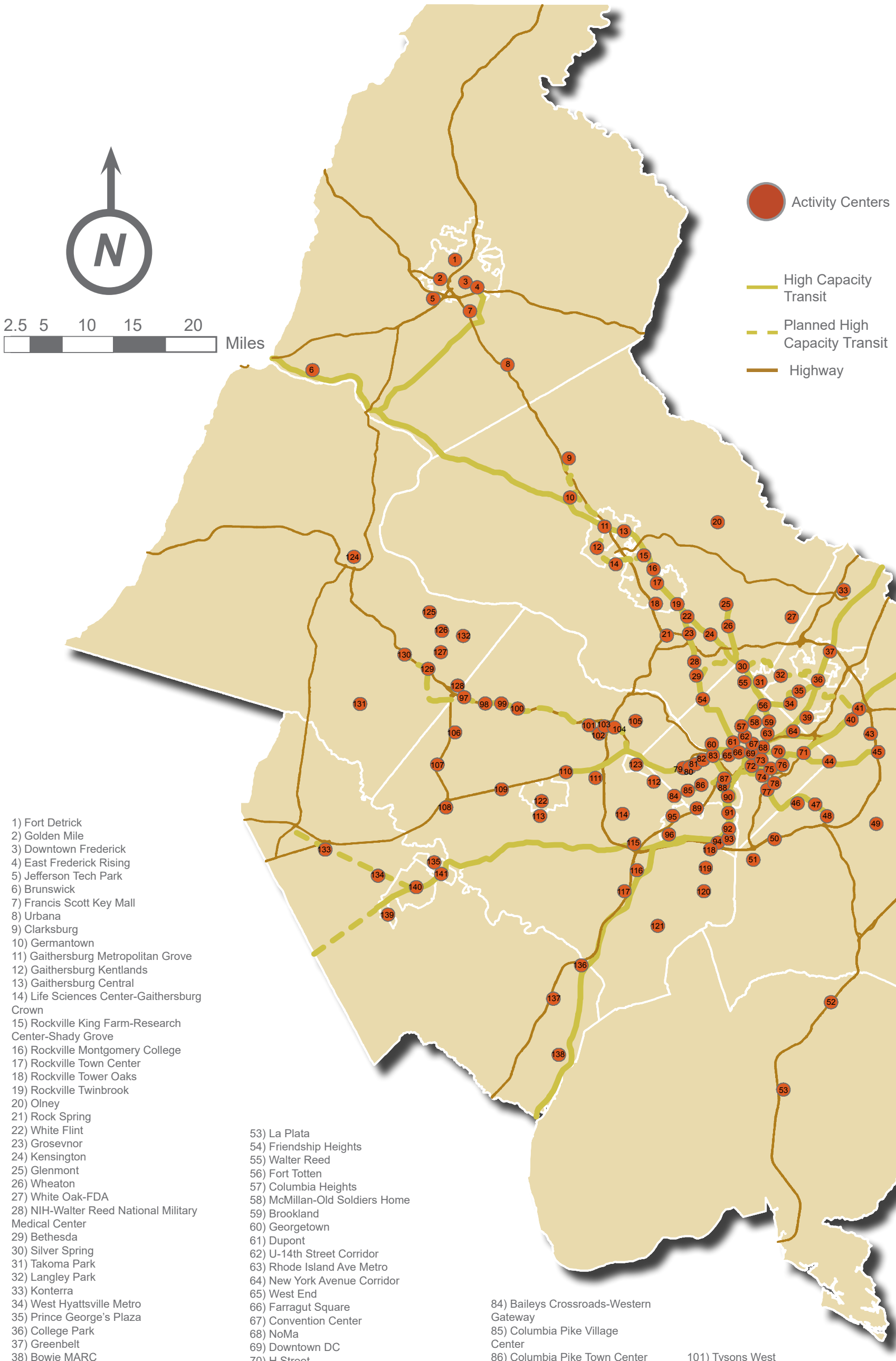
Table 2. Commute Trips by Mode and Job Accessibility (continued)

Activity Center	Jurisdiction	Commute Trips by Mode		Job Accessibility		
		Commute Trips to Activity Center	% Transit to Activity Center	Residents within a 45-Minute Drive	Residents within a 45-Minute Transit Trip	% Transit Access as % of Auto Access
Pentagon	Arlington	18,600	55%	3,029,000	1,187,000	39%
Pentagon City	Arlington	14,900	50%	2,977,900	923,500	31%
Rosslyn	Arlington	42,600	55%	3,022,400	1,002,200	33%
Capitol Hill	DC	46,000	62%	2,950,500	809,900	27%
Downtown DC	DC	129,000	67%	2,926,400	1,162,300	40%
Dupont	DC	56,700	62%	2,826,600	1,087,500	38%
Farragut Square	DC	245,600	67%	2,884,900	891,000	31%
Friendship Heights	DC	17,000	47%	2,769,500	740,400	27%
Georgetown	DC	24,900	42%	2,814,700	205,400	7%
Monumental Core	DC	84,800	65%	3,035,900	1,314,500	43%
NoMa	DC	68,700	63%	3,037,800	1,079,500	36%
West End	DC	85,700	62%	2,993,500	1,167,900	39%
Dunn Loring-Merrifield	Fairfax	45,500	13%	3,109,800	462,600	15%
McLean	Fairfax	5,600	9%	3,357,800	112,700	3%
Tysons Central 123	Fairfax	58,700	15%	3,217,500	489,000	15%
Tysons Central 7	Fairfax	19,400	14%	3,096,500	258,700	8%
Tysons East	Fairfax	12,900	12%	3,394,100	472,700	14%
Tysons West	Fairfax	15,500	13%	3,173,500	287,800	9%
Brunswick	Frederick	900	4%	897,500	3,100	0%
Downtown Frederick	Frederick	15,000	9%	1,369,100	50,100	4%
East Frederick Rising	Frederick	4,900	7%	1,606,400	29,900	2%
Fort Detrick	Frederick	8,300	8%	1,180,300	4,100	3%
Francis Scott Key Mall	Frederick	16,500	9%	1,732,500	6,600	0%
Golden Mile	Frederick	4,600	7%	1,345,800	39,800	3%
Jefferson Tech Park	Frederick	500	3%	1,669,800	7,900	0%
Urbana	Frederick	2,100	5%	1,668,500	7,000	0%

Note: Yellow highlighted cells represent Activity Centers in Montgomery County. Cells in the five rightmost columns are in shades of green. The darker the green, the higher the value relative to other values in the same column.

Regional Activity Centers Map

Submitted to COG Board for Approval January 13, 2013



1) Fort Detrick
2) Golden Mile
3) Downtown Frederick
4) East Frederick Rising
5) Jefferson Tech Park
6) Brunswick
7) Francis Scott Key Mall
8) Urbana
9) Clarksburg
10) Germantown
11) Gaithersburg Metropolitan Grove
12) Gaithersburg Kentlands
13) Gaithersburg Central
14) Life Sciences Center-Gaithersburg Crown
15) Rockville King Farm-Research Center-Shady Grove
16) Rockville Montgomery College
17) Rockville Town Center
18) Rockville Tower Oaks
19) Rockville Twinbrook
20) Olney
21) Rock Spring
22) White Flint
23) Grosevnor
24) Kensington
25) Glenmont
26) Wheaton
27) White Oak-FDA
28) NIH-Walter Reed National Military Medical Center
29) Bethesda
30) Silver Spring
31) Takoma Park
32) Langley Park
33) Konterra
34) West Hyattsville Metro
35) Prince George's Plaza
36) College Park
37) Greenbelt
38) Bowie MARC
39) Port Towns
40) Landover Metro
41) New Carrollton
42) Bowie Town Center
43) Landover Mall
44) Capitol Heights-Addison Rd
45) Largo Town Center-Morgan Blvd
46) Naylor-Southern Ave
47) Suitland
48) Branch Ave
49) Westphalia
50) Oxon Hill
51) National Harbor
52) Waldorf

53) La Plata
54) Friendship Heights
55) Walter Reed
56) Fort Totten
57) Columbia Heights
58) McMillan-Old Soldiers Home
59) Brookland
60) Georgetown
61) Dupont
62) U-14th Street Corridor
63) Rhode Island Ave Metro
64) New York Avenue Corridor
65) West End
66) Farragut Square
67) Convention Center
68) NoMa
69) Downtown DC
70) H Street
71) Minnesota Ave
72) Monumental Core
73) Capitol Hill
74) Capital Riverfront
75) Southwest Waterfront
76) Stadium Armory
77) St. Elizabeths
78) Poplar Point
79) Ballston
80) Virginia Square
81) Clarendon
82) Courthouse
83) Rosslyn

84) Baileys Crossroads-Western Gateway
85) Columbia Pike Village Center
86) Columbia Pike Town Center
87) Pentagon
88) Pentagon City
89) Shirlington
90) Crystal City
91) Potomac Yard
92) Braddock Road Metro Area
93) King Street-Old Town
94) Carlyle-Eisenhower East
95) Beauregard
96) Landmark-Van Dorn
97) Fairfax Innovation Center
98) Herndon
99) Reston Town Center
100) Wiehle-Reston East

101) Tysons West
102) Tysons Central 7
103) Tysons Central 123
104) Tysons East
105) McLean
106) Dulles East
107) Dulles South
108) Centreville
109) Fairfax Center
110) Vienna
111) Dunn Loring-Merrifield
112) Seven Corners
113) George Mason University
114) Annandale
115) Beltway South

116) Springfield
117) Fort Belvoir North Area
118) Huntington-Penn Daw
119) Beacon-Groveton
120) Hybla Valley-Gum Springs
121) Fort Belvoir
122) Fairfax City
123) City of Falls Church
124) Leesburg
125) Ashburn
126) Route 28 North
127) Route 28 Central
128) Route 28 South
129) Ashburn Station
130) Loudoun Gateway Station
131) Arcola
132) Dulles Town Center
133) Gainesville
134) Innovation
135) Yorkshire
136) North Woodbridge
137) Potomac Town Center
138) Potomac Shores
139) City of Manassas Regional Airpo
140) City of Manassas
141) Manassas Park