Veirs Mill Corridor Master Plan Appendix

Contents

Appendix A:

Veirs Mill Corridor ULI mTAP

Veirs Mill Corridor
ULI mTAP

2016-2017 ULI Regional Land Use Leadership Institute

Mini Technical Assistance Panel

Bill Eger | Sarah Goss | Jill Griffin | Walter Ploskon | Joyce Tsepas

Urban Land Institute
Washington

Contents

- mTAP Assignment and Approach
- Background and Research
- Recommendations
  - Improving safety, security and accessibility
  - Strengthening community cohesiveness
  - Leveraging development opportunities
- Appendix

Questions to be addressed by the Panel

- How will BRT influence market affordability, property values, and development pressure adjacent to the transit corridor?
- Can BRT and the associated stations act as a catalyst for reinvestment and/or redevelopment?
- What are the most appropriate uses of the single-family residential homes immediately adjacent to Veirs Mill Road?
- What are potential land use and station area typologies? What improvements should be considered to provide safe and convenient access to the BRT stations along the corridor?
- Should the current station locations be changed? How can the stations be designed and/or located to serve as an instrument for placemaking?

Assumptions

- Recommendations assume BRT is implemented through Alternative #3: New BRT Service in Dedicated Curb Lanes (where feasible)

- BRT stops within the Master Plan area will be located at:
  - Twinbrook Parkway
  - Parkland Drive
  - Connecticut Avenue
  - Aspen Hill Road
  - Randolph Road
  - Newport Mill Road

- Temporal boundary of Master Plan is 20 years

Background and Research

Population and Housing Characteristics

Urban Land Institute Washington

Regional Land Use Leadership Institute

Veirs Mill Corridor

Corridor Overview

KEY FACTS

9,064
Population

36.1
Median Age

3.4
Average Household Size

$57,173
Median Household Income

HOUSING UNITS – YEAR BUILT

KEY FACTS

2,640
2016 Total Households

$46,807
2016 Median Disposable Income

HOUSING REMODELING

$1,560.64
Maintenance & Remodeling Services for Owner-Occupied

HOUSING STATS

$332,130
Median Home Value

$8,450
Average Spent on Mortgage & Basics

$1,224
Median Contract Rent

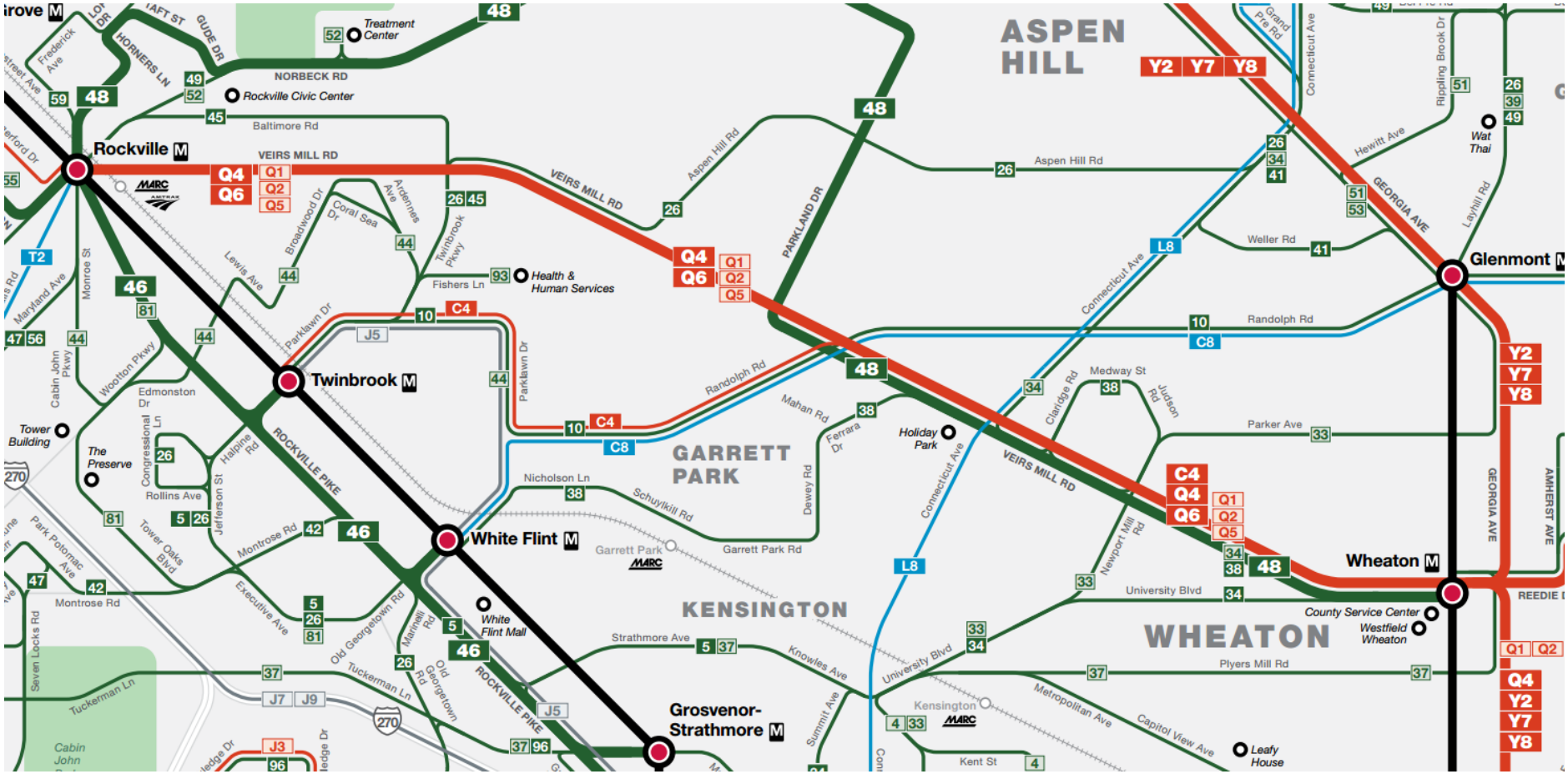
PUBLIC TRANSPORTATION – RIDERSHIP

25.97%
ACS Workers 16+: Public Transportation

Physical Characteristics

- Mix of frontage conditions and setbacks
- State of sidewalks and variable widths
- Service roads
- Variable roadway widths
- Terrain
- Limited transit access
- Uniform residential housing stock

Existing Transit Options



BRT Research

- BRT Case Studies
  - Bogotá
  - Boston
  - Cleveland
  - Los Angeles
  - Ontario
  - Ottawa
  - Pittsburgh
  - Seoul

Euclid Avenue HealthLine BRT (Source: Cleveland.com)

Boston Silver Line (Source: Wikipedia

- Light transportation systems & facilities
  - Standard bus service
  - Light rail
  - BRT

TransMilenio BRT (Bogota, Colombia,)

BRT Research: Example Economic Impacts

- Example BRT system economic impacts:
  - Boston: Approximately 7% increase in condominium value premium
  - Cleveland: Upwards of 2.4% and 1.4 % increase in commercial and residential value premiums, respectively, over 6-year period
  - Ontario:
    - Residential/MF (dedicated-lane = 4-8%, mixed-lane = 2-4%)
    - Commercial (dedicated-lane = 2-4%, mixed-lane = 1-2%)
  - Pittsburgh: Upwards of 11% increase in single-family dwelling value premium

- Example light rail system economic impacts:
  - Range from -4-33% for single-family and condominiums
  - 4-9% for multi-family
  - 5-15% for commercial

BRT Research: Opportunities

- Mixed-lane or dedicated-lane BRT can provide significant transportation benefits and have the potential to increase property value, particularly when implemented with public realm improvements, however they are unlikely to be a primary catalyst for new development

- Support transit-oriented development (TOD) and pro-development policies for new developments to increase potential economic development opportunities leveraging BRT
  - Zoning reforms
  - Development finance and tax policies
  - Land assemblage
  - Supportive infrastructure

- Should new development or redevelopment occur, implementing parking mitigation measures to increase transit ridership and decrease congestion provide additional benefit

BRT Research: Limitations

- Land with limited development potential is unlikely to develop regardless of the quality of transit investment

- A mass transit corridor is more likely to have a significant development impact — without additional government interventions — if it passes through a lot of land that is moderately desirable for redevelopment as opposed to through a small amount of such highly desirable land

- Inability to catalyze private development in an area with limited or no existing market activity

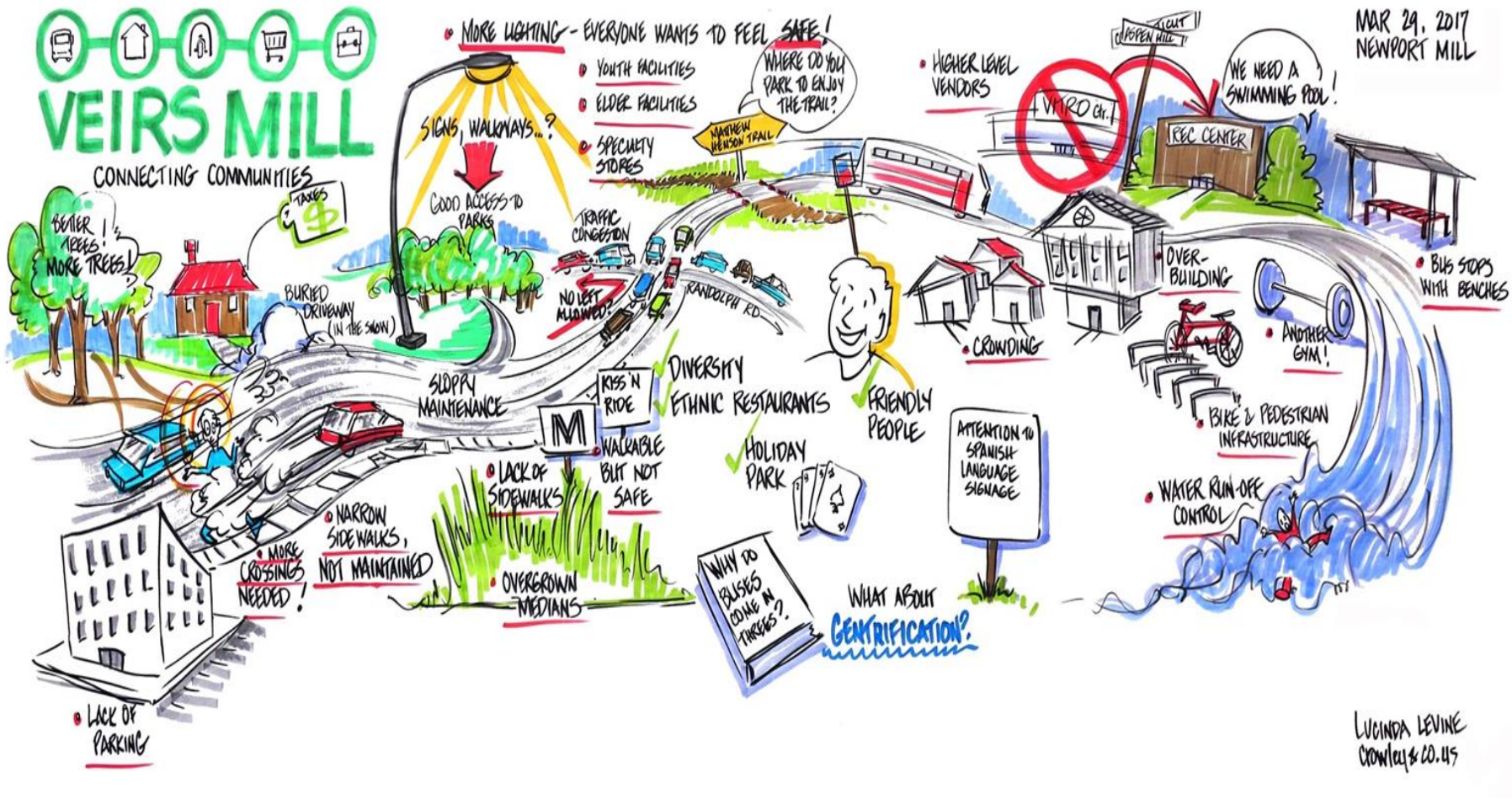
- While physical BRT features convey a sense of permanence to developers, deficient in major institutional, employment, and activity centers along or near the BRT corridor that can sponsor development projects

- BRT corridors appear to be gaining share of new offices; where new transit corridors increased their share of new office space from 11.4 percent to 15.2 percent, but very little of such space exists in the Veirs Mill corridor

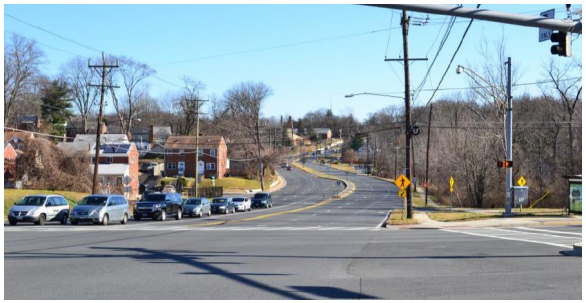
BRT Research: Possible Outcomes

- Evidence from other BRT and light-transportation system projects suggests possible outcomes may include:
  - Modest property land value appreciation within ~¼ mile radius of BRT stops; primarily commercial or mixed-use properties
  - Property land values may appreciate beyond the ~¼ mile radius of a BRT stop, but less than properties within closer proximity to BRT stops
  - In the short run, will likely not increase development pressures or change market conditions for redevelopment of existing housing stock
  - Leverage as a benefit for future infill or development opportunities in select locations
  - Leverage existing conditions to maximize benefit and ridership of BRT system

Community Input



Planning Objectives



Improving safety, security and accessibility

Strengthening community cohesiveness

Leveraging development opportunities

Recommendations

Safety, Security, Access

Data

- Mix of frontage conditions
- Service roads
- Mix of setbacks
- Inconsistent sidewalks
- Transit access
- Variable terrain

Recommendations

- Consistent sidewalks
- Street edge beautification
- Corridor maintenance
- Streetscape
- Parking management

Implementation

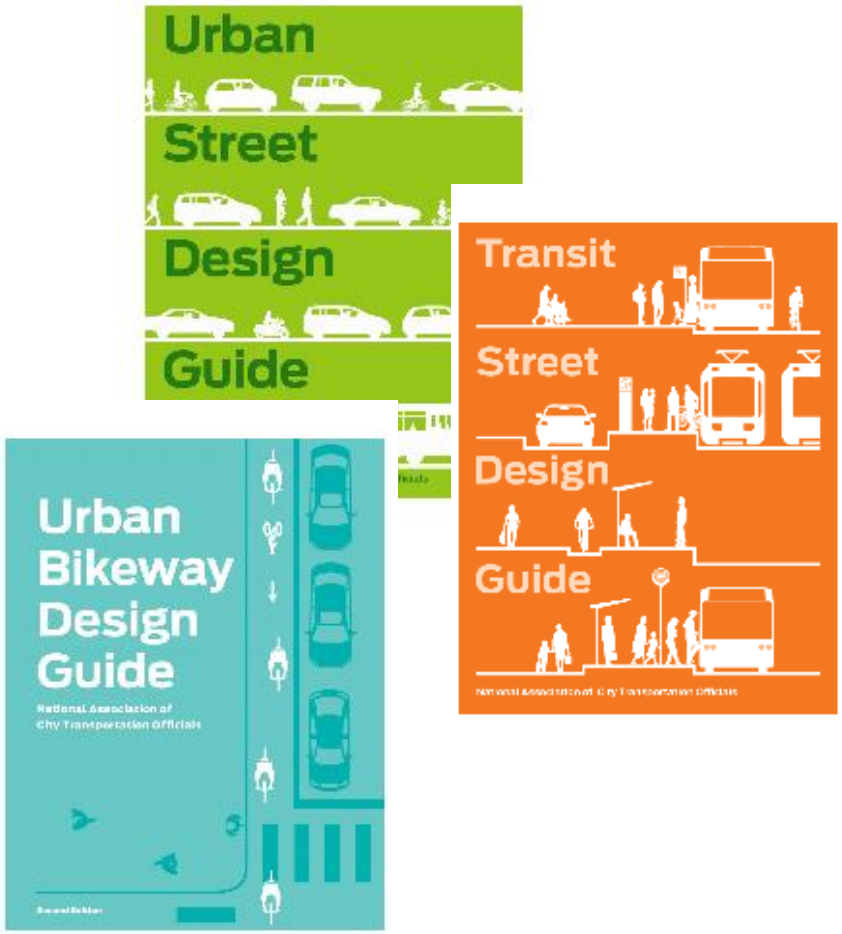
- State MOU
- Dedication of property taxes to O&M obligations

Safety, Security, Access

Safety, Security, Access

Recommendations

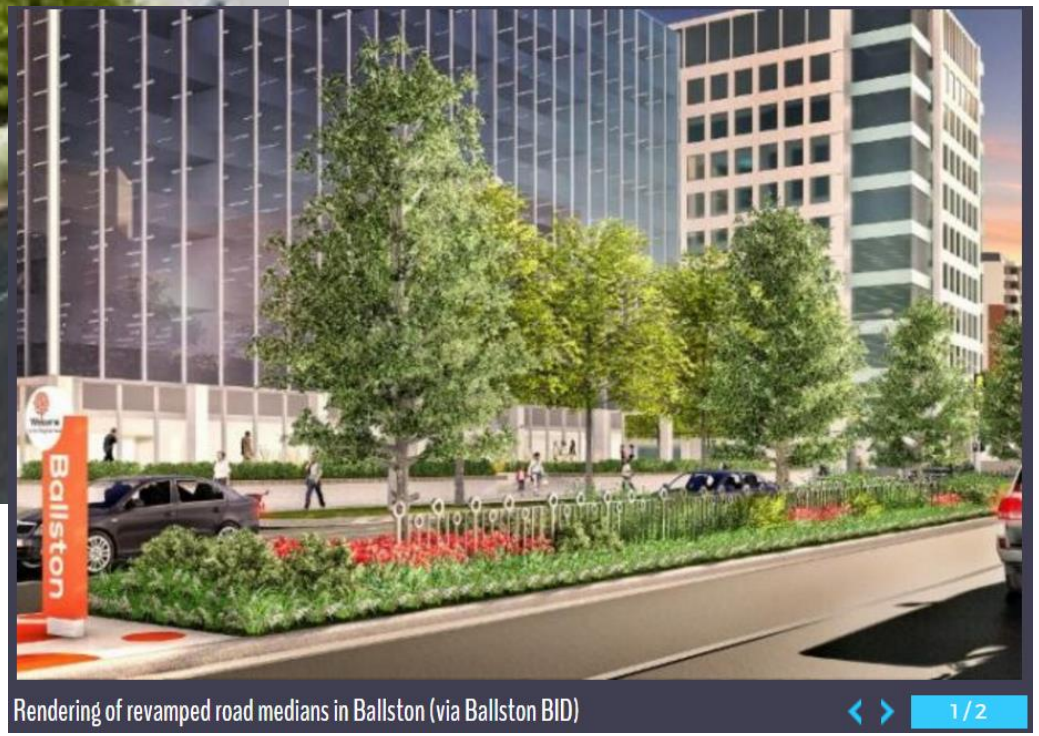
- Consistent sidewalks
- Street edge beautification
- Corridor maintenance
- Streetscape, “Green” corridor
- Complete streets (BRT, bikeway)
- Parking management analysis (consider BRT parking at Randolph)



Resources from NACTO: https://nacto.org/

Safety, Security, Access

Ocean City, NJ (SHA)



Arlington, VA (Ballston BID)

Safety, Security, Access

Implementation Tools

- State MOU for streetscape/beautification
- Dedication of property taxes to O&M obligations
- Develop Complete Streets Policy
- Restricted neighborhood parking
- Revenue generating parking

Example property tax dedication breakdown

	Annual	Capital Raised*
General County Taxes Generated by Veirs Mill Corridor	$8,741,708	
5% Dedication	$437,085	$5,447,050
10% Dedication	$874,171	$10,894,101

*Assuming 5% interest rate and 20 year term

Community Cohesiveness

Data

- BRT System Review
- Analysis of property sales
- Missing Middle typology

Recommendations

- Maintain existing zoning and density
- Preserve home values
- Placemaking
- Offset ped/bike path along Rock Creek extent (low bollard lighting)

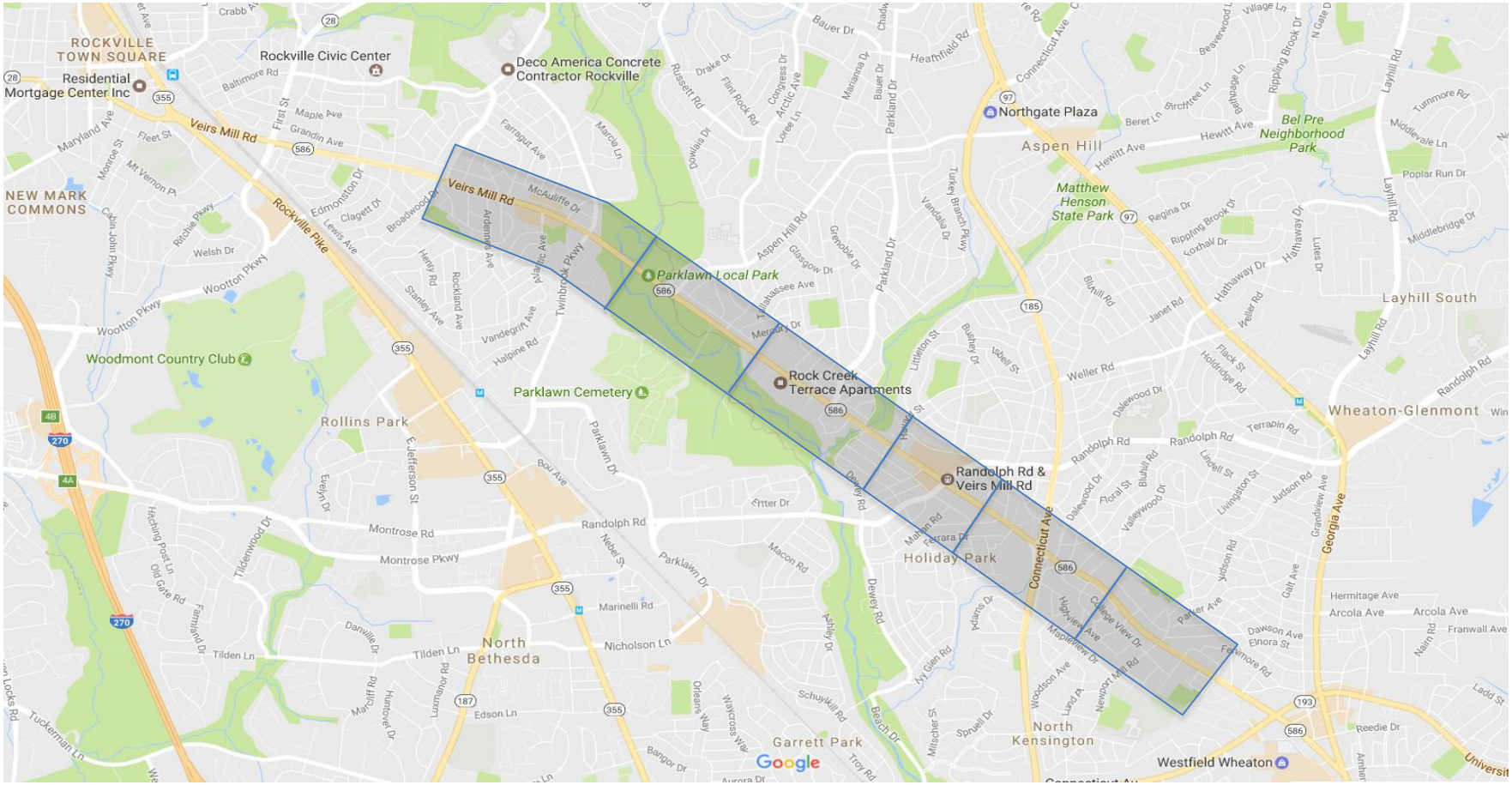
Implementation

- Home improvement opportunities
- Permitting processes
- Improving compatibility of land uses
- Pop-up programming, public art, markets
- Partnership with churches & community organizations
- Conservation districts

Community Cohesiveness

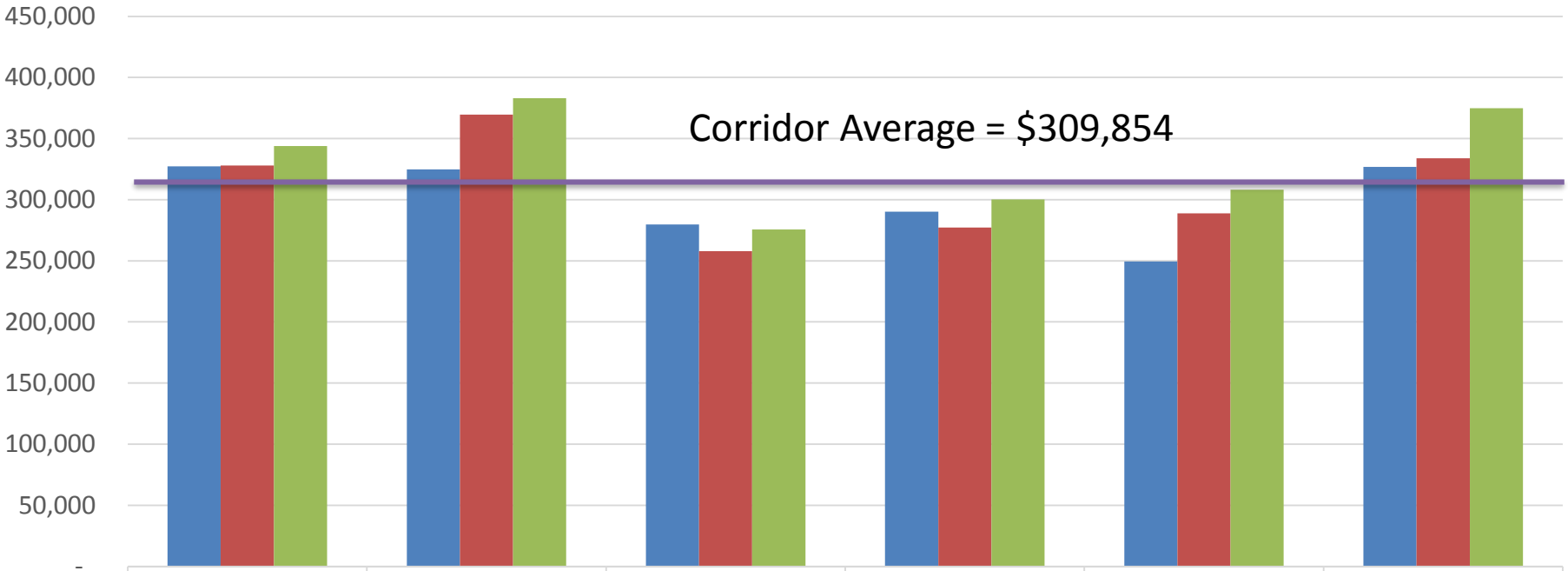
Community Cohesiveness

Node Boundaries



Community Cohesiveness

Average Sales Price by Node

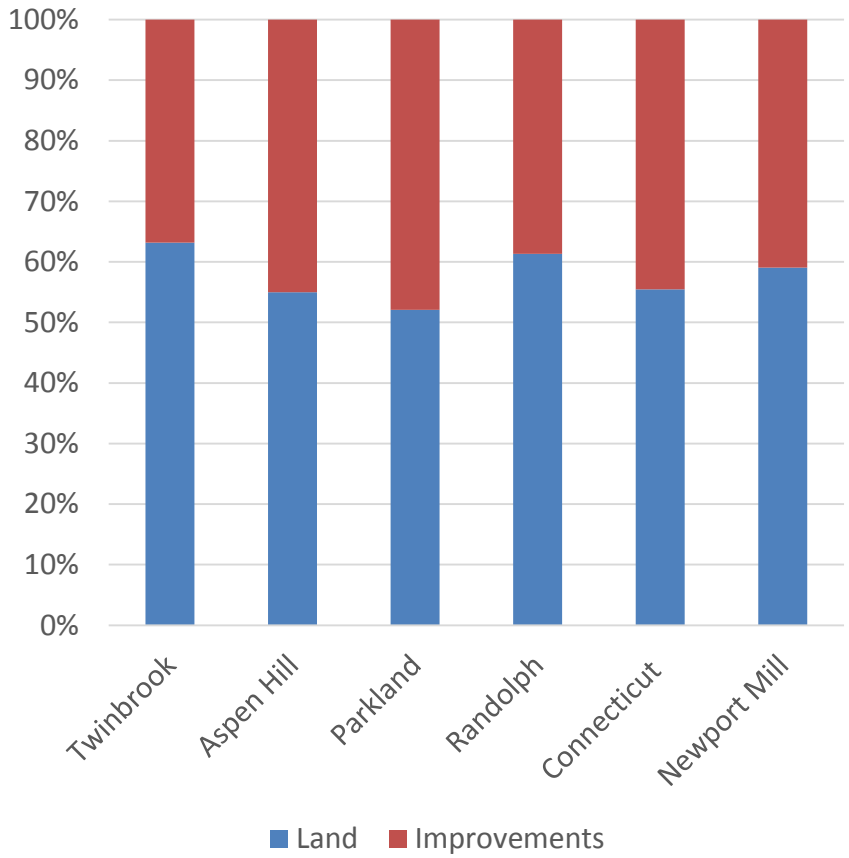


	Twinbrook Parkway	Aspen Hill Road	Parkland Drive	Randolph Road	Connecticut Avenue	Newport Mill Road
2014	327,314	324,673	279,722	290,102	249,573	326,760
2015	327,938	369,687	257,864	277,129	288,752	333,894
2016	343,891	383,111	275,611	300,194	308,101	374,821

Source: SDAT 2014-2016 Property Sales within 0.25 miles of Veirs Mill Road

Community Cohesiveness

Breakdown of Price by Land vs Improvements



Price Point by Dwelling Type

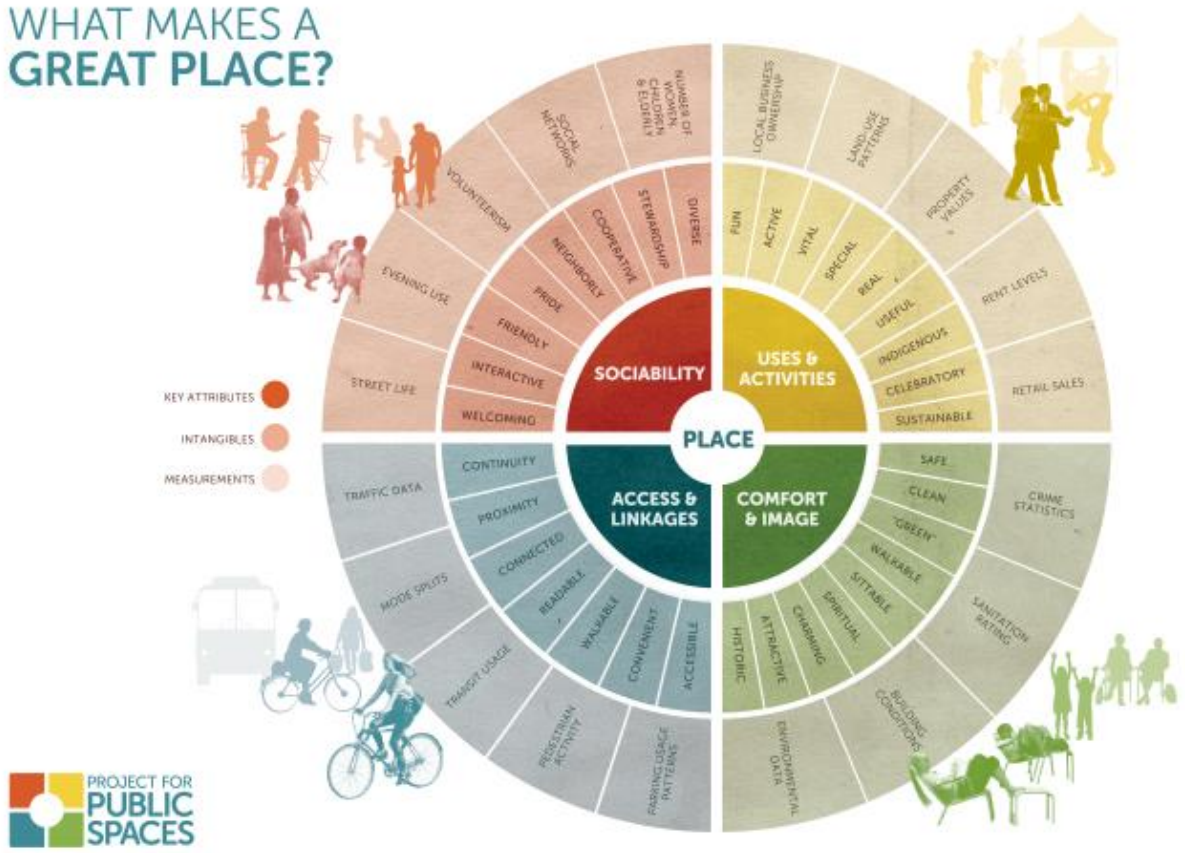
	SFD 1 STY	SFD 1.5 STY	SFD 2 STY	TH	Condo
Avg	308,450	330,766	373,348	260,007	192,848
Upper Midpoint	350,000	370,000	407,000	334,900	227,000
Max	599,000	473,000	700,000	374,000	415,000
Min	60,000	65,275	193,000	100,000	115,000
Median	315,750	340,000	371,500	246,000	151,000

Source: SDAT 2014-2016 Property Sales within 0.25 miles of Veirs Mill Road

Community Cohesiveness

Recommendations

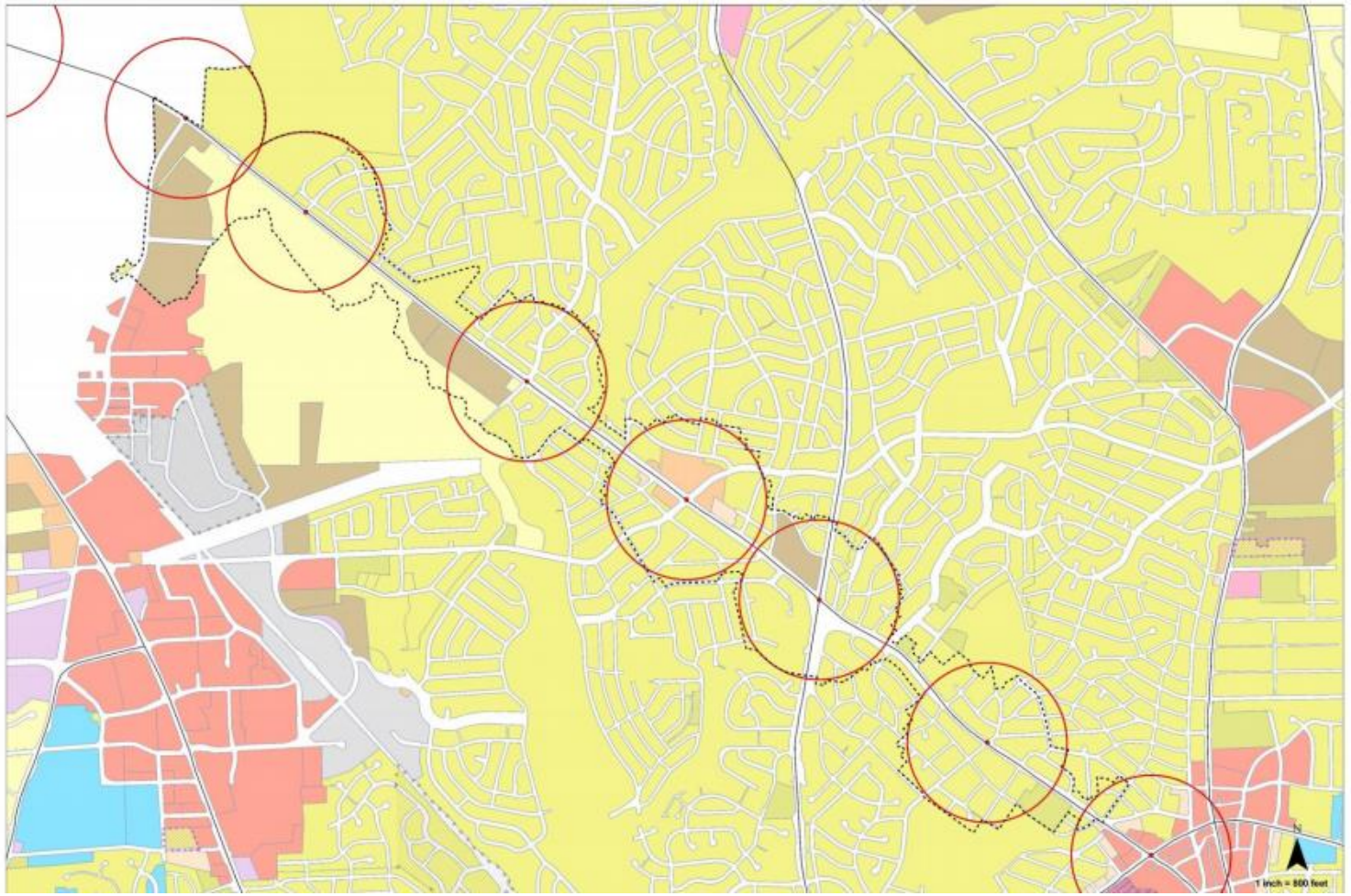
- Maintain existing zoning and density
- Preserve home values
- Placemaking
- Explore Low Impact Development Opportunities
- LED lighting retrofit and Rock Creek Park pathway
- Evaluate feasibility of Neighborhood Conservation District/ elements



https://www.pps.org/reference/what_is_placemaking/

Community Cohesiveness

PLAN AREA – LAND USE AND ZONING



Community Cohesiveness

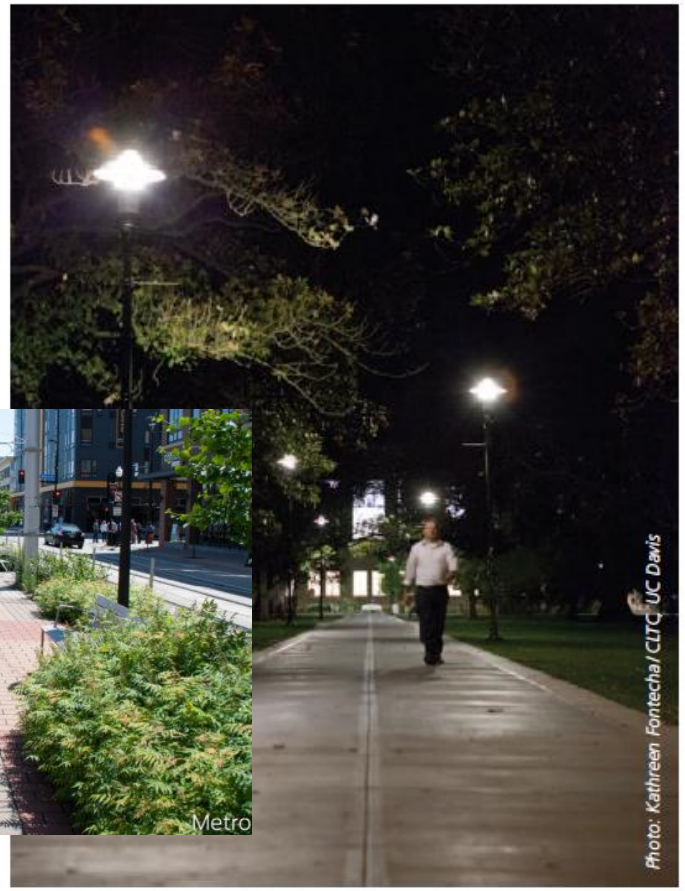
Community Cohesiveness

Implementation Tools

- Home improvement programs
- Permitting processes
- Pop-up programming, public art, markets
- Partnership with churches, community organizations
- Neighborhood Conservation Districts
- LED lighting retrofit
- Low Impact Development

NACTO Stormwater Guide

Figure 11. LED pathway lighting at UC Davis



NPS Outdoor Lighting Retrofits Guide

Community Cohesiveness

Home Improvement Programs

- Educate Homeowners on existing home improvement financing options
  - HUD Section 203(k) Loan Program
  - HUD Property Improvement Loan Insurance (Title I)

- Amend the Single Family Home Improvement Loan Program to allow for uses beyond addressing code violations and modify the repayment terms

- Offer an income tax credit on qualifying repair, renovation or improvement work

- Create an alternative to the Homestead Property Tax Credit by offering one-time incentive payments based on the amount of the increase in County taxes

Community Cohesiveness

Pop-up Programming

Open streets initiatives temporarily close streets to automobile traffic, so that people may use them for walking, bicycling, dancing, playing, and socializing.

http://openstreetsproject.org/

Community Cohesiveness

Public Art

- Station design can:
  - provide a sense of place
  - project community values
  - foster ownership

Public art can be a tool to facilitate community dialogue & enhance station design.

TriMet Orange Line - Portland, OR

Krumback, Austria (via CityLab.com)

Potomac Yard/Crystal City Transit Way - Arlington County, VA

Community Cohesiveness

Community Art

Photo: www.greatcity.org, Seattle, WA

Photo: Greg Raisman, Portland, OR

What is an Intersection Mural?
It's a permanent mural that's painted on the pavement at an intersection. It's used as a community-building tool—murals are generally designed by the neighborhood, and represent the local community. Experience from other cities shows that intersection murals can help calm traffic, and foster a sense of community identity (these murals can be found in multiple cities, including Seattle, WA, Portland, OR and Ft. Lauderdale, FL).

Intersection murals are a simple, low cost way to reclaim streets as a shared space for the whole community to enjoy.

What are the benefits of Intersection Murals?
Intersection murals have many benefits, including:

- Bringing neighbors together to create a sense of community
- Traffic-calming
- Place-making—murals can represent the communities that surrounds them
- Making streets more enjoyable!

The mural continues to be an important neighborhood anchor, slowing down cars and providing residents with a safer place to walk, cycle, or admire the work of their community. Over time, as the mural begins to fade from sun and use, Haley and others see this as a perfect opportunity to bring everyone together again to repaint the mural and create a tradition around co-creation. With each quilt "square," Montclair's Placemaking movement will continue to grow.

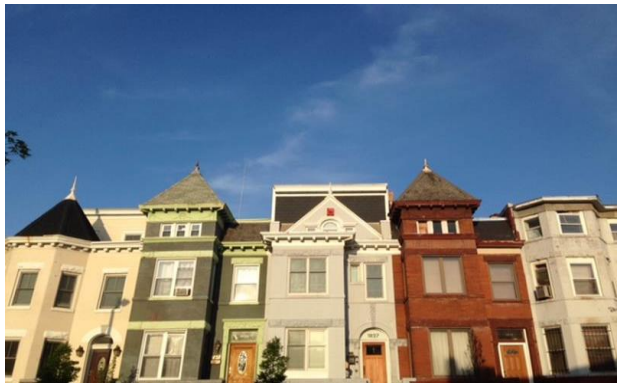
Montclair, NJ (from PPS.org)

Community Cohesiveness

Neighborhood Conservation Districts

- Types
  - Purpose to preserve historic resources or architecture character
  - Purpose to regulate urban form or land use, in anticipation of redevelopment

- Administration
  - Zoning or planning board/ commission
  - Planning department
  - Independent neighborhood group/ commission



Community Cohesiveness

Example: Lincoln Park Neighborhood Conservation District

- Assemblage of separate lots not permitted
- 25% lot coverage at 25' height (45% line of sight slope)
- Resubdivision of existing original lots not permitted
- Roof heights of new additions should not dominate
- Irregular setback patterns should be maintained
- Additions constructed on rear or side
- "Sympathetic materials" for new construction

FEBRUARY 26, 2007

CITY OF ROCKVILLE
MARYLAND

325 Lincoln Avenue

325 Lincoln Avenue

- 1-1/2 stories. Less than 25 feet high
- 1,120 square foot lot coverage excluding porch
- Full basement
- Substantial portico
- Total square footage: 2,660 SF with basement
- No garage

http://www.rockvillemd.gov/index.aspx?NID=189

Development Opportunities

Data

- BRT Review
- Analysis of property ownership
- Review of ridership patterns
- Analysis of local shopping centers
- Community feedback

Recommendations

- Leverage BRT for infill or future development opportunities at:
  - Stoney Mill Square Shopping Center
  - Parklawn Local Park
  - Rock Creek Terrace

Implementation

- Rezone & missing middle typologies
- Land dispositions
- Partnership with churches & community organizations
- P3's
- Shift BRT stops

Development Opportunities

Development Opportunities

Potential HH Income absent induced growth	
2010 Montgomery Co. Per Capita Personal Income	$68,454
2010 Montgomery Co. Median HH Income	$88,559
Median HH Income : Per Capita Personal Income	**129%**
2015 Montgomery Co. Average Income	$133,543
2015 Veirs Mill Corridor Average Income	$82,023
Veirs Mill Corridor : Montgomery Co.	**61%**
2016 Veirs Mill Corridor Median HH Income	$57,713
2016 Veirs Mill Corridor Average HH Income	$73,080
Average HH Income : Median HH Income	**128%**

"...none of the project alternatives will cause growth-inducing effects nor other effects related to induced changes in the current and planned pattern of land use, population density, or growth rate..."

MD 586/ Veirs Mill Road Bus Rapid Transit Study

Potential Home Prices	**2015**	**2020**	**2025**	**2030**	**2035**
Montgomery Co. Projected Per Capita Personal Income	$70,996	$77,059	$80,945	$83,769	$86,701
Montgomery Co. Projected Median HH Income	91,848	99,691	104,719	108,372	112,165
Veirs Mill Corridor Projected Median HH Income	56,413	61,231	64,319	66,563	68,893
Veirs Mill Corridor Projected Average HH Income	72,109	78,267	82,214	85,082	88,060
Housing Costs as 30% of Average HH Income	21,633	23,480	24,664	25,525	26,418
Estimated Sales Prices	**$365,000**	**$400,000**	**$420,000**	**$435,000**	**$450,000**

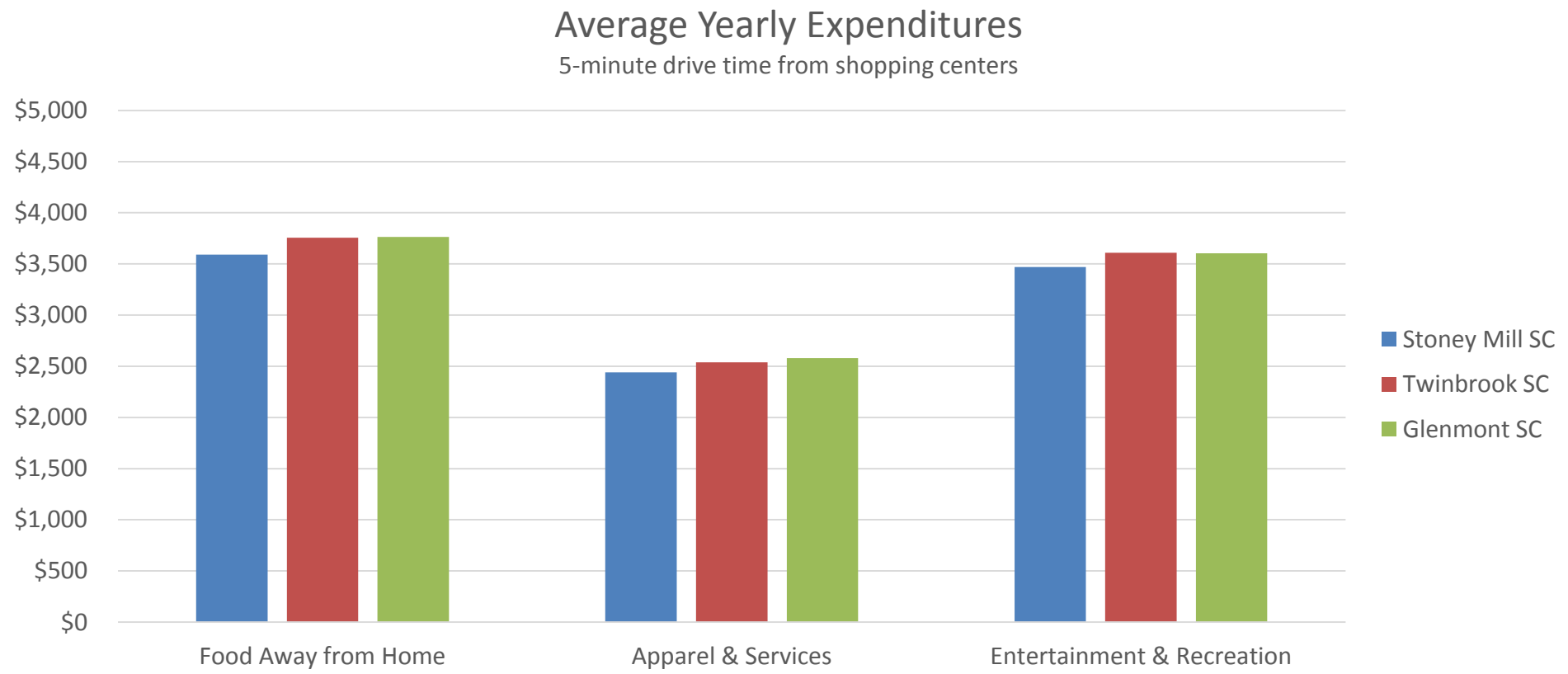
Sources: 2014 Maryland Statistical Handbook; Veirs Mill Scope of Work Planning Board Presentation; Esri Market Profile 0.25 mile radii

Development Opportunities

Simplified Pro Forma	SFD Renovation	SFD Expansion	SFD New Build	3 Story TH	2 over 2 TH
Acquisition	281,148	281,148	281,148	281,148	281,148
Hard and Soft Costs	67,627	74,575	151,437	415,2878	445,276
Total Costs	348,775	355,723	432,585	696,435	726,424
Average Sale Price (2014-2016)	398,187	426,995	481,965	335,651	248,953
Total Revenues	398,187	426,995	481,965	1,006,953	1,493,718
Profit/(Loss)	49,412	71,272	49,380	310,517	767,294
IRR	5%	12%	3%	29%	61%
Key Assumptions					
Number of Units	1	1	1	3	6
Land SF	6,000	6,000	6,000	6,000	6,000
Existing Improvements SF	1,200	1,200	1,200	1,200	1,200
Construction SF	1,200	600	2,400	6,300	8,400
Land Cost per SF	25.85	25.85	25.85	25.85	25.85
Existing Improvement Cost per SF	105.04	105.04	105.04	105.04	105.04
Hard Costs per SF	56.36	124.29	63.10	65.92	53.01

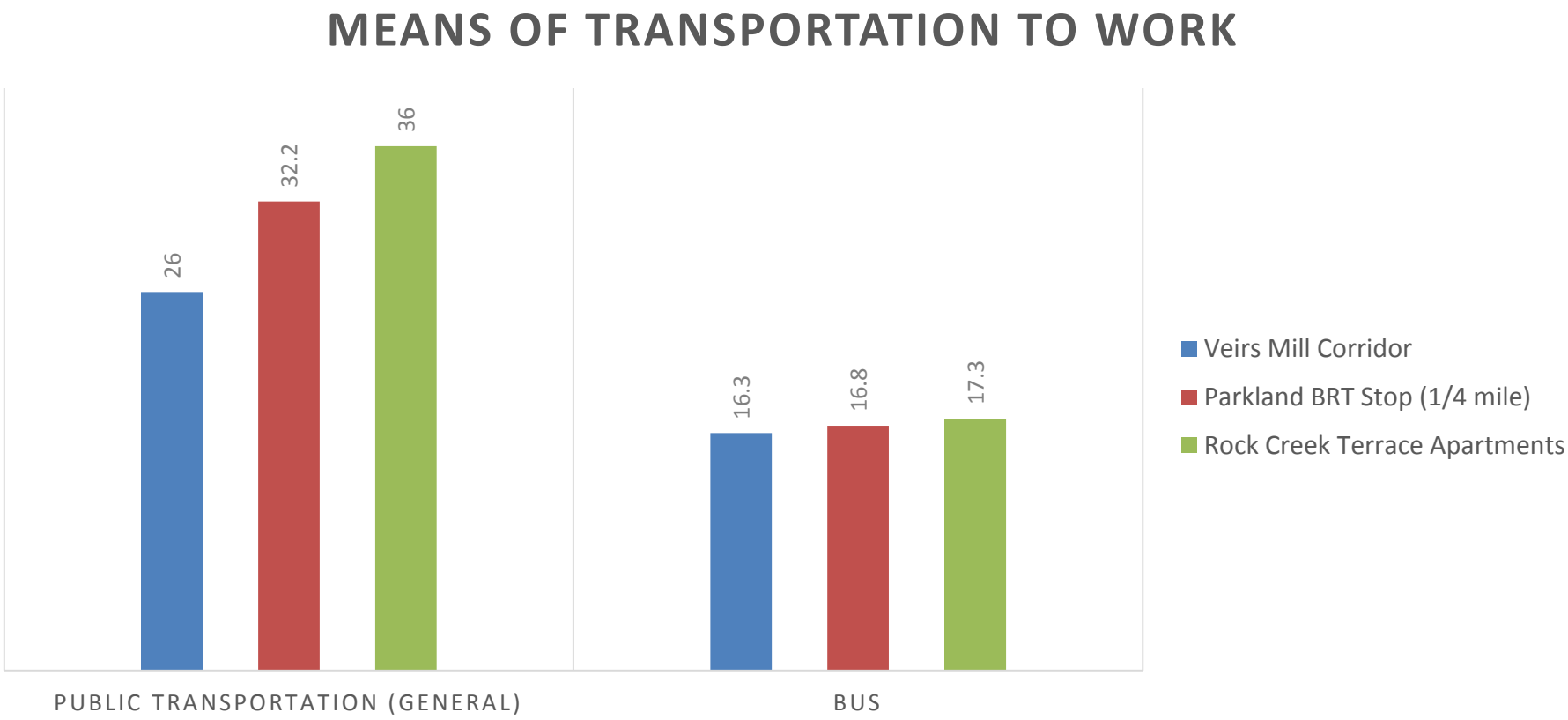
Source: SDAT 2014-2016 Property Sales within 0.25 miles of Veirs Mill Road, Montgomery County Residential Building Permits issued since 2000

Development Opportunities



Source: Esri; Consumer Spending data are derived from the 2013 and 2014 Consumer Expenditure Surveys, Bureau of Labor Statistics.

Development Opportunities



Source: ACS Population Summary prepared by Esri from U.S. Census Bureau, 2010-2014 American Community Survey

Development Opportunities

Recommendations

- Use BRT as a catalyst for infill development or future development:
  - Stoney Mill Square SC
  - Parklawn Recreation Center
  - Twinbrook SC
  - Rock Creek Terrace

Development Opportunities

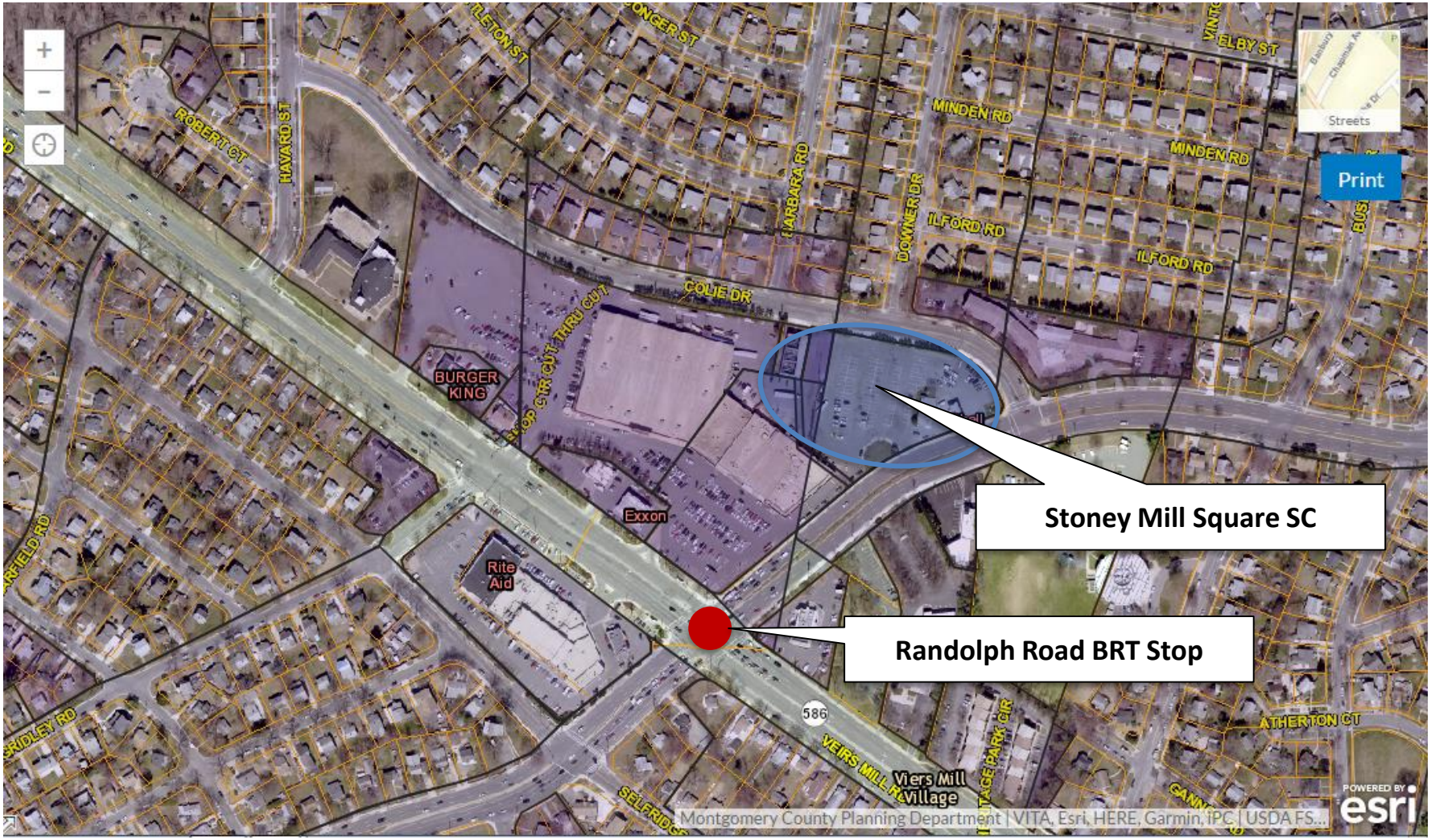
Mixed-use Mid-Rise Development

- Dense, urban development combining multiple uses
  - Residential, commercial, cultural, institutional and/or industrial
- Uses are physically and functionally integrated into 'walkable communities'

Missing Middle Housing

- Multi-unit housing structures
  - duplex, fourplex, courts, carriage house
- Compatible scale to large single-family homes
- Often integrated in 'walkable communities'

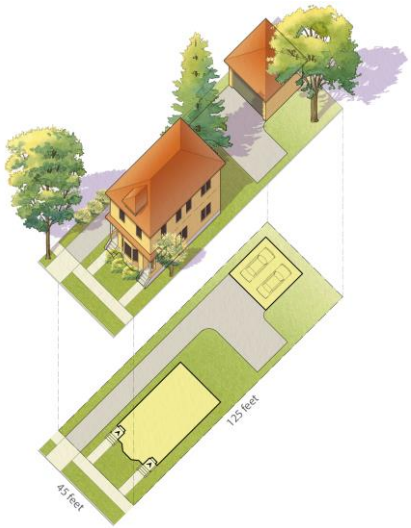
Development Opportunities - Housing



Development Opportunities - Housing

- Side-by-Side Duplex

- Stacked Duplex



- Fourplex

Development Opportunities - Recreation

Development Opportunities - Recreation

Arlington Mill, Arlington, VA
Affordable housing development co-located with a community center

- shared underground garage
- shared infrastructure costs saved nearly $9 million (almost $75,000 per unit)
- public land with discounted ground lease
- unique financing structure
- Low Income Housing Tax Credits
- combination of bonds and carry-over funds

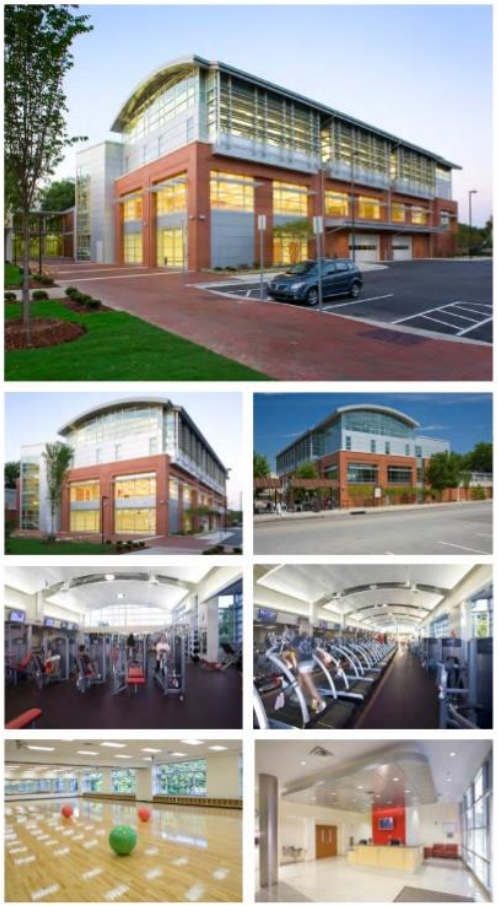
Clark Patterson Lee

NORTH CAROLINA STATE UNIVERSITY CARMICHAEL GYMNASIUM

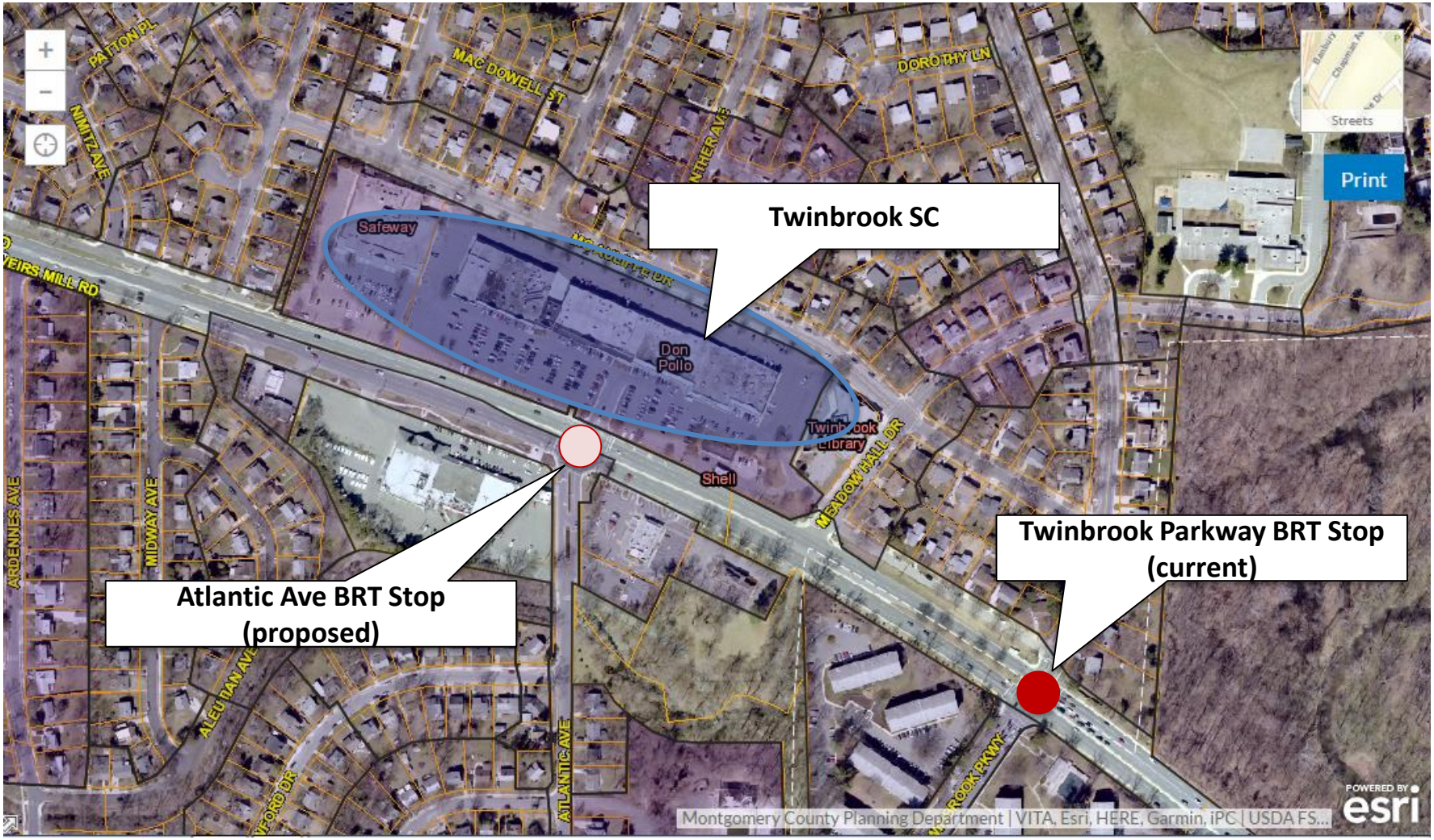
Location: Raleigh, NC
Area: 43,000 s.f. Addition
Total Cost: $8 million
Completion Date: 2007
Services: Design through Construction
Reference: Michael A. Harwood, Associate Vice Chancellor for Centennial Campus Development; (919) 515-6259

Providing overdue expansions to student recreation programs, this project is designed to architecturally upgrade an aging Carmichael Gymnasium Complex. Through the strategic placement of windows and building massing, the new freestanding building acts as a beacon for this part of campus by advertising the activities occurring within it. Program Spaces include cardiovascular, outdoor adventures, aerobics, multipurpose, and fitness assessment areas. Funded by student fees increases, it was critical to obtain student body approval during the design process.

The Carmichael Gymnasium Project was selected for inclusion the 2010 American School and University Architectural Portfolio, winning an award for Outstanding Designs: Sports Stadiums/ Athletic Facilities.



Development Opportunities – Mixed-Use



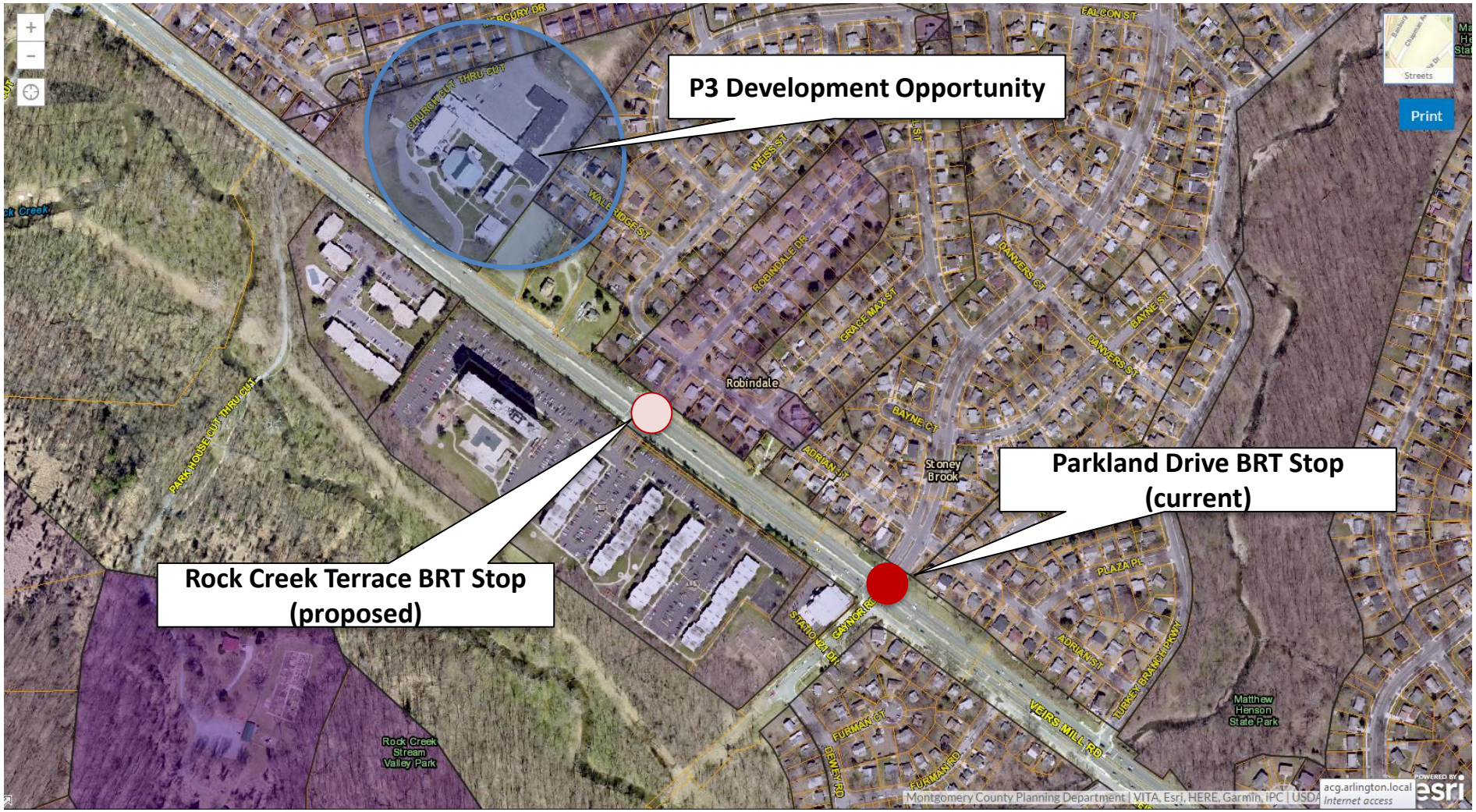
Development Opportunities – Mixed-Use

Galvan, Rockville MD
- 356 apartments
- 100,000 sf ground floor retail
- Walkable to public transportation

Upstairs at Bethesda
- 180 apartments
- 45,000 sf ground floor retail
- Below grade parking
- Walkable to public transportation

Terano, Rockville MD
- 214 apartments
- ground floor retail
- Walkable to public transportation

Development Opportunities – P3



Development Opportunities – P3

Matthew Memorial Terrace, DC
- 99 new senior and low to mid-income apartments
- New admin and community support building program space

Central, Silver Spring MD
- 234 apartments
- 16,000 sf ground floor retail
- New sanctuary
- $50 million

Riverside Baptist Church, DC
- 170 mixed-income apartments
- 6,900 sf ground floor retail
- New two-story sanctuary
- $50 million

Summary

Improve safety, security and accessibility

Strengthen community cohesiveness

Leverage development opportunities

Thank you!

Appendix

Development Opportunities with Alternative Costs

Simplified Pro Forma	SFD Renovation	SFD Expansion	SFD New Build	3 Story TH	2 over 2 TH
Acquisition	281,148	281,148	281,148	281,148	281,148
Hard and Soft Costs	71,313	89,788	332,426	621,661	673,588
Total Costs	352,461	370,936	613,574	902,809	954,736
Average Sale Price (2014-2016)	398,187	426,995	481,965	335,651	248,953
Total Revenues	398,187	426,995	481,965	671,302	746,859
Profit/(Loss)	45,725	56,060	(131,609)	(231,507)	(207,877)
IRR	4%	7%	-39%	-49%	-40%
Key Assumptions					
Number of Units	1	1	1	2	3
Land SF	6,000	6,000	6,000	6,000	6,000
Existing Improvements SF	1,200	1,200	1,200	1,200	1,200
Construction SF	1,200	600	2,400	4,200	4,200
Land Cost per SF	25.85	25.85	25.85	25.85	25.85
Existing Improvement Cost per SF	105.04	105.04	105.04	105.04	105.04
Hard Costs per SF	59.43	149.65	138.51	148.01	160.38

Source: SDAT 2014-2016 Property Sales within 0.25 miles of Veirs Mill Road, NAHB Cost of Constructing a Home, RS Means City Cost Indexes, RLB North American Quarterly Construction Cost Report, Montgomery County Residential Building Permits issued since 2000

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- RLB North American Quarterly Construction Cost Report, http://rlb.com/en/index/publications/?filter-region=americas
- ESRI Business Analyst, https://bao.arcgis.com/esriBAO/
- City of Rockville, http://www.rockvillemd.gov/index.aspx?NID=189

Appendix B:

Vision Zero Initiative Report

VEIRS MILL ROAD

VISION ZERO INITIATIVE

FEBRUARY 2018

KITTELSON & ASSOCIATES

RHODESIDE & HARWELL

BACKGROUND

The Veirs Mill Vision Zero Initiative is a safety-focused study that is being conducted in parallel and in collaboration with the Veirs Mill Corridor Master Plan; the Initiative aligns with the east and west boundaries of the master plan, from Galt Avenue/ College View Drive to Twinbrook Parkway. The primary difference between the two projects is that the Vision Zero Initiative is narrowly focused on roadway safety, whereas the Veirs Mill Corridor Master Plan will create a comprehensive view of the land use, transportation and community facilities in the plan area, with a focus on neighborhood access to existing and anticipated transit, improved connectivity, a comprehensive streetscape, and limited potential redevelopment opportunities.

This report includes both Short-Term Safety interventions to improve safety quickly, and a Long-Term Concept for creating a safe Veirs Mill Road corridor.

CONTENTS

CHAPTER 1

VISION ZERO HISTORY AND METHODS

1.1 WHAT IS VISION ZERO?

According to the Vision Zero Network, "Vision Zero is a strategy to eliminate all traffic fatalities and severe injuries, while increasing safe, healthy, equitable mobility for all. First implemented in Sweden in the 1990s, Vision Zero has proved successful across Europe — and now it's gaining momentum in major American cities."[1] As shown in Exhibit 1, Montgomery County is one of the only suburban jurisdictions in the United States to have adopted Vision Zero.

Vision Zero seeks to use engineering, education, and enforcement (in some contexts) in order to prevent traffic fatalities and serious injuries. In the United States, traffic fatalities occur at a rate of approximately 34,000 per year. While the majority of people killed on US roadways are in motor vehicles, bicyclists and pedestrians have higher fatality rates. Consequently, in locations where there are pedestrians and bicyclists, Vision Zero measures focus on these vulnerable road users as well as drivers.

This approach has a proven track record from Sweden, where it was first introduced in 1997, and is credited with that country's reduction in traffic injuries and fatalities, even as more people are driving, biking, walking, and using transit.

1.1.1 HOW IS THE VISION ZERO APPROACH DIFFERENT?

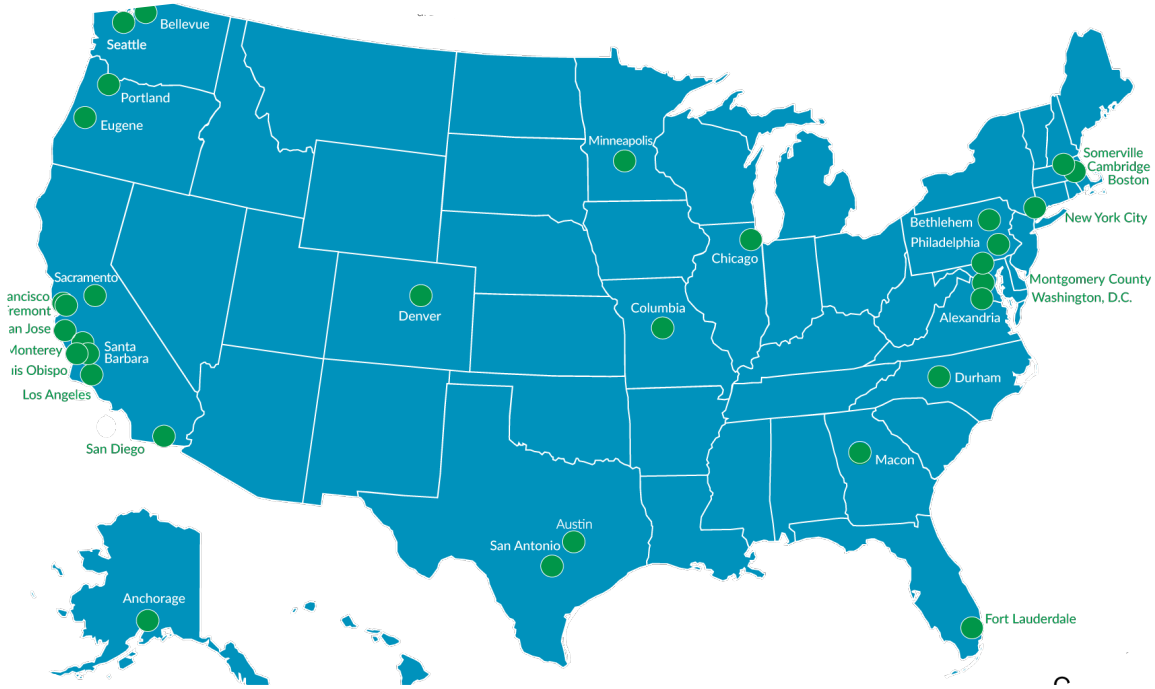
The following is paraphrased from the Vision Zero Network website to describe the differences between a traditional traffic approach to transportation safety and Vision Zero:

Traditional Approach

» Traffic deaths are inevitable

» Increase safety by perfecting human behavior

EXHIBIT 1. VISION ZERO JURISDICTIONS



Graphic from the Vision Zero Network showing the location of participating cities and counties, including Montgomery County, as of October, 2017. (https://visionzeronetwork.org/about/what-is-vision-zero).

[1] *https://visionzeronetwork.org/about/what-is-vision-zero/*

» Reduce the total number of collisions

» Emphasize individual responsibility for driver behavior

» Saving lives requires expensive engineering solutions

Vision Zero Approach

» Traffic deaths are preventable

» Human failings should be accounted for in design

» Reduce the severity of collisions

» Emphasize a systems approach

» Saving lives can be accomplished cost-effectively

1.1.2 A PARADIGM SHIFT

Adoption of a Vision Zero initiative represents a fundamental change in thinking about roadway planning and design priorities. Traditional approaches to intersection evaluation, which rely on vehicle level of service, may be replaced by measures that focus on safety of all users.

Reduction of motor vehicle speed is the single largest safety improvement that can be made on a street, especially for vulnerable road users; thus, practices that make it more difficult to reduce speeds must be reconsidered. Using the 85th percentile speed (the speed below which 85 percent of vehicles on a roadway travel) on a roadway to determine its speed limit is another example of a long-standing practice that is being challenged by safety advocates such as the National Transportation Safety Board in a recent report. Changes in speed limits should also be reinforced by both enforcement and a suite of engineering changes to change driver behavior to match safety priorities.

Maintenance and snow-clearing practices that favor roadways over bicycle and pedestrian facilities are also being challenged. Rendering these facilities impassible, even temporarily, can force these vulnerable road users to share space with much heavier and faster moving motor vehicles.

Specific categories of Vision Zero interventions will be introduced in the next section.

1.2 HOW IS SAFETY CREATED?

Roadway safety is increased by reducing the **frequency of crashes**, and the **severity of crashes**. The Veirs Mill Vision Zero Initiative is recommending both short- and long-term engineering solutions to accomplish both.

1.2.1 DECREASING CRASH FREQUENCY

Crash frequency describes how often crashes occur, on a per traveler basis. To decrease the frequency of crashes, interventions should reduce the number of conflicts that occur on a roadway and increase drivers' success in yielding when a conflict occurs.

DECREASING THE NUMBER OF CONFLICTS THAT OCCUR

Reducing conflicts is accomplished by providing clearly designated space for different road users, and using traffic signals and other traffic control measures to create predictability where different road users interact. Shortening crossing distances using curb extensions can help pedestrians judge how much time they will need to cross in front of oncoming vehicles, thus reducing how often they conflict with oncoming vehicles.

Designated, protected space for different travel modes can reduce conflict points, as shown above (Photo credit: NACTO)

INCREASING SAFE YIELDING

When conflicts do occur, drivers must successfully yield to the conflicting road user to prevent a crash. **Decreasing motor vehicle speed is key** to enabling safe yielding. Sufficient roadway lighting and visibility is also important.

1.2.2 DECREASING CRASH SEVERITY

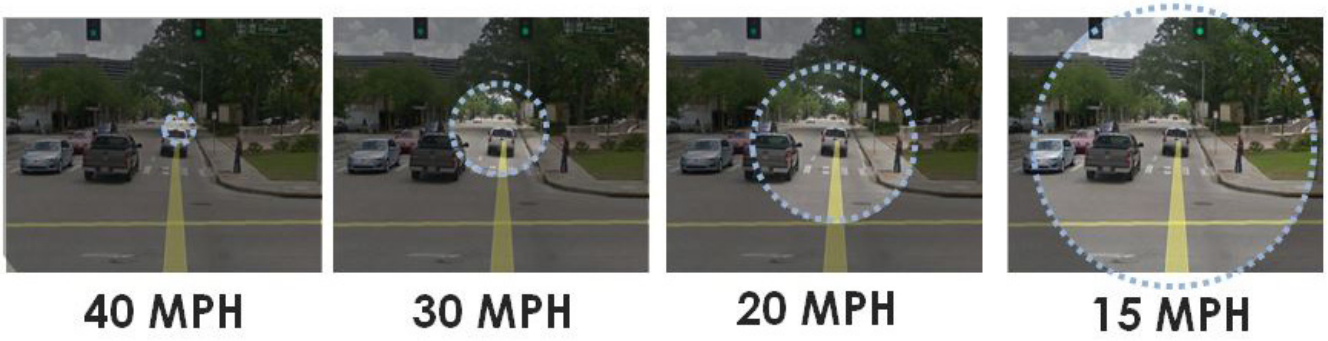
Crash severity describes how badly the people involved in a crash are hurt. While it is unlikely that any corridor will achieve zero crashes, it is possible to drastically reduce the severity of the crashes that do occur through conscientious engineering choices. Specifically, reducing vehicle speed is essential to reducing crash severity. Reducing vehicle speeds particularly improves safety for vulnerable road users such as pedestrians and bicyclists, since they have no physical protection.

Exhibit 2 illustrates the effect of vehicle speed on driver cone of vision. Exhibit 3 shows the mass differential between different road users, a key factor in the severity of crashes involving bicyclists and pedestrians, in particular. Exhibit 4 shows the rates of pedestrian fatality when hit by motor vehicles traveling at various speeds. These, taken together, account for why speed reduction is so crucial to reduction in both crash frequency and crash severity.

Recommendations to reduce and enforce a lower speed limit, or undertake engineering solutions to reduce the prevailing speed, on a roadway are often met with concerns about capacity and congestion. In reality, the capacity of most corridors is dictated by the signal timing. Anyone who has had a driver speed past them only to be stopped next to them at a red light has experienced this phenomenon. Average speed determines travel time, while reaching high speeds greatly increases crash severity.

Exhibit 5 shows that corridor capacity is largely determined by signal timing at intersections and thus speed reduction may have a smaller than anticipated impact on corridor capacity.

EXHIBIT 2. ILLUSTRATION OF DRIVER CONE OF VISION AT DIFFERENT SPEEDS

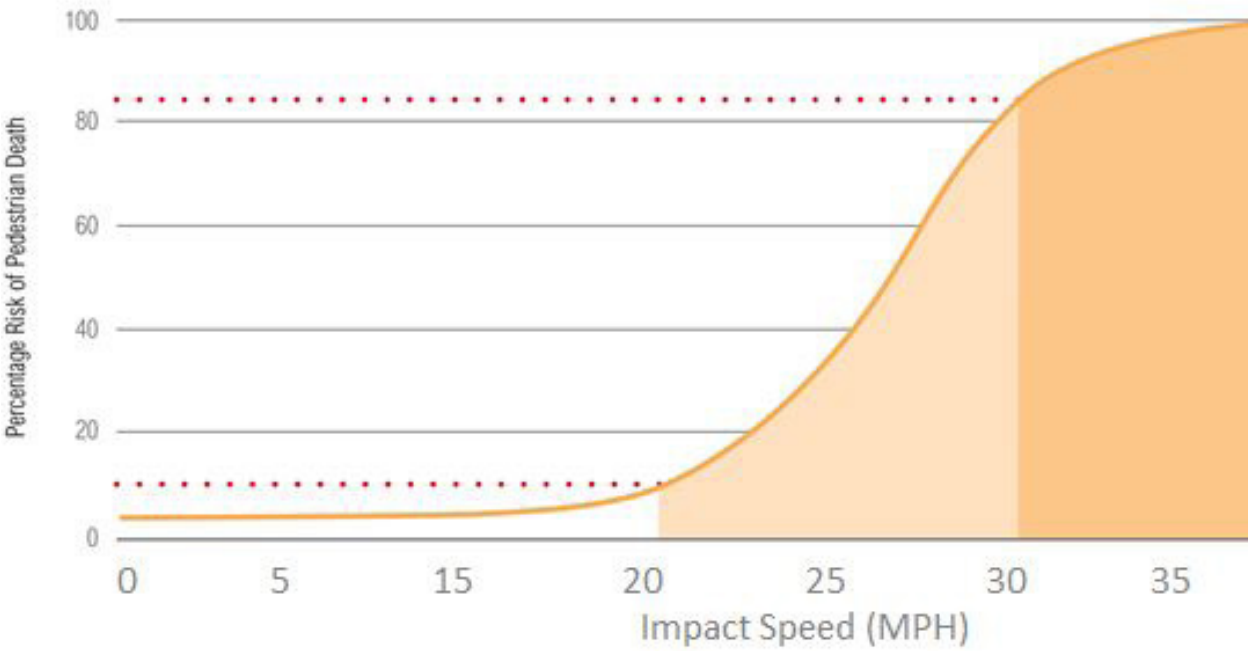


Graphic showing driver cone of vision at different speeds; lower speeds allow drivers to better see conflicts that might occur and increase their chances of successfully avoiding a crash.

EXHIBIT 3. MASS OF DIFFERENT ROAD USERS

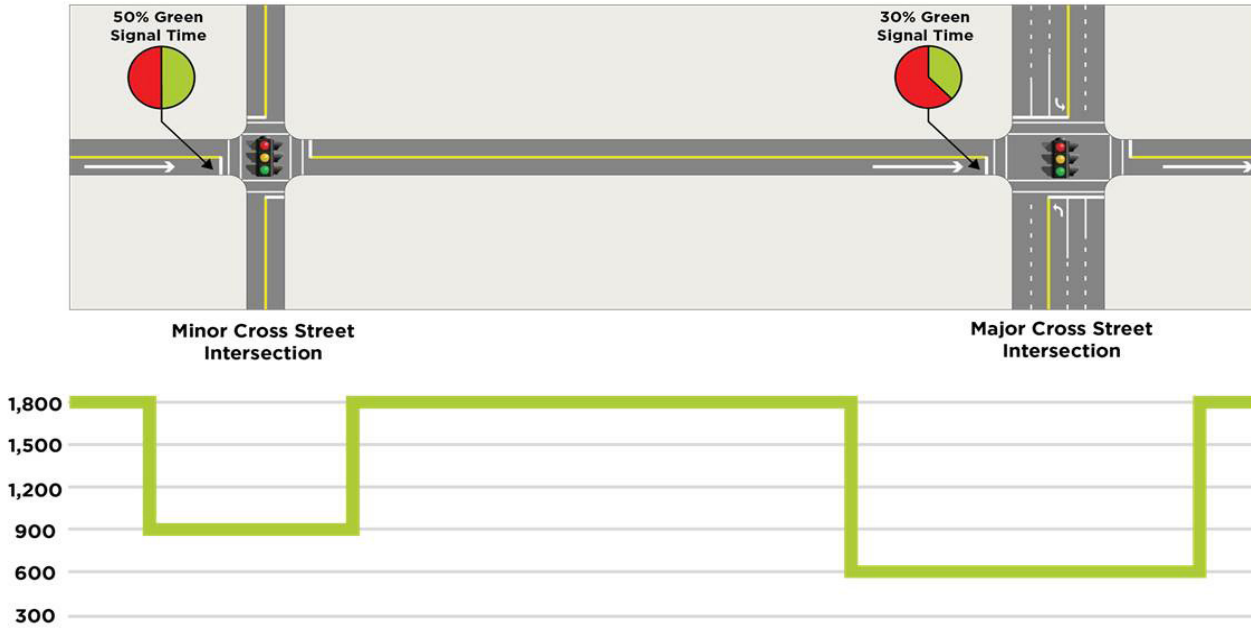
The comparative mass of different road users is one factor that contributes to crash severity. Additionally, the lower-mass road users also have little to no technology providing physical protection (Image Credit: NACTO).

EXHIBIT 4. RATES OF PEDESTRIAN FATALITY AT VARIOUS SPEEDS



Rates of pedestrian fatality when hit by a car traveling at various speeds (Image Credit: World Resource Institute).

EXHIBIT 5. CAPACITY ALONG THE LENGTH OF A CORRIDOR



As shown in the above figure, the amount of green-time dedicated to cross streets is a main contributor to a corridor's overall capacity.

1.3 HOW IS VISION ZERO APPLIED IN MONTGOMERY COUNTY?

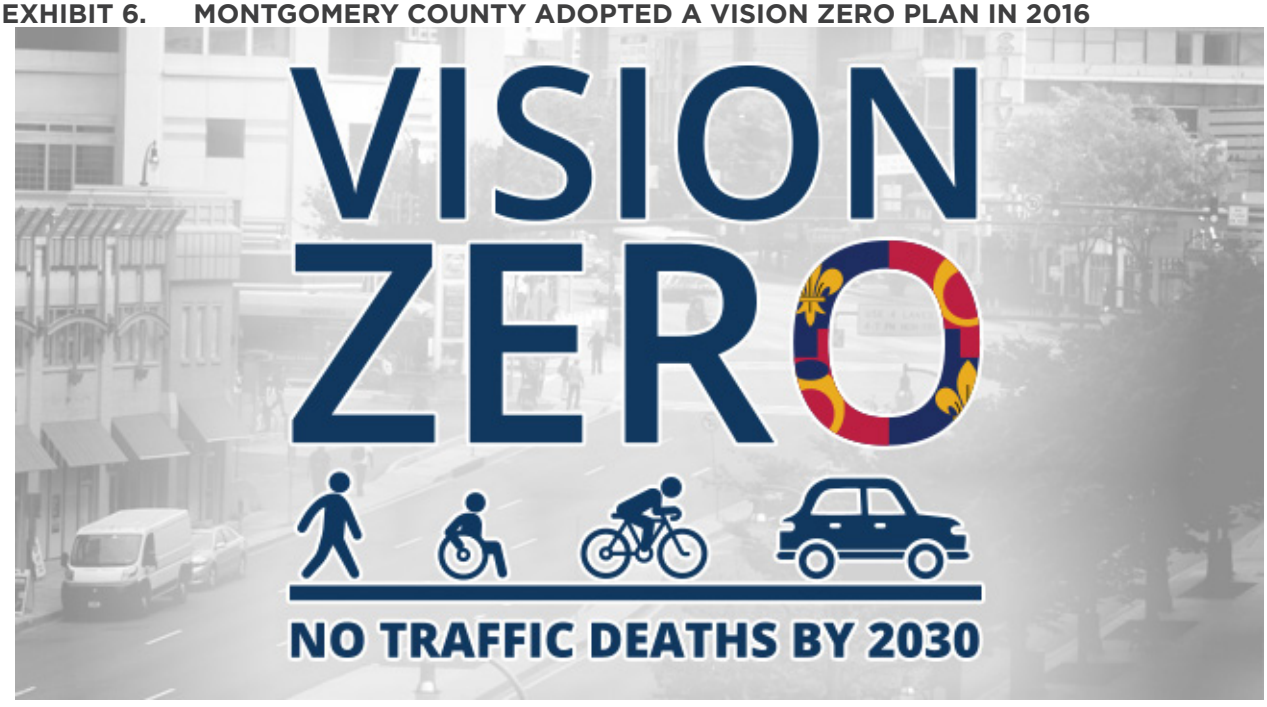
Montgomery County has adopted a resolution, and developed a two year Action Plan to move toward the ambitious goal of No Traffic Deaths by 2030.

The communication around these actions recognizes the paradigm shift that Vision Zero represents. The following represents Montgomery County's priorities for creating a Vision Zero environment: (from http://www.montgomerycountymd.gov/visionzero.)

Transportation-related deaths and severe injuries are preventable and unacceptable.

1. *Human life takes priority over mobility and other objectives of the road system. The road system should be safe for all users, for all modes of transportation, in all communities, and for people of all ages and abilities.*
2. *Human error is inevitable; the transportation system should be designed to anticipate error so the consequences are not severe injury or death. Advancements in vehicle design and technology, as well as roadway engineering advancements, personal electronic device innovations, etc., are necessary components for avoiding the impacts of human errors.*
3. *People are inherently vulnerable, and speed is a fundamental predictor of crash survival. The transportation system should be designed for speeds that protect human life.*
4. *Safe human behaviors, education, and enforcement are essential contributors to a safe system.*
5. *Policies at all levels of government need to align, making safety the highest priority for roadways.*

EXHIBIT 6. MONTGOMERY COUNTY ADOPTED A VISION ZERO PLAN IN 2016



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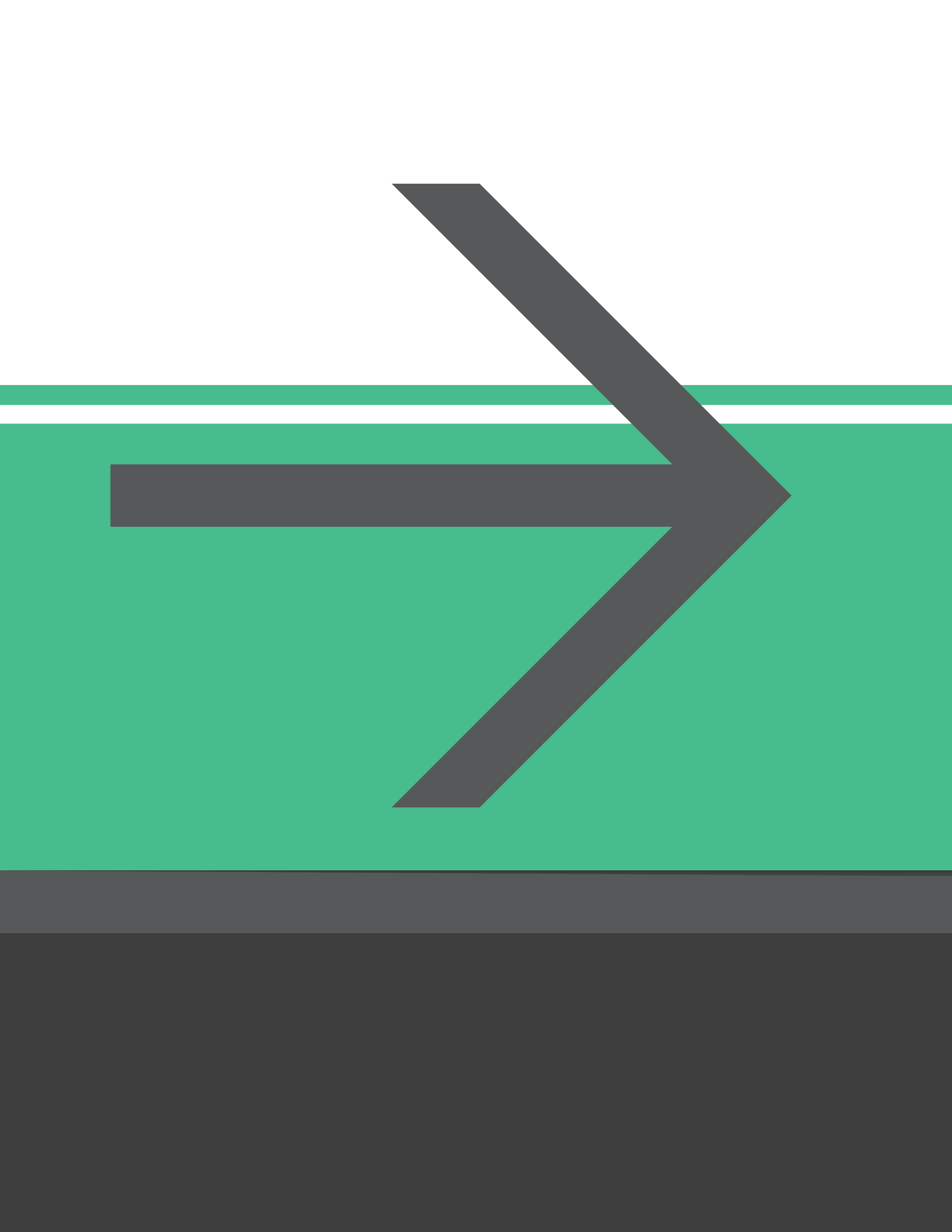


CHAPTER 2

IDENTIFYING PROBLEMS ON VEIRS MILL ROAD

2.1 WHY VEIRS MILL ROAD?

In 2016, when the Montgomery County Council adopted Vision Zero to demonstrate the county's commitment to eliminating traffic fatalities and severe injuries on county roads by 2030, it became one of the first suburban jurisdictions in the United States to adopt a Vision Zero Policy and Action Plan. This builds on previous efforts to address road safety issues including the 2002 Blue Ribbon Task Force on Pedestrian Safety and the 2007 Pedestrian Safety Initiative. The county released a two-year action plan in November 2017 and urged the State of Maryland to adopt Vision Zero for all state highways.

As a partner agency in the development and implementation of the two-year action plan, the Planning Department has a responsibility to support the Vision Zero approach in all policies, plans and projects. The Veirs Mill Corridor Master Plan, initiated in early 2017, is the first master plan to commence following the adoption of the Vision Zero Policy in Montgomery County. The Planning Department sees a unique opportunity to develop a Vision Zero case study within the context of the Veirs Mill Corridor Master Plan to develop short-term recommendations which address immediate safety concerns as well as a long-term concept for the corridor.

The county's two-year action plan identifies Veirs Mill Road as one of the highest risk roadways, with medium-to-high crash rates on Veirs Mill Road, and high crash rates at the intersection of Randolph Road at Veirs Mill Road. The action plan further identifies the communities adjacent to Veirs Mill Road as an equity emphasis area, which acknowledges that communities with higher rates of poverty, ethnic diversity, and younger residents experience higher rates of collisions.

In addition to these crash-related characteristics, Veirs Mill Road also has high rates of people who walk and people who use transit; there are also vehicles that are traveling above the speed limit, which increases the danger of severe crashes the current roadway. Veirs Mill Road is classified as a major highway, with average volumes of 35,000 to 40,000 vehicles per day. While it is classified as a major highway, it also serves as a residential street with a combination of residential service roads and direct driveway access.

Veirs Mill Road serves as a significant transit corridor, with bus service provided by the Washington Metropolitan Area Transit Authority's Metrobus and Montgomery County's Ride-On. WMATA considers Veirs Mill Road a high priority corridor, as the Veirs Mill routes (the C4 and Q routes) have some of the highest ridership in the Metrobus system. Based on the historic ridership volumes and the east-west connection that Veirs Mill Road provides, it is also identified as a future bus rapid transit corridor.

With existing high rates of people that use transit and high rates of people who walk combined with future enhanced bus service, and ultimately bus rapid transit, the number of people who walk is anticipated to grow. Continuous sidewalks and safe crossings, currently not present today, are needed to create safe conditions for walking. These conditions are explored in more depth in the Veirs Mill Corridor Master Plan.

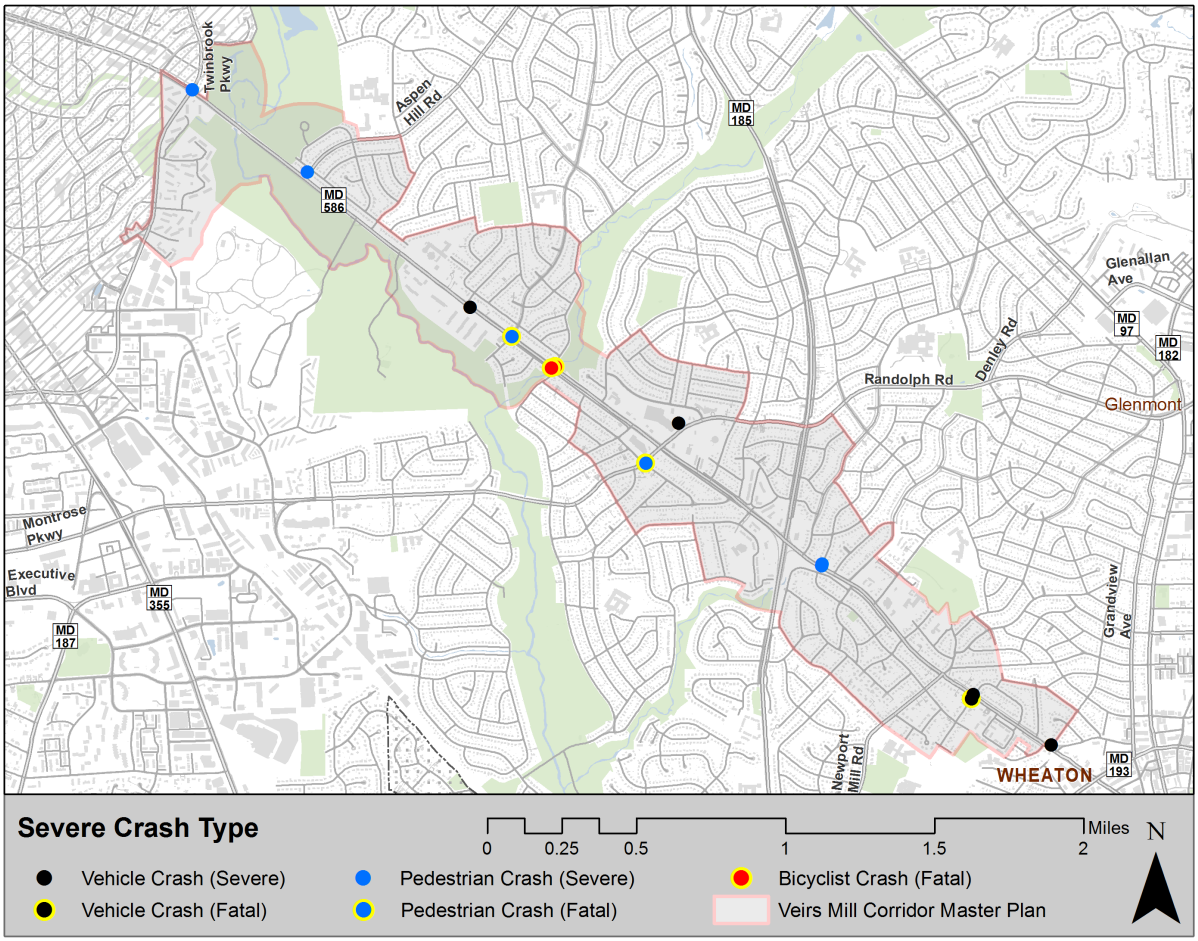
For people that bike, there are two significant trails which intersect Veirs Mill Road – the Rock Creek Trail and the Matthew Henson Trail – both of which serve pedestrians, bicyclists and recreational users. The existing at-grade crossing of the Matthew Henson Trail with Veirs Mill Road presents safety concerns. It is located at the bottom of two steep downslopes along Veirs Mill Road, and is the site of two fatalities since 2015. With the planned addition of Montrose Parkway opposite Parkland Drive, significant traffic increases are anticipated on Veirs Mill Road between Montrose Parkway and Randolph Road, and the number of people that bike are anticipated to increase on Veirs Mill Road.

While Veirs Mill Road is located within a

suburban land use context, the area has high transit ridership when compared to the county average. Although the corridor serves many users, the necessary infrastructure to accommodate each user is inadequate, and in many cases, absent. The corridor is designed to prioritize people that are driving single occupancy vehicles. Due to the competing roles of Veirs Mill Road, the recent severe and fatal crashes on the corridor, and the increased demand for all users in the future, the Planning Department believes that it is critical to approach the future of the Veirs Mill Corridor through a Vision Zero lens. This report focuses primarily on engineering solutions to creating safe conditions on Veirs Mill Road, both due to the roadway context and the scope of this study. However, speed enforcement is mentioned in the strategies toolbox, and there may be high pedestrian activity locations such as schools that could be appropriate sites for education initiatives, at the County's judgment.

Exhibit 7 shows the locations of transportation-related fatal and severe injury crashes that have occurred along Veirs Mill Road between 2015 and 2017. This data was compiled by County Stat, the agency responsible for developing the Vision Zero Action Plan. During this three-year time period there were five fatal and seven serious injury crashes. Even though travel by motor vehicle represents the majority of person trips along the corridor, pedestrian and bicyclists accounted for two-thirds of these crashes, including four fatalities and four serious injury crashes.

EXHIBIT 7. SEVERE AND FATAL CRASHES ALONG VEIRS MILL ROAD (2015 – 2017)



Source: County Stat, www.montgomerycountymd.gov/visionzero

2.2 THE PROBLEM LIST

A list of existing safety hazards on Veirs Mill Road was assembled using crash data, field visit observations, and public comments. These challenges fall under three broad categories:

- **Poor separation of road user groups**
- **Conflicts between road users at crossings**
- **Motor vehicle traffic is too fast and erratic**

While solving some of these issues entirely will take time and require significant funding, there are interim solutions that can provide immediate, low cost improvements. A toolbox of these improvements is included in the Toolbox section of this report, and the locations where they are applicable are mapped in Chapter 3.

This section shows the problem types observed and illustrative images. A full copy of the Problem List (which includes the specific observations that contributed to problem formulation) is included as an appendix to this report.

2.2.1 POOR SEPARATION OF ROAD USER GROUPS

One important way to minimize conflicts between road users is to provide each travel mode with clearly designated space on the corridor. Currently, Veirs Mill Road falls short of providing this for its length.

» The pedestrian environment is poorly separated from fast moving traffic, both where there is no sidewalk, or the sidewalk is directly adjacent to the roadway.

» Sidewalks are not continuous, including missing connections to bus stops.

» Driveways and pedestrian ramps are often not ADA compliant, which can force wheelchair users and pedestrians with reduced mobility into the roadway.

» Continuous right-turn lanes that function as through lanes bring fast/weaving traffic near to the edge of the roadway, where there is no buffer between pedestrians and the street

» Grade changes and uneven terrain adjacent to the roadway make walking where there is no sidewalk difficult even for able-bodied pedestrians

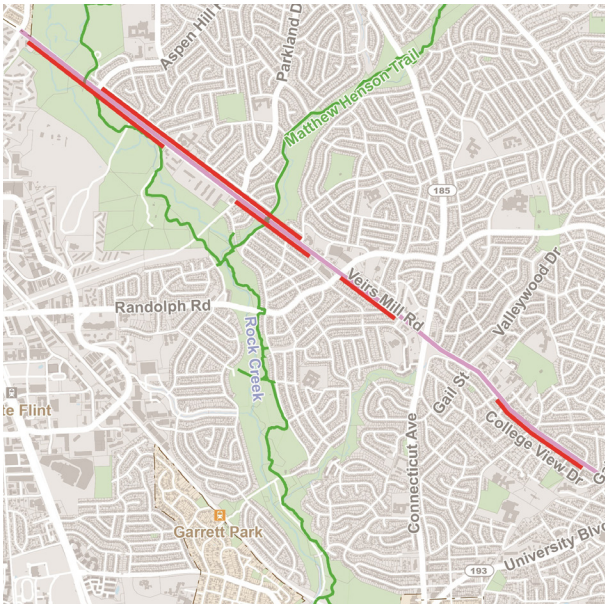
» Existing sidewalks are narrow and poorly maintained.

Incomplete sidewalk

Continuous turn lane and no sidewalk connection to bus stop

ADA non-compliant ramp

Sidewalk blocked with mowing debris

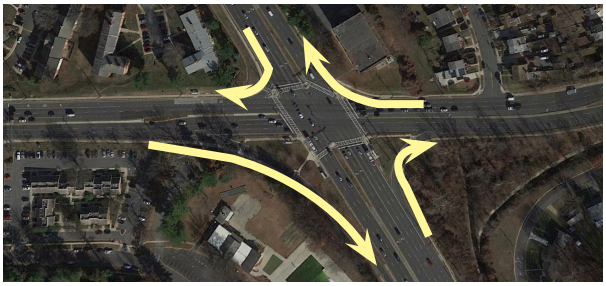


Current gaps in sidewalk network

2.2.2 CONFLICTS BETWEEN ROAD USERS AT CROSSINGS

Another important way to minimize conflicts between road users is to reduce conflicts at crossings. The following problems were found:

- Several locations along the corridor have very long distances between signalized crossings, including approximately a half mile distance, such as between Twinbrook Parkway and Aspen Hill Road.
- The length of the current Matthew Henson Trail crossing makes it difficult to cross in a single signal cycle; the signal pole reduces pedestrians' ability to see oncoming traffic while waiting to cross.
- The Connecticut Avenue intersection has long, sweeping channelized right turn lanes which both enable high speed motor vehicle turns and pose challenges for vision-impaired pedestrians; the speed enabled by the lane configuration means that any collision occurring in that crosswalk is likely to be severe.
- A large number of residential and commercial driveways open directly into a high speed roadway, increasing the risk of crashes as drivers pull into traffic.
- Many intersections lack a pedestrian refuge island, but require pedestrians to cross six or more lanes.
- Many bus stops, which are significant pedestrian destinations, lack an adjacent signalized crossing opportunity.
- The frontage roads connect to the main road in an irregular and inconsistent manner, causing unpredictable conflicts between road users.
- Pedestrian connections between frontage roads and transit stops are inconsistent or absent.
- Many bus stops lack sufficient waiting space, which can cause conflicts between waiting transit users and other sidewalk traffic, or even force them into the roadway.



Channelized turn lanes at Connecticut Avenue

Example of a long pedestrian crossing with no median refuge island at Randolph Road

2.2.3 MOTOR VEHICLE TRAFFIC IS TOO FAST AND ERRATIC

High vehicle speeds are a persistent problem along the length of Veirs Mill Road, and are likely a key contributor to the roadway's high crash rate.

» With a posted speed limit of 40 – 45 miles per hour on Veirs Mill Road, pedestrians and bicyclists that are struck by a vehicle are very likely to be killed.

» Significant weaving and merging were observed, particularly where lane configuration changes occurred.

» Continuous right-turn lanes and wide open shoulders make the corridor feel very open, inviting high speeds; using these spaces to pass aggressively was also observed.

Wide shoulder contributes to unconstrained-feeling corridor

2.3 TOOLBOX OF INTERVENTIONS

Many of the previously identified problems have engineering solutions that can be implemented at specific locations, where the need is presently demonstrated. These interventions are displayed in this section, organized by the primary safety function they serve:

- Decreasing crash frequency by providing designated roadway space for different user groups
- Decreasing crash frequency by reducing crossing conflicts
- Decreasing crash severity (and, secondarily, crash frequency) by reducing motor vehicle speeds.

Many of these interventions and best practices actually serve multiple functions, but they are organized by their primary purpose, and not repeated in multiple categories.

Many of these interventions are recommended in multiple locations; these locations are mapped in Chapter 3. This section is intended to build familiarity with the tools, and for referencing when considering each recommendation in its context on the corridor.

The components of each intervention are shown and labeled, as are corridor-wide best practices that are included in the concept as a recognition that they should be applied corridor-wide.

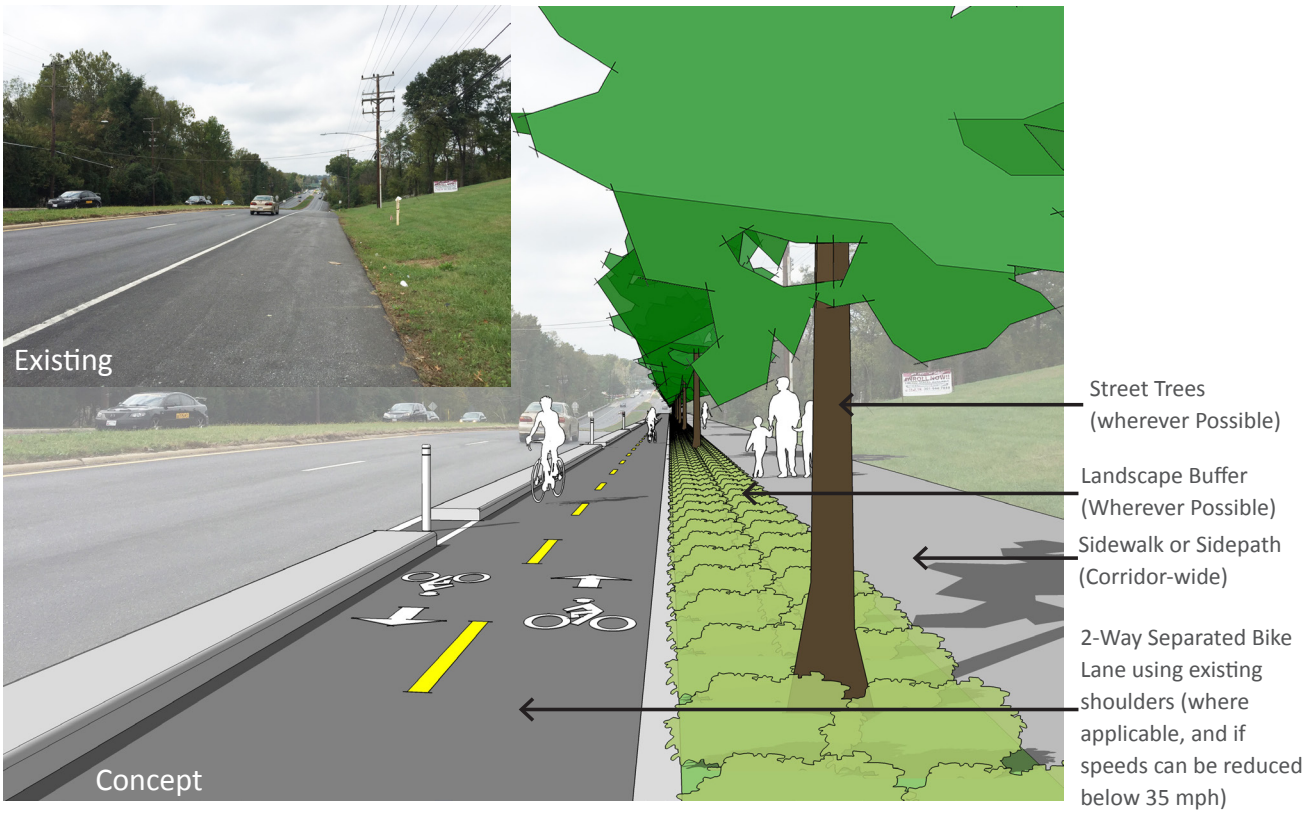
2.3.1 DECREASE CRASH FREQUENCY BY CREATING DESIGNATED SPACES FOR DIFFERENT ROAD USERS

Creating designated space for vulnerable road users enhances their safety, and also makes the corridor feel more comfortable. Where space allows, bicyclists and pedestrians should each have their own designated facility where space allows. Since they are both low-speed road users, and can share a sidepath, provided it is at least 8 feet wide.

CREATE CONTINUOUS SIDEWALK

Providing uninterrupted, ADA-compliant sidewalks is essential to allowing people to walk along the corridor safely. Best practices such as including a landscaped buffer with street trees are shown below. Exhibit 8 depicts a concept for a portion of the corridor that could accommodate a two-way separated bike lane; in more constrained portions of the corridor, a sidepath is the recommended bicycle and pedestrian treatment.

EXHIBIT 8. ACCOMMODATING CONTINUOUS SIDEWALKS



CREATE CONTINUOUS BIKE NETWORK

Bicyclists, like pedestrians, are vulnerable road users. Similarly, a corridor-wide network of bike facilities, either on or very near Veirs Mill Road, is essential to the safety of bicyclists. Exhibit 9 shows options for accommodating bike travel on frontage roads. Exhibit 10 shows a neighborhood greenway approach that is suitable for parallel local streets. Exhibit 11 shows a separated bike lane that could be suitable for portions of the corridor with a shoulder. Exhibit 12 shows a sidepath, which is the recommended treatment where space is more constrained and provides the most separation between bikes and motor vehicle traffic. In order to increase the safety and comfort of pedestrians, these sidepaths should be 12 feet wide, where space allows, and at least 8 feet wide, so there is enough room for all users to pass each other and interact comfortably.

EXHIBIT 9. FRONTAGE ROAD TREATMENTS

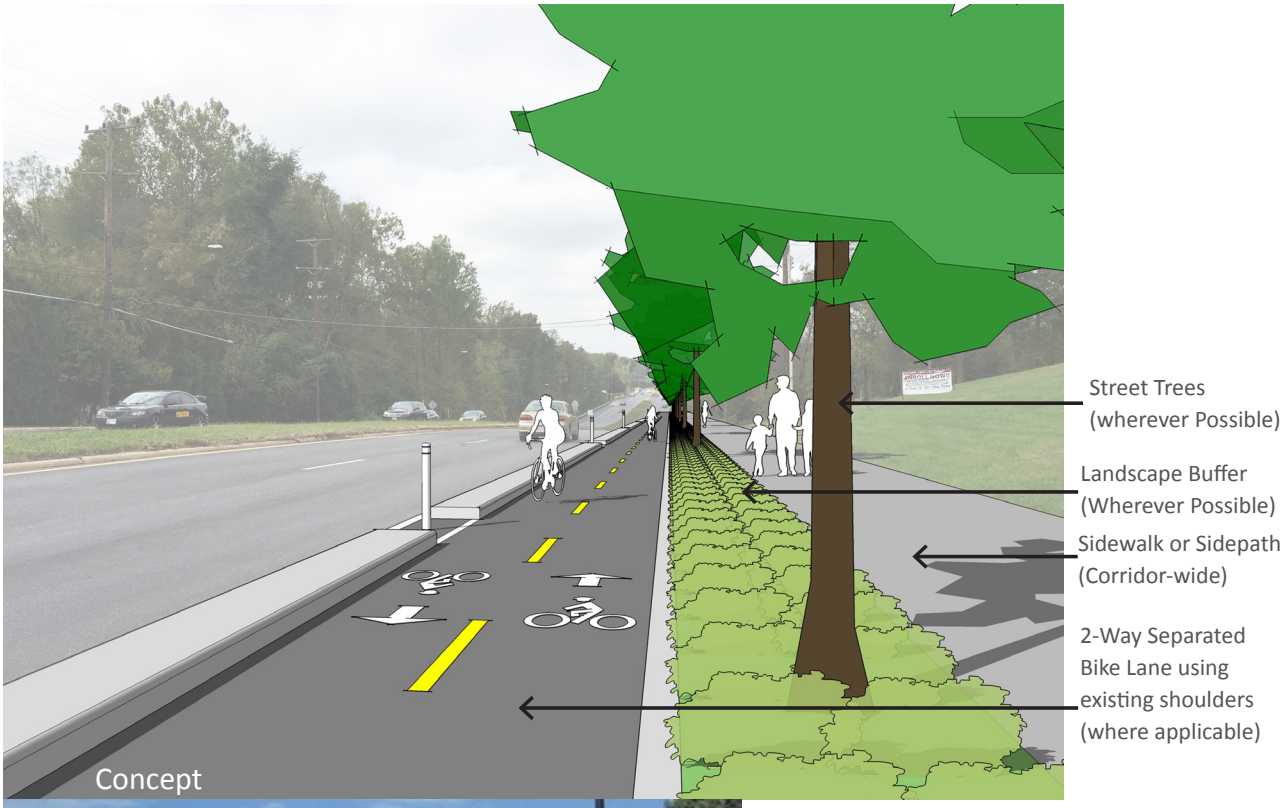
Alternative concept if it is determined that parking is not desired on any segments of the frontage roads

EXHIBIT 10. CREATE NEIGHBORHOOD GREENWAYS ON PARALLEL STREETS

Typical Parallel Residential Street to Veirs Mill Road

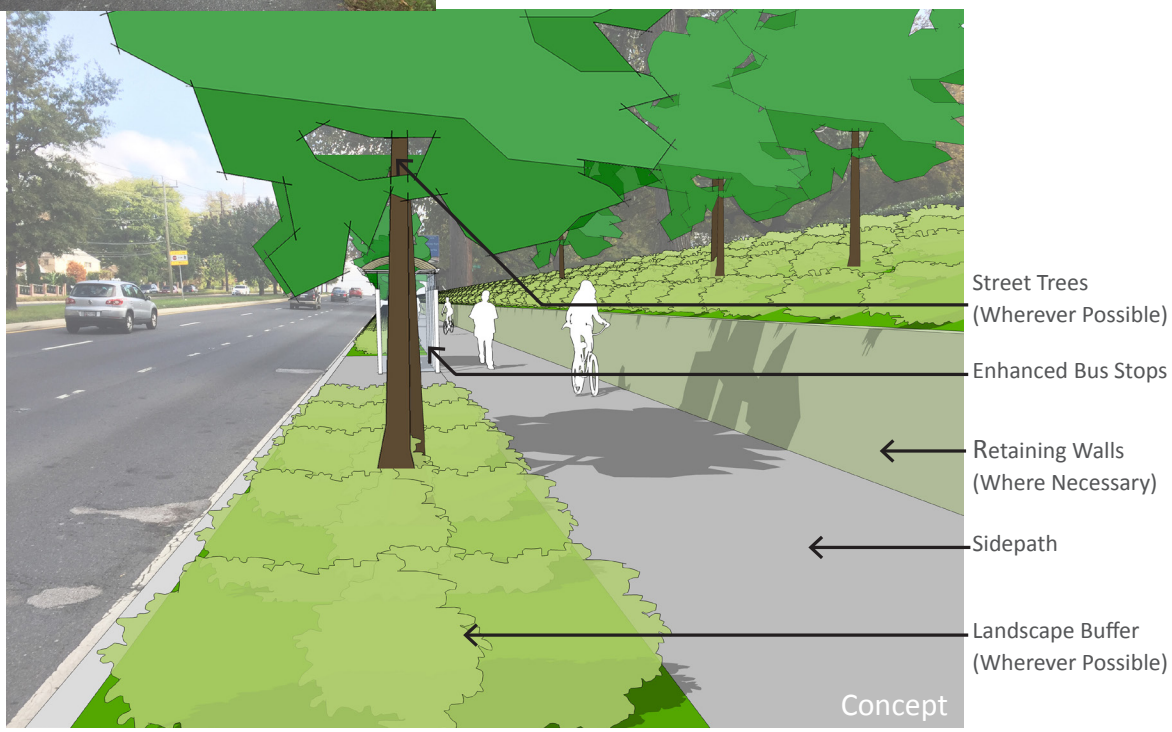
Example of a neighborhood greenway (Photo credit: NACTO).

EXHIBIT 11. CREATE A TWO-WAY SEPARATED BIKE LANE IN CURRENT SHOULDER



Cost-efficient rapid-implementation variation of a two way separated bike lane on Baseline Road in Boulder, CO.

EXHIBIT 12. CREATE SIDEPATHS WHERE RIGHT-OF-WAY IS NARROWER



2.3.2 DECREASE CRASH FREQUENCY BY REDUCING CROSSING CONFLICTS

Increasing safety at crossings requires both enhanced crossing opportunities and slowed vehicle speeds at crossing points so that interactions between motor vehicles and vulnerable road users happen at lower, safer speeds.

ENHANCING CROSSING FACILITIES

At both intersection and driveway crossings, vulnerable road users such as bicyclists and pedestrians need safe and accessible ways to cross the street that will decrease their chances of being struck by a motor vehicle. Treatments to accomplish this include enhanced and raised crosswalks, pedestrian refuge islands, full signals or beacons (e.g., a Modified HAWK signal such as at the Matthew Henson Trail crossing, or a HAWK signal if SHA policy allows), and the ADA-compliant retrofit of driveways and ramps.

Exhibit 13 shows how space can be reclaimed from a left turn lane to create a pedestrian refuge island to ease crossings. Exhibit 14 shows the "short ramp" method for easing crossings across driveways, particularly for wheelchair users. Exhibit 15 shows a concept for creating signalization and a refuge island at currently uncontrolled crossings; it also shows an opportunity for motor vehicles to make a U-turn that is separate from the bicycle and pedestrian crossing.

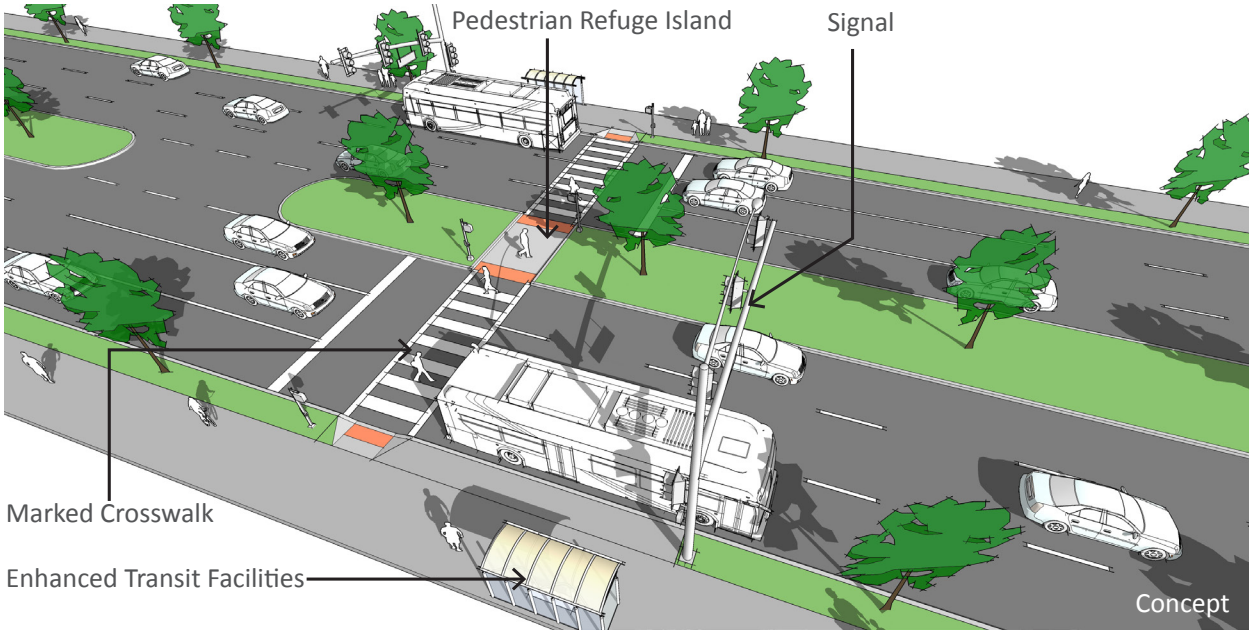
EXHIBIT 13. ADD PEDESTRIAN REFUGE ISLANDS

Pedestrian refuge islands allow pedestrians to recognize a safe gap in traffic for one direction at a time. It also allows pedestrians a safe space to wait if they are unable to complete their crossing in one signal phase. The minimum width of a pedestrian refuge island is 6 feet, but 8-10 feet is preferred (Recommendation source: NACTO).

EXHIBIT 14. CREATING A LEVEL SIDEWALK SURFACE ACROSS DRIVEWAYS

Note that steep ramps will cause turning vehicles to slow considerably before completing their turn. While this has safety benefits for sidewalk users, if it is applied in the wrong context, it could increase rear end crashes when trailing vehicles are unable to slow in response to the unexpected slow down. This risk can be mitigated by using this technique in appropriate contexts, such as downstream of curb extensions, and in conjunction with other interventions that will slow the prevailing roadway, speed, increasing the chances of trailing vehicles stopping in time.

EXHIBIT 15. SIGNALIZE UNCONTROLLED INTERSECTIONS



At each unsignalized intersection, study the feasibility of adding a traffic signal or crossing beacon. Consider adding signal controls to mid-block crossings and any new crossings, similar to the Matthew Henson Trail crossing (or a HAWK signal if SHA policy allows). Also consider adding new crossings, transit shelters, and other facilities at bus stops. All signalization changes will require a warrant study as specified in the MdMUTCD.

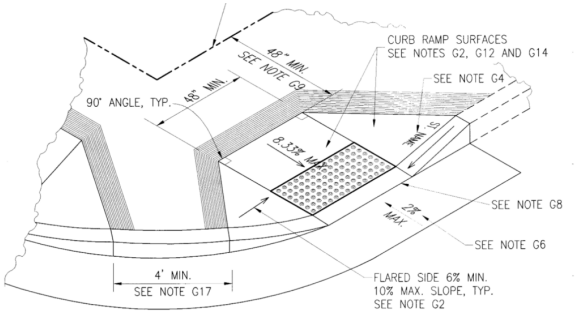
SLOWING VEHICLES AT CROSSINGS

Speed reduction is essential for enabling safe yielding by motor vehicle drivers. Interventions that slow vehicles at crossings take this approach and apply it at the locations where conflicts are most likely to occur. Exhibit 16 shows raised crossings, which can be used at many intersection and crossing types both to keep the sidewalk or sidepath level, and to slow motor vehicles using vertical deflection. When applied at channelized right turn lanes, raise crossings have the added benefit of providing a detectable crossing path for visually impaired pedestrians for whom the unpredictable angle of channelized turn lane crossings are particularly challenging. Exhibit 17 shows tightened turn radii which can be used to slow the speed of turning vehicles at any intersection. This traffic calming effect and the predictability of a single straight crossing are why standard intersection configurations with tightened curb radii are preferred. In all cases where tightening curb radii is considered, analyses that take into account the types of turning vehicles that will use the intersection must be conducted.

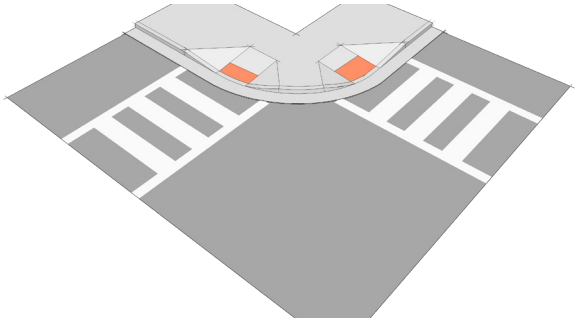
EXHIBIT 16. RAISED PEDESTRIAN CROSSING

The best option for channelized right-turn lanes is to close them. If traffic analysis shows that one or more lanes must be maintained, raised crossings can be used to slow turning vehicles and ease pedestrian crossings. Where feasible, these can be accompanied with an accessible pedestrian signal (a device that provides auditory cues on when it is safe to cross, to aid pedestrians with impaired vision), since crossings at channelized right turns are particularly challenging for pedestrians with impaired vision.

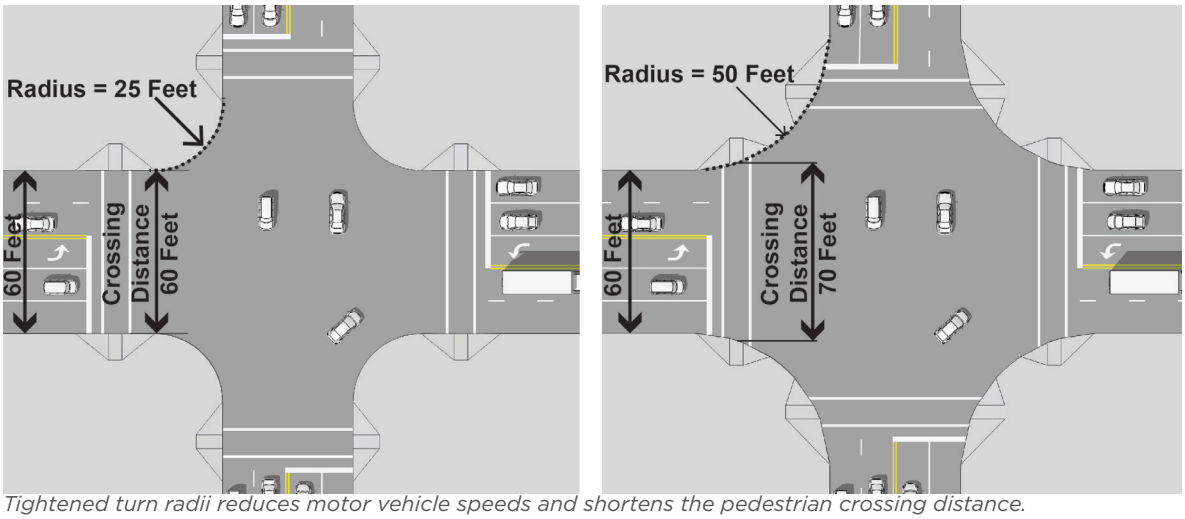
EXHIBIT 17. CURB RAMP AND TURNING RADII TO IMPROVE CROSSINGS



Typical ADA Compliant Pedestrian Curb Ramp.



Typical Bidirectional Pedestrian Curb Ramps.



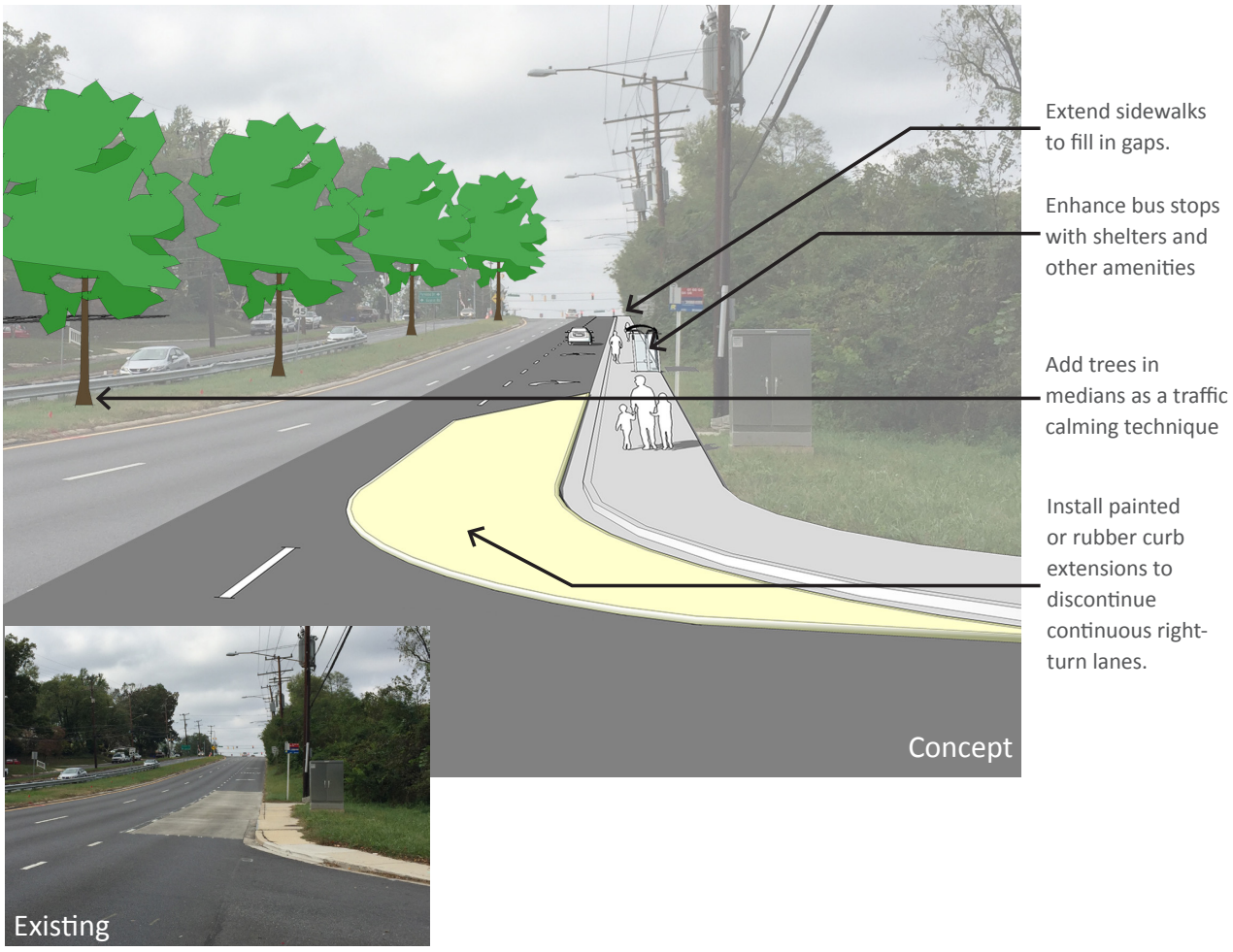
Tightened turn radii reduces motor vehicle speeds and shortens the pedestrian crossing distance.

2.3.3 DECREASE CRASH SEVERITY BY SLOWING MOTOR VEHICLE SPEEDS

Creating curb extensions to disrupt the continuous right turn lane, as shown in Exhibit 18, is the only spot-intervention shown with a primary purpose of reducing through speed. This is because each of the best practices such as planting street trees, and many of the other interventions all also serve a traffic calming purpose. Taken together as a suite, the recommendations will have a corridor-wide traffic calming effect. Table 1 on Page 27 also shows the multiple functions of each recommended improvement.

Where bus lanes are present, curb extensions must be placed to minimize the need for buses to pull back into traffic, thus experiencing reentry delay. Clearly marked and well-enforced bus lanes are another way to move high volumes of motor vehicle traffic away from the curb, but curb extensions are an interim solution, or appropriate for places where a bus lane is not viable.

EXHIBIT 18. CURB EXTENSIONS TO INTERRUPT CONTINUOUS TURN LANES



2.3.4 CORRIDOR-WIDE POLICIES AND BEST PRACTICES

Several interventions are not engineering interventions applied to a particular location, but are instead corridor-wide policies and management practices. The below best practices should be applied to the full corridor.

MAINTENANCE

The majority of the interventions described in the previous chapter are improvements to the bicycle and pedestrian realms. In addition to being road users who are vulnerable to injury, travelers using these modes are sensitive to the details of the conditions of their facilities. This means that relatively slight disruptions to grade, degradation of the surface quality, or blockage by debris can have a significant effect on how well the facility functions for these users. Consequently, as any bicycle or pedestrian realm intervention is designed and constructed, a plan should also be made for its maintenance. Policies and practices should be coordinated across agencies so that snow and brush removal happens in both a timely and satisfactory manner; in some cases, specialized plows and lawnmowers must be acquired to ensure that crews can complete appropriate maintenance.

Plowing a separated bike lane with a smaller plow in Washington, D.C. (Photo credit: District Department of Transportation)

Bicycle facilities that are within the portions of the roadway used by motor vehicles (such as on frontage roads, neighborhood greenways, and conventional bike lanes) should have higher standards of repair before calling for repaving, and should be subjected to more frequent inspection to establish satisfactory conditions. This is also true for the locations of the sidewalk or sidepath that are frequently crossed by motor vehicles, especially at commercial driveways.

SPEED REDUCTION THROUGH NARROWING THE "FEEL" OF THE ROADWAY

Streets and roads that feel constrained to drivers encourage driving at lower speeds. Short of physically narrowing the roadway (which can be reassessed in the long term, if conditions change), lanes can be narrowed using striping and the visual field can be constrained using street trees.

Street trees are recognized as a traffic calming measure in the NACTO Urban Streets Design Guide. They provide rhythm and constraint to the driver's visual experience, helping them gauge their speed, and making high speeds feel less comfortable.

Rows of street trees creating a visually-constrained corridor (Photo Credit: University of Washington)

SPEED REDUCTION THROUGH SPEED LIMIT, SIGNALIZATION, AND ENFORCEMENT POLICIES

As shown in Chapter 1, and again in Exhibit 19, rates of pedestrian survival drop precipitously if they are struck by a vehicle traveling above approximately 20 miles per hour. While this may not be a realistic speed limit for a roadway that is designated a major highway, comprehensive speed limit reduction should be considered, for the length of the corridor.

The traditional method of setting speed limits at the 85th percentile speed of the roadway 85th percentile speed fails to consider safety impacts of non-auto users. This topic was addressed in a recent National Transportation

Safety Board report titled *Reducing Speeding-Related Crashes Involving Passenger Vehicles.*

The report describes how using the existing speed on a roadway to determine the appropriate speed on a roadway can have unintended consequences. When the speed limit is raised to match the speed over which only 15% of drivers drive, that may increase the operating speed, thus triggering a cycle of increasing speeds, dictated by driver behavior. Instead, speed limits should be set with the safety and travel need of all road users (not just drivers) in mind.

As an adopter of Vision Zero, Montgomery County is moving toward a "safe system" approach to roadway safety. The same NTSB report says the following about setting speed limits as part of a safe system:

Within a safe system paradigm, road designers should use "a proactive urban street design approach (in which the posted speed limit is determined by a target speed based on a desired safety result)." The report also recommends choosing speed limits near the AASHTO minimum for a given roadway type (e.g., the target speed for urban arterial roadways is 35 miles per hour).

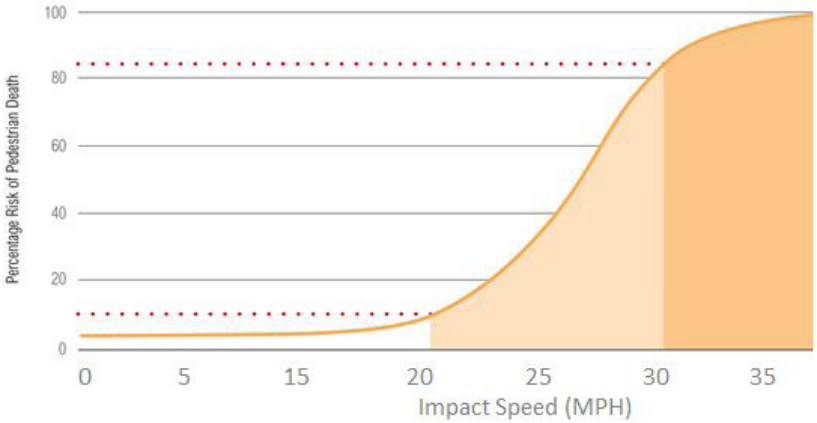
All portions of Veirs Mill Road would see safety benefits from speeds this low, or lower. This is particularly true for the portions with many driveways, vulnerable users, and other conflicts, such as the Newport Mill and Connecticut/Randolph districts. With judgment, highest conflict locations could be reduced to 30 miles per hour.

Once lower speed limits are set, automated enforcement through average speed cameras is one strategy for improving compliance. Another is to use coordinated signal timing so that vehicles traveling at the desired speeds reach repeated green lights and vehicles traveling above this speed must stop frequently at red lights. While actuated beacons are listed as a crossing intervention, full signalization with automatic pedestrian crossing phases offers this further speed control opportunity, as this works best with closely space intersections. Exhibit 19 reiterates the pedestrian fatality rates when hit by vehicles traveling at different speeds, due to the crucial role that speed reduction plays in safety.

SAFETY THROUGH SIGNAL TIMING

Some traffic signal features are known to have safety benefits for pedestrians; specifically, leading pedestrian intervals should be considered at all signalized intersections, and any pedestrian signals that do not yet have countdowns, should be upgraded when possible. In general, programing of signal phasing should be another part of the "safe system" approach in which safety is prioritized, even when Level of Service trade offs may be necessary.

EXHIBIT 19. RATES OF PEDESTRIAN FATALITY AT VARIOUS SPEEDS.



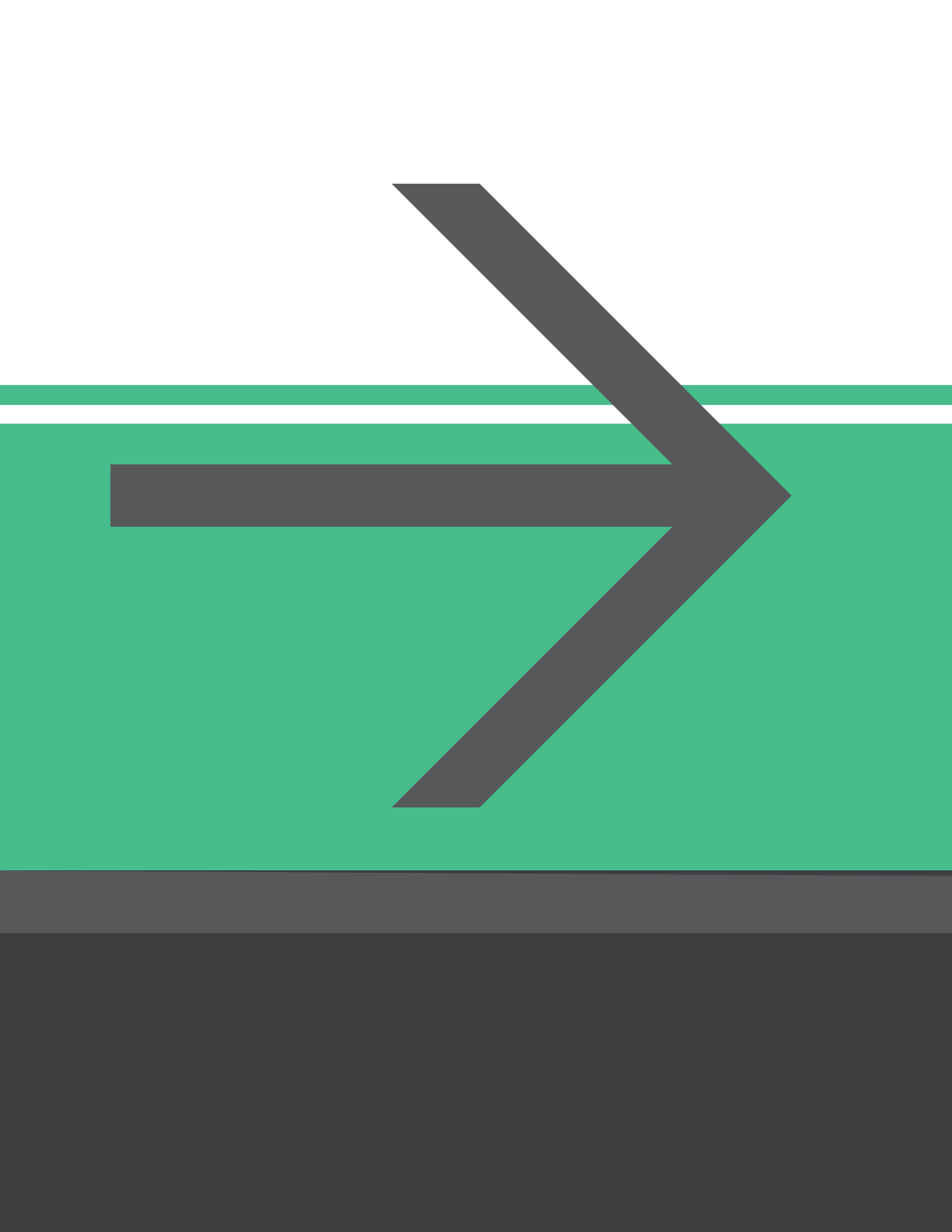
Rates of pedestrian fatality when hit by a car traveling various speeds. (Image Credit: World Resource Institute)

2.4 IMPACTS OF THE INTERVENTIONS

As mentioned previously, each intervention in the toolbox can perform multiple safety Table 1 represents their full range of safety benefits, organized by how they contribute to the ways that safety is created.

TABLE 1. INTERVENTIONS AND THEIR SAFETY BENEFITS

Treatment	Decrease Crash Frequency				Decrease Crash Severity (by slowing motor vehicles)
	Decrease conflicts by providing separate spaces	Decrease conflicts by improving crossing opportunities	Increase safe yielding by slowing motor vehicle speeds	Increase predictability of road users	
Create continuous sidewalks	✓			✓	
Create continuous bikeways	✓			✓	
Add pedestrian refuge islands		✓			
Create a level sidewalk or sidepath across driveways	✓			✓	
Add signalized crossing opportunities		✓	✓	✓	✓
Create raised crossings		✓	✓		✓
Tighten turn radii		✓	✓		✓
Create curb extensions		✓	✓	✓	✓
Reduce posted speed limit (and enforce)				✓	✓
Ensure proper sidewalk, sidepath, and bikeway maintenance	✓			✓	
Signal phasing used to prioritize safety				✓	



CHAPTER 3

SHORT-TERM SAFETY INTERVENTIONS

3.1 ADDRESSING THE PROBLEM LIST

This chapter will show how the toolbox of interventions can be applied to Veirs Mill Road, to improve safety for all users. The following corridor-wide strategies should be applied for the length of the study corridor:

- Speed Reduction through Speed Limit, signalization, and Enforcement Policies
- Maintenance practices that maintain bicyle and pedestrian mobility at all times

The site-specific improvements are mapped on the following pages according the the "districts" identified in the Veirs Mill Corridor Master Plan. Exhibit 20 shows the limits of each of the districts.

The most major, and among the most pressing, recommendations are to add or retrofit signals or beacons, in order to create a pattern of protected pedestrian crossings, at regular intervals. These locations are shown in the tables below, as well as on their respective district maps.

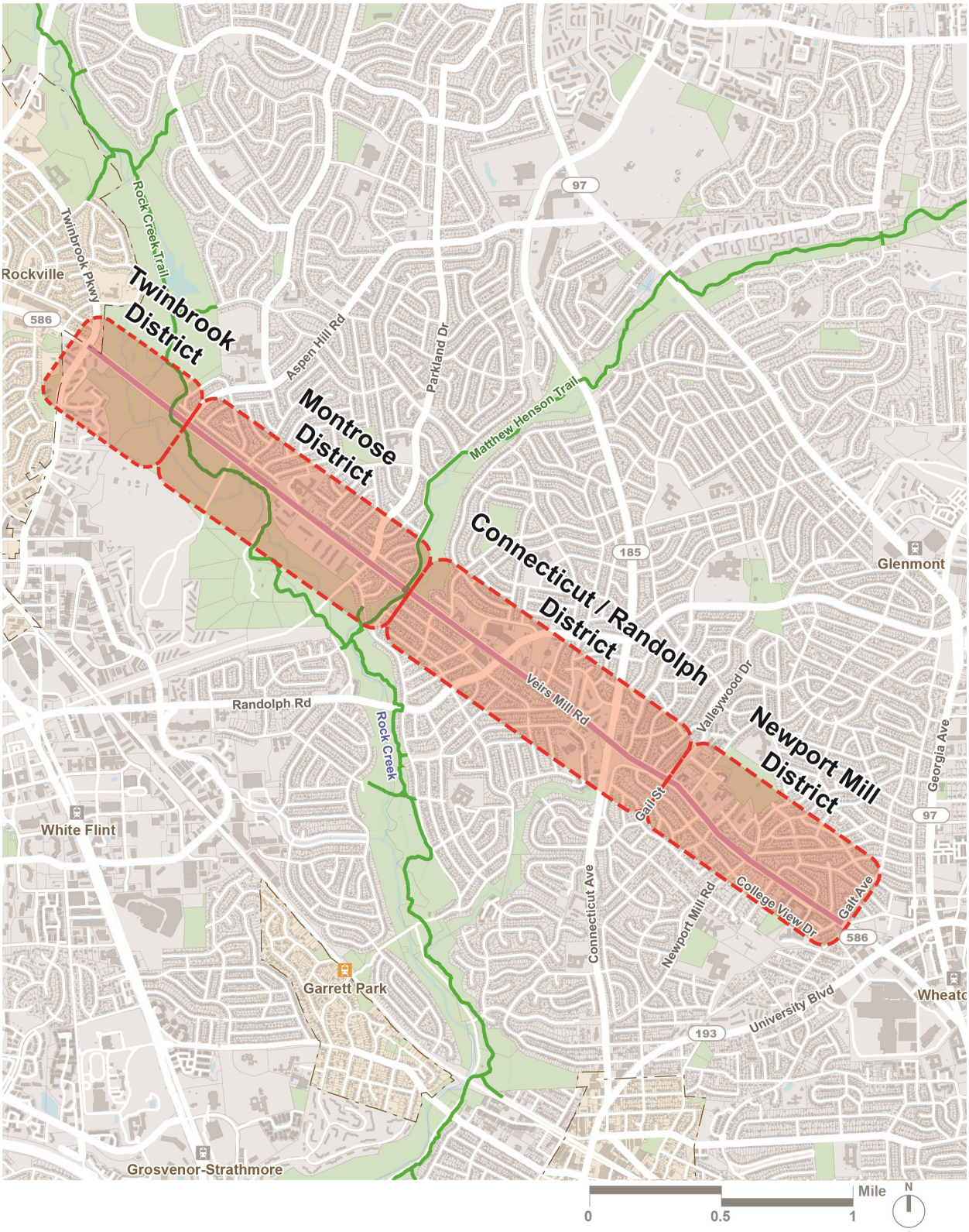
TABLE 2. LOCATIONS OF NEW SIGNAL OR BEACON RECOMMENDATIONS

District	Location
Newport Mill	Galt Avenue & Veirs Mill Road
Newport Mill	Pendleton Drive & Veirs Mill Road
Newport Mill	Valleywood Drive & Veirs Mill Road
Montrose	Arbutus Avenue & Veirs Mill Road

TABLE 3. LOCATIONS OF SIGNAL RETROFIT RECOMMENDATIONS

District	Location
Newport Mill District	Newport Mill Road & Veirs Mill Road
Newport Mill District	Claridge Road & Veirs Mill Road
Connecticut/Randolph	Connecticut Avenue & Veirs Mill Road
Connecticut/Randolph	Ferrara Drive & Veirs Mill Road
Connecticut/Randolph	Randolph Road & Veirs Mill Road
Connecticut/Randolph	Gridley Road & Veirs Mill Road
Connecticut/Randolph	Connecticut Avenue and Veirs Mill Road
Montrose	Matthew Henson Trail Crossing
Montrose	Gaynor Road & Veirs Mill Road
Montrose	Robindale Drive & Veirs Mill Road
Montrose	Aspen Hill Road & Veirs Mill Road
Twinbrook	Twinbrook Parkway & Veirs Mill Road

EXHIBIT 20. LIMITS OF EACH DISTRICT



3.2 NEWPORT MILL DISTRICT

The eastern portion of the study corridor from approximately University Boulevard to Gail Street is described as the Newport Mill District, and its limits are shown in Exhibit 21. This area is characterized by a mix of institutional and residential uses, a relatively constrained right of way, and frequent driveways. Additionally, portions of the south side of the corridor are missing a sidewalk.

3.2.1 RECOMMENDED IMPROVEMENTS

This segment is not wide enough to provide a two-way separated bike lane in the short term, therefore the primary bicycle and pedestrian accommodation recommendation is to provide a sidepath 8 feet in width or wider, wherever there is not a frontage road.

This corridor segment provides occasional signalized opportunities for pedestrians and bicyclists to cross, but the existing signals at Newport Mill Road and Claridge Road should be upgraded to include high-visibility crosswalks on each approach, pedestrian refuges if space allows, and an actuated or pedestrian recall crossing phase. Most changes to the operation of signalized intersections will require further study, but each of the following changes should be considered where retrofitting is recommended:

1. Add additional crosswalks across legs that currently do not have marked crosswalks.
2. Shorten crossing distance by adding curb extensions, reducing lane widths, or reducing number of through or turning lanes.
3. Add pedestrian refuge islands.
4. Evaluate signal phasing to reduce pedestrian wait time as well as ensuring pedestrian green time is sufficient enough for pedestrians to cross.

The existing unsignalized crossings at Pendleton Drive and Gail Street should be upgraded to include an actuated beacon similar to that at the Matthew Henson Trail crossing (or a HAWK signal, if deemed feasible), and a median refuge for pedestrians, to break up the crossing distance. The location for each of these recommended improvements is shown in Exhibit 22.

Where a frontage road is present (such as from Glorus Place continuing past Gail Street and between Dawson Avenue and Galt Avenue) it can be striped with a contraflow bike lane and sharrows (or simply sharrows, if parking is to be maintained) and the frontage road's sidewalks can be used by pedestrians, though they should still be assessed for ADA compliance and upgraded if necessary, using techniques such as the short-ramp described in the previous section. Bicycle-friendly speed humps (or other appropriate vertical deflection techniques) can be used to calm traffic where sharrows are present, as warranted or determined feasible by study.

College View Drive and Upton Drive should also be considered for neighborhood greenway treatments to provide an additional low-stress bicycling option.

EXHIBIT 21. NEWPORT MILL DISTRICT

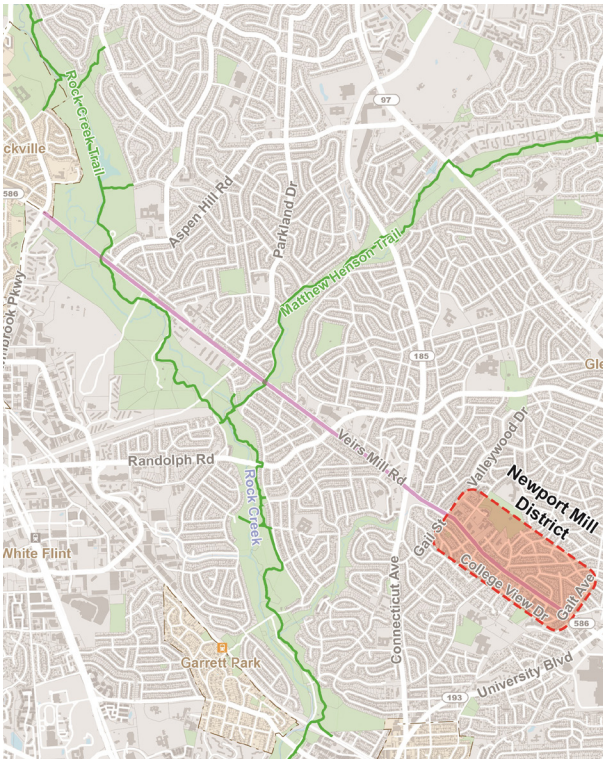


EXHIBIT 22. RECOMMENDATIONS FOR THE NEWPORT MILL DISTRICT

3.3 CONNECTICUT/ RANDOLPH DISTRICT

The section of the study corridor from Gail Street to the eastern edge of Matthew Henson Park is named for its two major intersections, Connecticut Avenue, and Randolph Road; its limits are shown in Exhibit 23.

3.3.1 RECOMMENDED IMPROVEMENTS

This segment is not wide enough to provide a two-way separated bike lane in the short term, thus, the primary bicycle and pedestrian recommendation is to provide a sidepath 8 feet in width or wider on each side of the street, wherever there is not a frontage road. This may be a new sidewalk/ sidepath, or may be a widening retrofit of an existing sidewalk

Where a frontage road is present, it can be striped with a contraflow bike lane and sharrows (or simply sharrows, if parking is to be maintained), and the frontage road's sidewalks can be used by pedestrians, though they should still be assessed for ADA compliance and upgraded if necessary, using techniques such as the short-ramp described in the previous section. Bicycle-friendly speed humps (or other appropriate vertical deflection techniques) can be used to calm traffic where sharrows are present, as warranted or determined feasible by study.

Connecticut Avenue's channelized right-turn lanes warrant detailed traffic study; if their necessity cannot be definitively determined, they should be removed, and the intersection retrofitted with standard right-turn lanes with sufficiently tight turn radii to slow turning vehicles crossing the crosswalks. If it is determined that they cannot be removed, they should be retrofitted with raised crossings and accessible pedestrians signals, as described in the toolbox section, and as determined feasible by warrant and engineering studies. The signalized intersections at Randolph Road, Ferrara Drive and Gridley Road should be retrofitted to ease pedestrian crossings, as described in the Newport Mill District section.

The Intersection of Veirs Mill Road and Havard Street should be improved with a curb extension on the north side of the street. The location for each of these recommended improvements is shown in Exhibit 24.

College View Drive, Ferrara Drive, and Selfridge Road should also be considered for neighborhood greenway treatments to provide an additional low-stress bicycling option.

EXHIBIT 23. CONNECTICUT/RANDOLPH DISTRICT

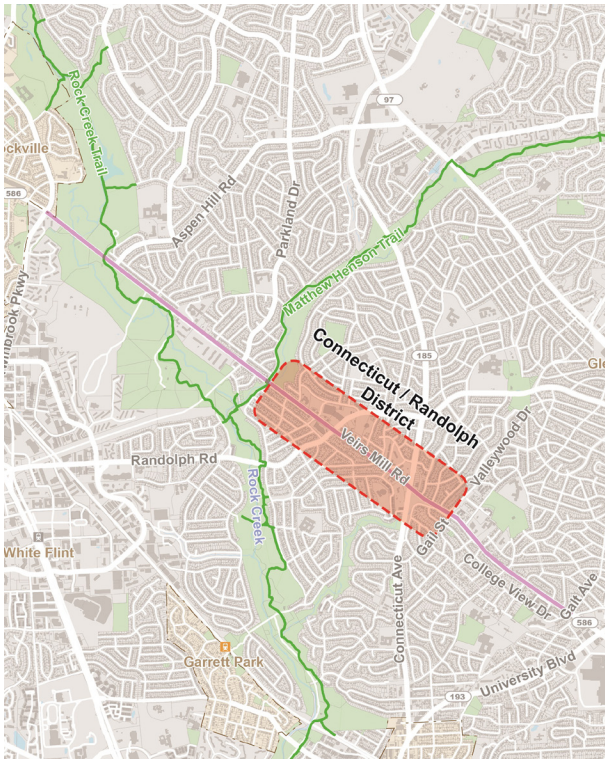


EXHIBIT 24. RECOMMENDATIONS FOR THE CONNECTICUT/RANDOLPH DISTRICT

3.4 MONTROSE DISTRICT

The section of the study corridor bounded by the eastern edge of Matthew Henson Park and the Rock Creek Trail crossing is known as the Montrose District; its limits are shown in Exhibit 26. It is wider than the eastern segments of the corridor, and highly influenced by the parks and open space that border it.

3.4.1 RECOMMENDED IMPROVEMENTS

The segments shown in Exhibit 27 with missing sidewalks should be upgraded with a sidewalk where adjacent to a frontage road or separated bike lane, or a sidepath where indicated.

This segment would also benefit from crossing upgrades as indicated in Exhibits 25 and 27.

This segment is sufficiently wide to provide a two-way separated bike lane in the short term in most places. This separated bike lane is envisioned for the space that currently functions as a shoulder. It should include a vertical separation from traffic such as a curb (which can be crossed in emergency situations but still provide protection), and would require repaving of the shoulder. A neighborhood greenway on Furman Road would provide connection from the bike facilities on Veirs Mill Road to the Matthew Henson Trail.

EXHIBIT 26. MONTROSE DISTRICT

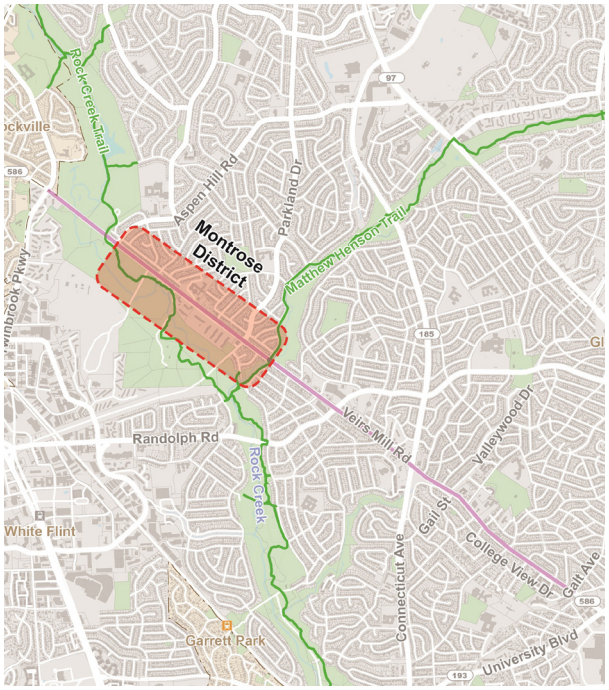


EXHIBIT 25. IMPROVE MATTHEW HENSON TRAIL CROSSING

EXHIBIT 27. RECOMMENDATIONS FOR THE MONTROSE DISTRICT

3.5 TWINBROOK DISTRICT

The westernmost portion of the study corridor is the Twinbrook District, which is bounded by the Rock Creek Trail Crossing. It is missing a sidewalk on the south side of the street, and does not have bicycle accommodations. The limits of the Twinbrook District are show in Exhibit 28.

3.5.1 RECOMMENDED IMPROVEMENTS

The sidewalk should be completed in this district, adjacent to the separated bike lane; this segment would also benefit from curb extensions and crossing upgrades as indicated in Exhibit 29.

This segment is sufficiently wide to provide a two-way separated bike lane in the short term in most places. This separated bike lane is envisioned for the space that currently functions as a shoulder. It should include a vertical separation from traffic such as a curb (which can be crossed in emergency situations but still provide protection), and would require repaving of the shoulder.

EXHIBIT 28. LOCATION OF TWINBROOK DISTRICT

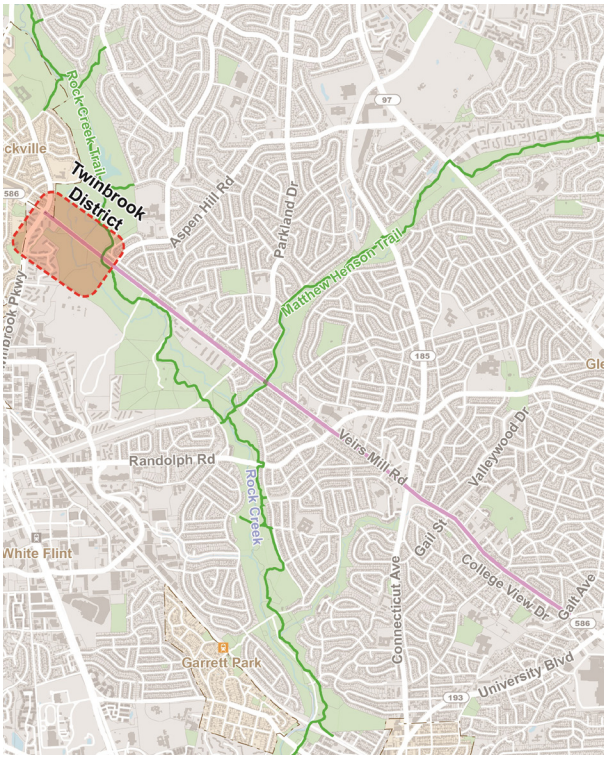
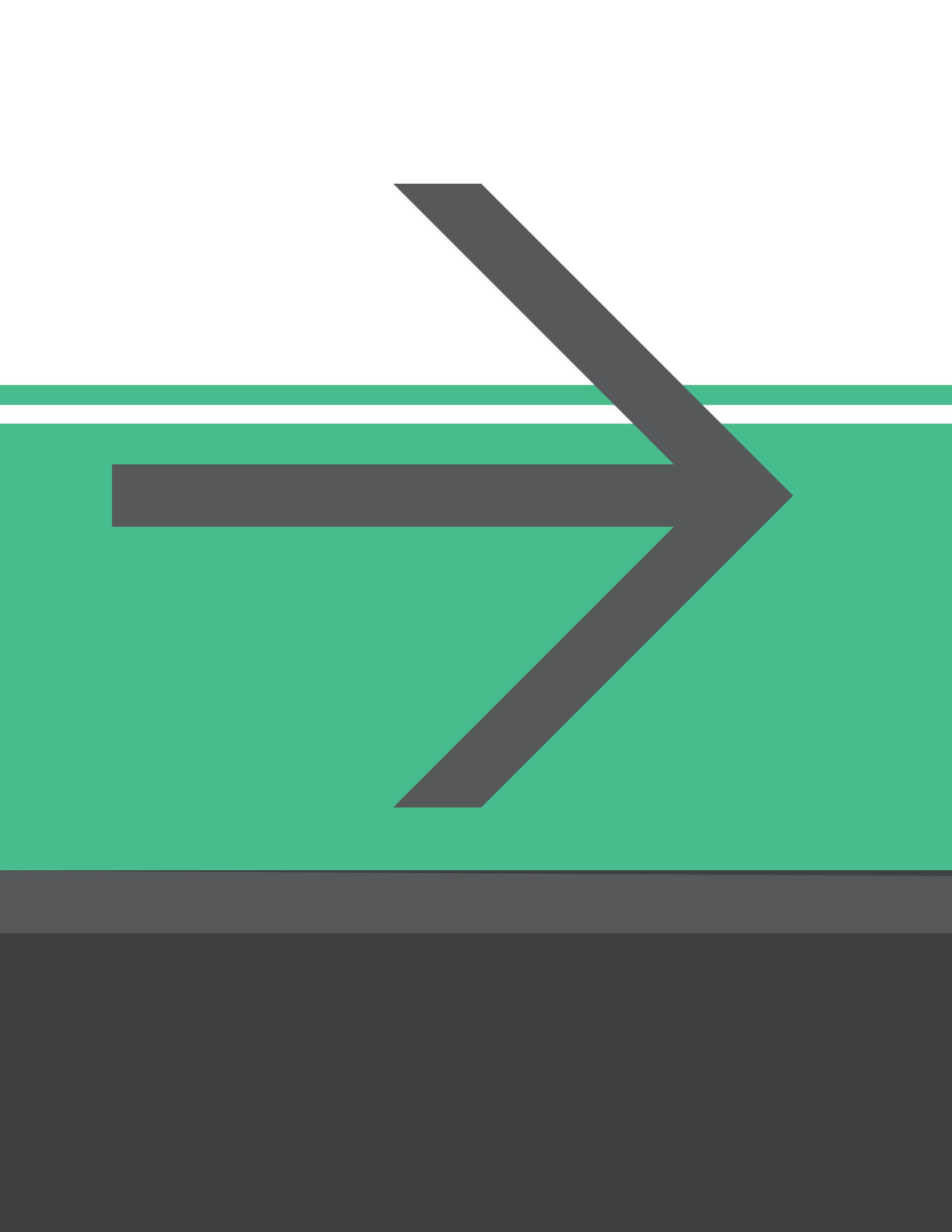


EXHIBIT 29. RECOMMENDATIONS FOR THE TWINBROOK DISTRICT



CHAPTER 4

LONG-TERM COMPLETE STREET CONCEPT

4.1 VISION

The task for the long-term vision for Veirs Mill Road is to provide a high-level conceptual plan to reach Vision Zero in a 30-year time frame. Two options were shared with the community at a meeting on October 24, 2017. The recommended option is a complete street concept, which is described further in this chapter.

4.1.1 CORRIDOR-WIDE DESIGN CONSIDERATIONS FOR CREATING A COMPLETE STREET

A "complete street" design fosters a safe and comfortable environment for all road users by creating separate, clearly demarcated spaces for private automobiles, transit vehicles, pedestrians, and bicyclists.
The ideal complete street is designed to be intuitive and safe for all users. The long-term plan expands on the short-term improvements by providing further separation between all road users, including larger vegetated buffers between vehicles and people walking and biking. The long term plan also incorporates considerations for Bus Rapid Transit.

Long term recommendations for the corridor in general include:

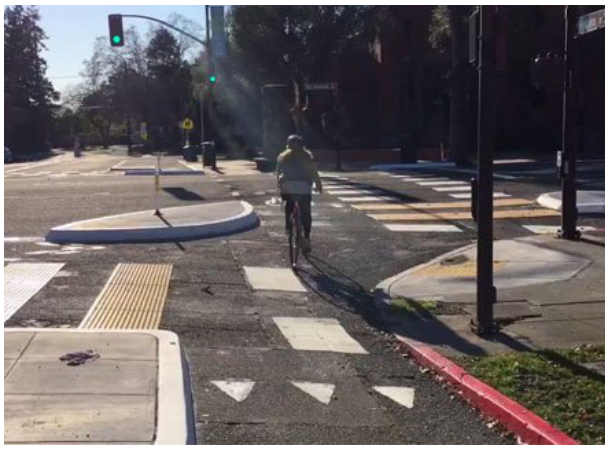
- **Two-way movements for people walking and riding bicycles on both sides of Veirs Mill Road, with vegetated buffers.**
    - » In unconstrained portions of the corridor (those where the available right-of-way width is 120 feet or more), facilities may include, for example, a sidewalk plus a two-way separated bike lane (with a center stripe) on each side of Veirs Mill Road.
    - » In constrained portions of the corridor, where there is less available right-of-way, bicycle and pedestrian sidepaths are envisioned.
    - » Due to varying conditions along the corridor, there are some portions with a sidepath on one side of Veirs Mill Road and a two-way separated bike lane with a sidewalk on the other side of the street.

A complete street design fosters a safe and comfortable environment for all road users by creating separate spaces for private automobiles, transit vehicles, pedestrians, and bicyclists.

Example of a two-way separated bike lane with a sidewalk (Photo credit: Bicycle Coalition of Greater Philadelphia)

Example of a path shared by people walking and riding bicycles (Photo credit: Laura Stark)

- **More frequent safe crossings.**
  - » The long-term plan incorporates and builds on the short-term improvements related to newly signalized intersections & crossings.
  - » All bicycle and pedestrian crossings will be, at a minimum, level and well-marked. Where possible, crossings should be raised to encourage cautious movement by vehicles, particularly for crossings at driveways and small side street intersections.
  - » Where separate (as opposed to shared-use) bicycle and pedestrian facilities are utilized, bicycle crossings should be separate from pedestrian crossings.
  - » All curb ramps should be ADA compliant.
  - » At the time of adoption of this plan, protected intersections are the state of the practice for extending separated bike lanes through the intersection and should be implemented where separated bike lanes cross major highways, arterial roads, business district streets or other high-volume streets. Should best—practices change, the most recent guidance for these designs should be applied.



Protected intersections, such as the one shown here (from Berkeley, California) help to avoid crashes between turning vehicles and people walking or riding bicycles using a raised curb that protects people as they wait to cross the intersection. (Photo credit: Bike East Bay)

- **Rows of trees** planted along the roadway edges and all medians, except near intersections where the center median may be replaced by a turn lane. In addition to the obvious shade benefits, these trees help to visually and physically narrow the roadway, potentially reducing traffic speeds.
- **A lane in each direction for bus rapid transit and local buses,** with easily-accessible stations provided along the curb or in a median between the access road and the main road (where an access road currently exists). This bus lane can also be used for right turns by other vehicles. The recommended width for these lanes is 11 feet.
- **Two general travel lanes in each direction.** These lanes should be as narrow as they can safely be in order to encourage slower driving. The recommended width is 10 feet.
- **Removal of all dual left-turn lanes** for increased safety and appropriate intersection scale. A single left turn lane remains at these locations.
- **Utilities buried underground or re-routed** behind buildings or along alleys when possible, to leave a clearer path for people walking and riding bicycles.
- **Pedestrian-scale lighting** in addition to adequate roadway lighting, particularly at intersections.
- **No new access roads.** Existing access roads will be improved for bicycle and pedestrian safety.

4.1.2 BUS RAPID TRANSIT

Any long-term improvements to Veirs Mill Road must consider Bus Rapid Transit (BRT). Maryland Department of Transportation (MDOT) and Montgomery County Department of Transportation (MCDOT), completed a BRT study in 2016. The study analyzed the costs and benefits of several options for providing enhanced service on the Veirs Mill Road corridor. The County Council voted to move forward with a design called Alternative 2.5, retaining Alternative 3 for the master plan and potential eventual long-term design. Alternative 2.5 was developed at the request of the County Council and is called Alternative 2.5 because it is a hybrid of Alternative 2 and Alternative 3. Any future BRT project or implementation would be led by Montgomery County DOT.

- **Features of Alternative 2.5**:
  - » No dedicated curb lane.
  - » Provision of queue jump lanes at Veirs Mill Road's 12 busiest intersections between Rockville and Wheaton, with transit signal prioritization.
  - » Stations with features such as level-boarding, off-board fare collection, and real-time information, and new BRT service would be provided using new, branded, and larger BRT vehicles.
- **Features of Alternative 3**:
  - » Curb lanes along most of the corridor, shared only with local buses and right-turning vehicles.
  - » Stations with features such as level-boarding, off-board fare collection, and real-time information, and new BRT service would be provided using new, branded, and larger BRT vehicles.

Because Alternative 3 was retained as the master plan option, this Vision Zero long-term concept plan incorporates dedicated curb lanes for buses. Alternative 3 would require extension of the current curb line, within the existing right-of-way, for several parts of the corridor. While Alternative 2.5 would not require extension of the current curb line in most locations, it may be necessary to widen the roadway to provide for queue jump lanes for buses, which are proposed at six locations within the study area:

- Twinbrook Parkway (EB and WB)
- Aspen Hill Road (EB and WB)
- Parkland Drive/ Montrose Parkway (EB and WB)
- Gridley Road (WB)
- Randolph Road (WB)
- Connecticut Avenue (EB and WB)

These queue jumps promote improved travel times for the bus, particularly when paired with signal prioritization, as proposed. Of the six locations where they are proposed, it is likely that only one (Parkland Drive / Montrose Parkway East) may require widening to achieve the queue jumps, should Alternative 2.5 proceed.

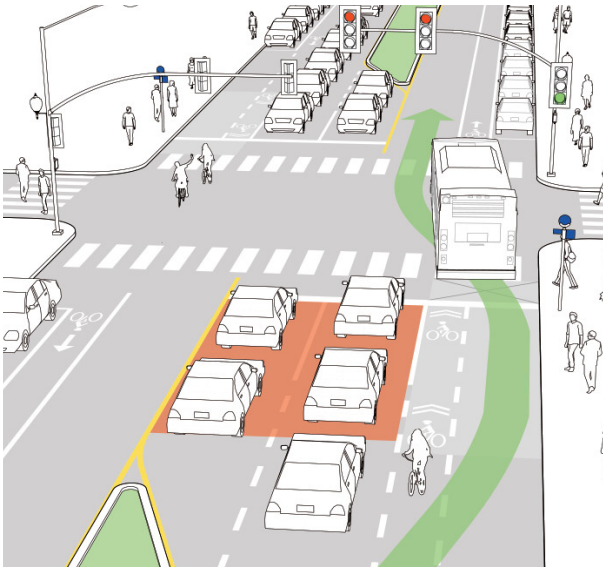


Illustration depicting the use of a bus queue jump lane, which can significantly provide improve transit travel time, even without a dedicated lane (Image Source: NACTO Transit Street Design Guide)

It is very likely that enhancements to the bus system would draw more riders, which means more people traveling to each bus station. Stations must be easily and safely accessible by pedestrians and bicyclists. This includes signalized crossings at all BRT stations.

4.1.3 LAND USE CONSIDERATIONS

Though this plan does not specifically address potential future land use patterns, land use can play an important role in creating a safer and more comfortable experience for people walking and riding bicycles. To further support the vision for Veirs Mill Road, future development and redevelopment plans along the corridor should include:

- Buildings built up to the sidewalks, rather than set back behind parking lots, in order to both visually narrow the roadway and provide enhanced pedestrian accessibility to buildings.
- Access points from side roads or the rear of the property, rather than directly off of Veirs Mill Road.
- A mix of land uses, where feasible, to provide greater interest and visibility for people walking and riding along Veirs Mill Road.

4.1.4 DISTRICT-SPECIFIC RECOMMENDATIONS

The remainder of this chapter provides general design concepts for each of the four Districts (see Exhibit 29), starting at the far southeastern end of the Veirs Mill Road corridor.

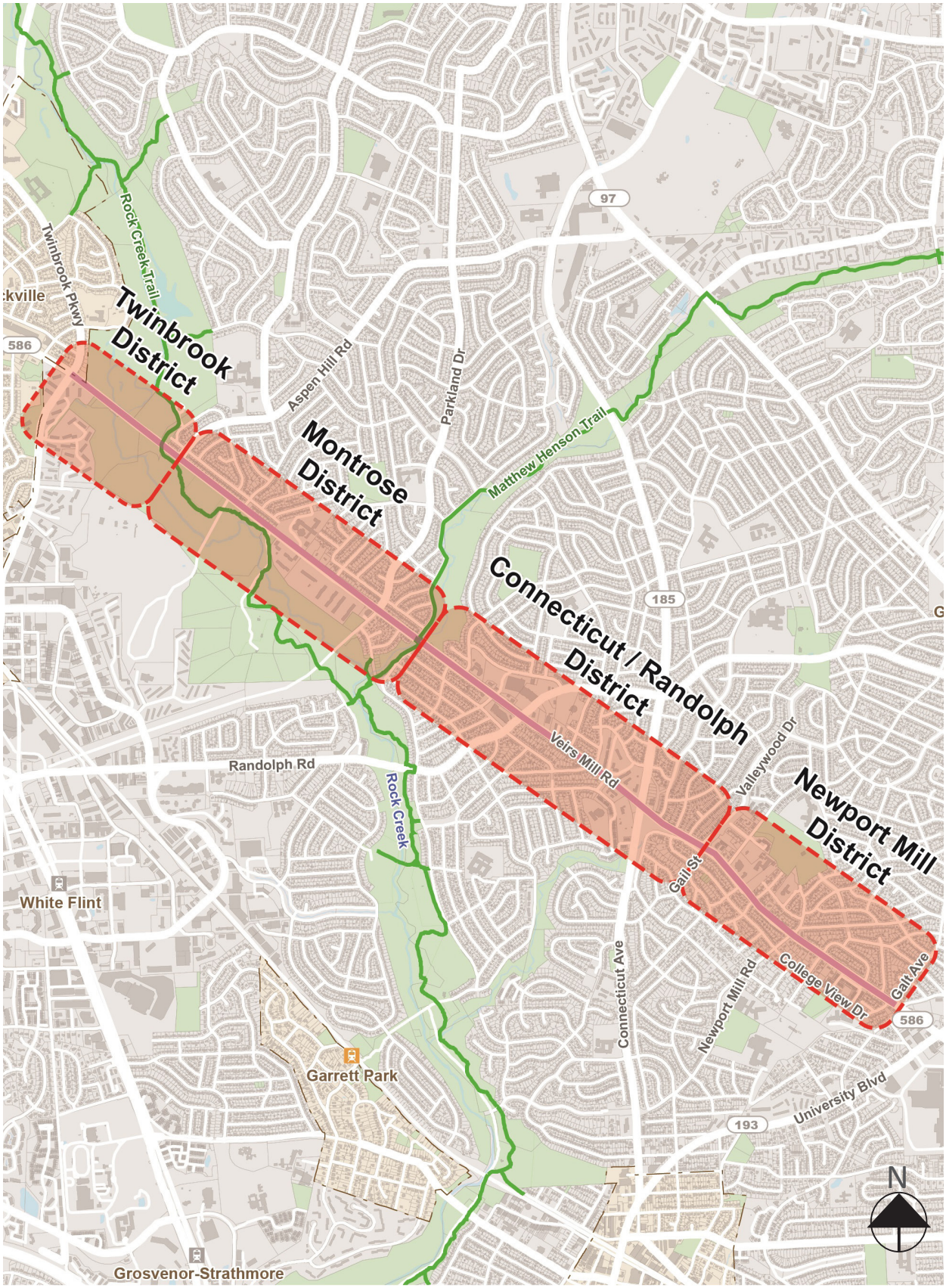
Recommendations include examples of typical cross sections within each District, and solutions to certain problem/issue areas. The full concept plan provided in the Appendix provides a high-level overview of one way these recommendations could create a complete street redesign for Veirs Mill Road.

The long-term District-specific recommendations incorporate many of the short-term recommendations, but also make changes to some facilities and utilize additional features to provide greater safety enhancements and separation between modes.

- In general, the long-term plan incorporates increased separation between different types of modes, where right-of-way allows.
- The long-term plan incorporates protected intersections, which are not included as a short-term solution.

Note that while the cross sections and other solutions indicate recommended dimensions for facilities based on the available right-of-way in each District, detailed design guidance for each type of facility is not provided. Conditions will vary along the corridor based on available width and other considerations. The plan assumes compliance with all County standards found in the Bicycle Facility Design Toolkit (2017). Facilities must also be compliant with ADA standards.

EXHIBIT 30. VEIRS MILL ROAD DISTRICTS



4.2 NEWPORT MILL DISTRICT

4.2.1 RECOMMENDED IMPROVEMENTS

BICYCLE AND PEDESTRIAN FACILITIES

In the Newport Mill District (as shown in Exhibit 31) as in all Districts in the Veirs Mill Corridor, the recommended bicycle and pedestrian facilities seek to provide as much space and separation between the two modes as is allowed by the available right-of-way.

From Galt Avenue to just east of Norris Drive, the recommended facilities are two-way separated bike lanes with a six-foot sidewalk on the south side of the road, and a 12-foot sidepath on the north side; see Exhibit 34, which represents this condition with the access road. A similar cross section is recommended from Galt Avenue to Sherrie Lane, with the exception of the access road.

For the western portion of the District, Norris Drive to Gail Street, the general recommended bicycle and pedestrian facility is a 10-foot sidepath on both sides of Veirs Mill Road as shown in Exhibit 33.

When the facilities change from separated spaces for bicyclists and pedestrians to shared space, as is recommended east of Norris Drive, there should be a transition period where a sidepath coexists with a sidewalk to allow pedestrians time to move to the sidewalk before the addition of the separated bike lanes.

On the south side of Veirs Mill Road between Glorus Place and Pendleton Road, there is a large change in elevation. Because the slope is very steep, it does not allow for continuation of the access road to Pendleton Road, or for an easy connection from the access road to Veirs Mill Road. Though that connection may be possible with further engineering, a simpler solution to continuous bicycle and pedestrian facilities is to provide these facilities in the median between the primary roadway and the access road, rather than on the outside of the access road.

EXHIBIT 31. LOCATION OF NEWPORT MILL DISTRICT

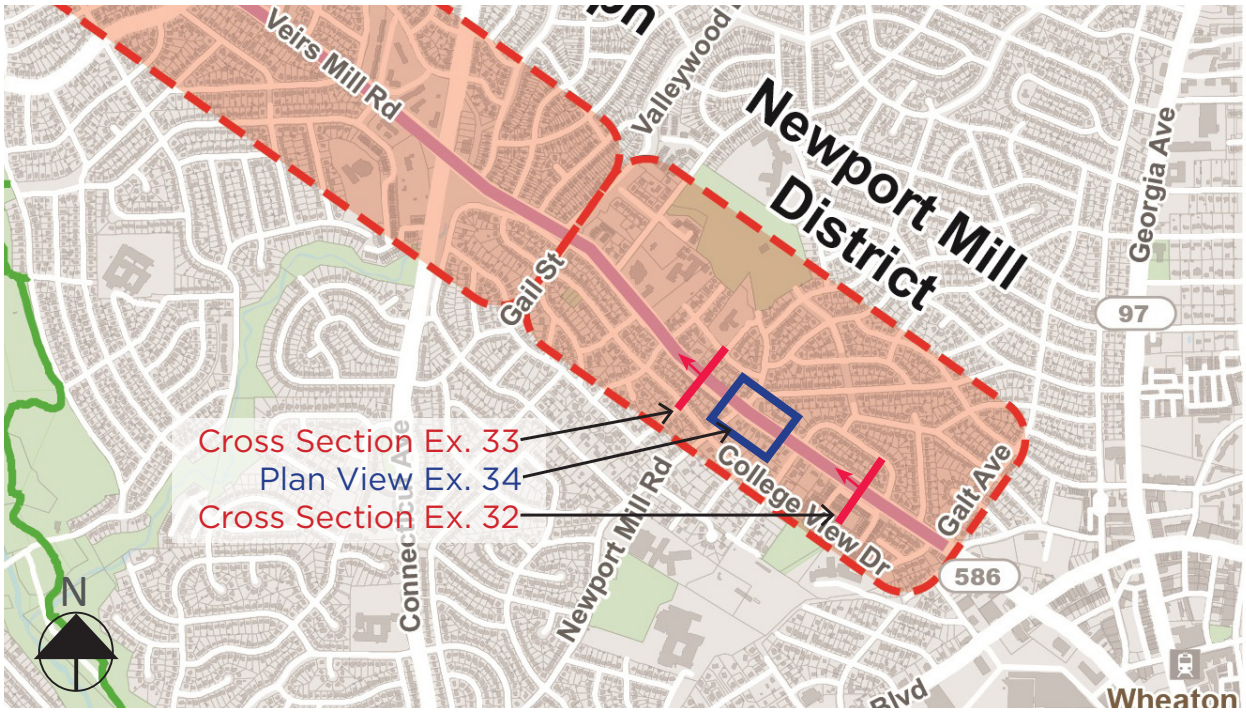


EXHIBIT 32. EXISTING AND RECOMMENDED CROSS SECTIONS, GALT AVE TO EAST OF NORRIS DRIVE

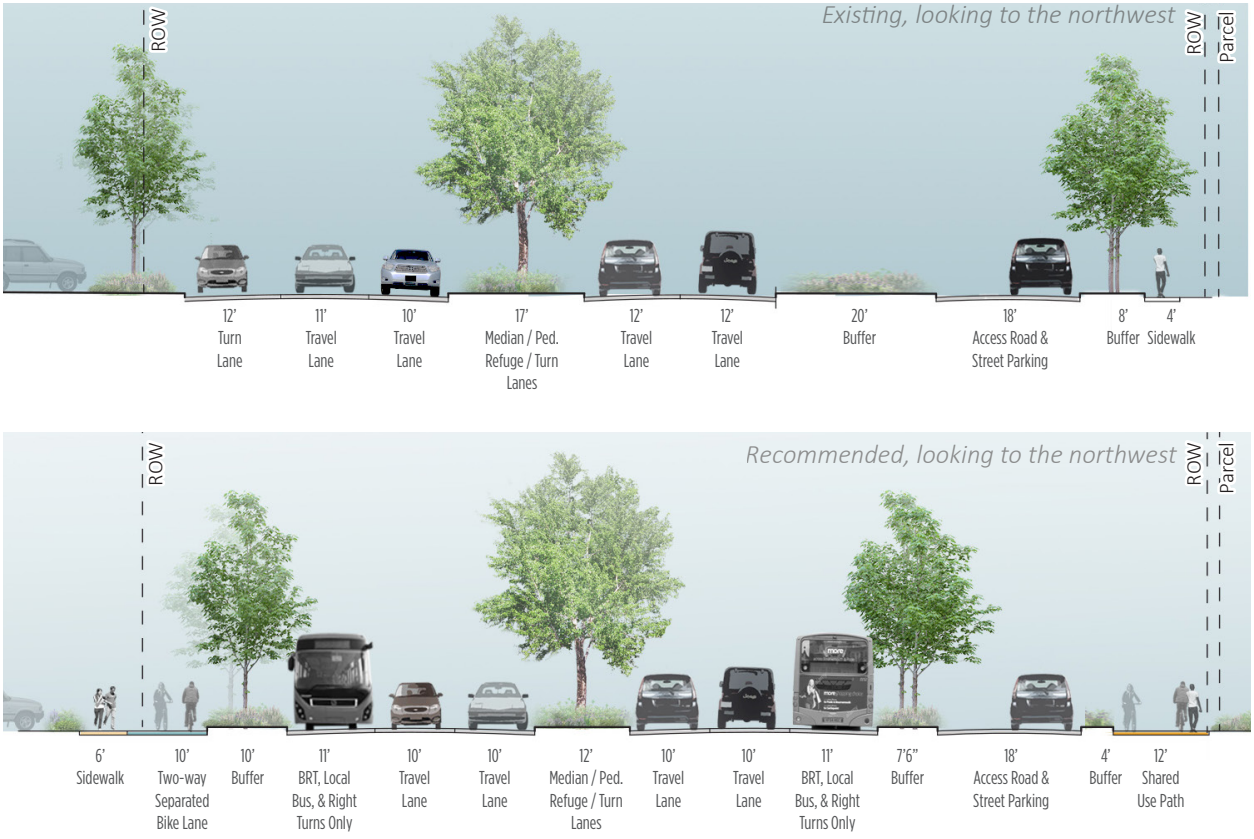
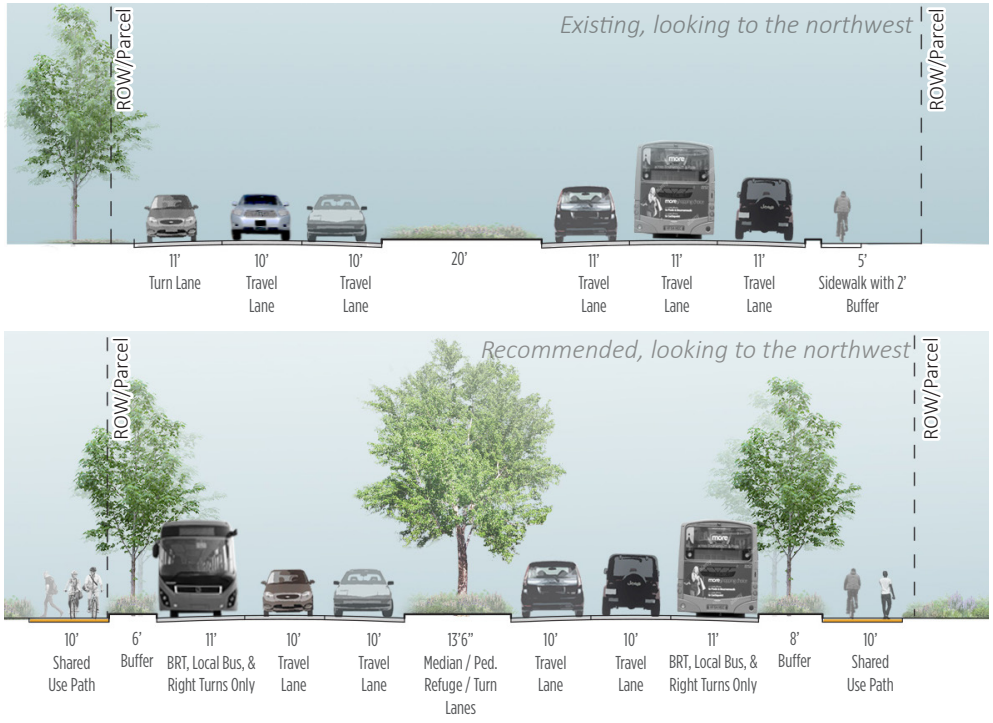


EXHIBIT 33. EXISTING AND RECOMMENDED CROSS SECTIONS, EAST OF NORRIS DRIVE TO GAIL STREET



The cross section recommended in Exhibit 32 would require approximately six additional feet of right of way. If this is not feasible to obtain, some cross section elements could be narrowed.

The cross section recommended in Exhibit 33 would require an additional 10 feet of right of way in some sections (between Norris and Pendleton and between Pendleton and Gail. Cross section elements could be narrowed if necessary.

CROSSINGS & INTERSECTIONS

Galt Avenue, Norris Drive, Pendleton Drive, and Gail Street should be considered for, at minimum, actuated beacons, and perhaps full signalization. In either case, these intersections should include pedestrian refuge medians that are as wide as allowed by the right-of-way. Existing signalized intersections must be upgraded, as needed, to include high-visibility crossings on each side of the intersection.

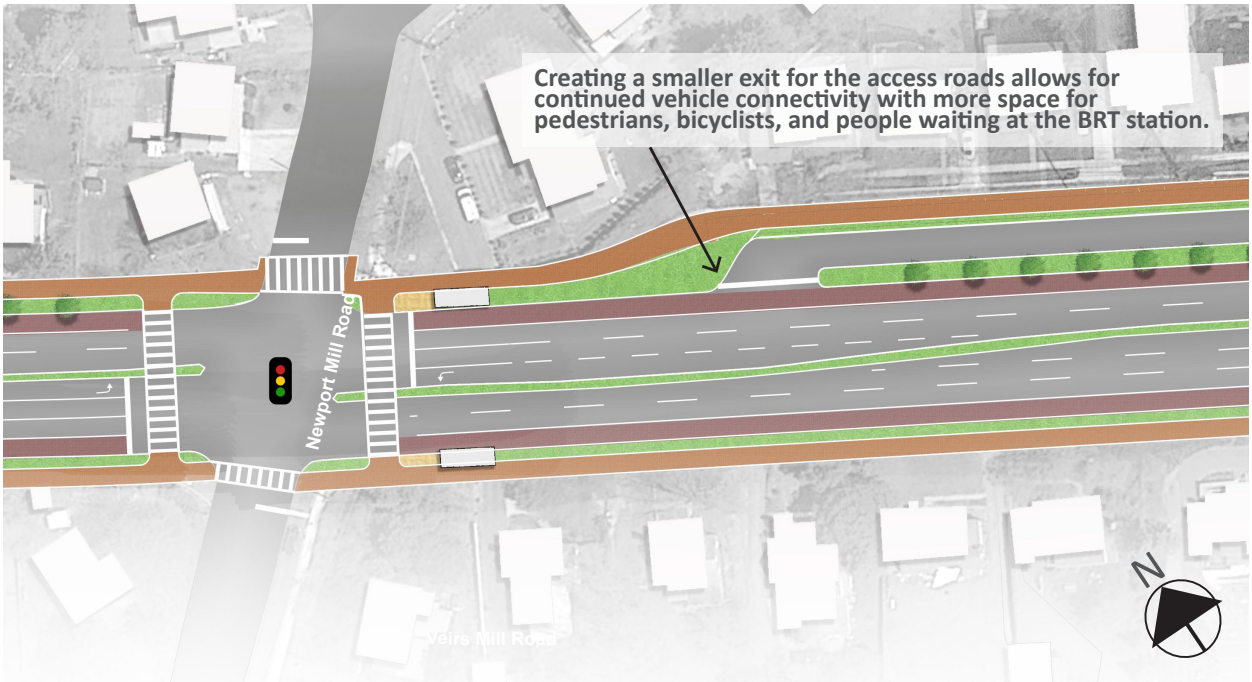
ACCESS ROADS

Tightening the space for the exit of the access road just east of Newport Mill Road will clarify vehicle movements and provide more space for people walking and riding bicycles as seen in Exhibit 34.

BRT CONSIDERATIONS

Though the plans for the future BRT system show a westbound stop on the far side of Veirs Mill Road at Newport Mill Road, it is recommended that the stop be moved to the near side of the intersection, to take advantage of the extra space provided by the tightening of the access road exit, for enhanced station amenities.

EXHIBIT 34. RECOMMENDATIONS FOR THE NEWPORT MILL ROAD AREA



4.3 CONNECTICUT/ RANDOLPH DISTRICT

4.3.1 RECOMMENDED IMPROVEMENTS

BICYCLE AND PEDESTRIAN FACILITIES

There are three recommended cross sections for the Connecticut/Randolph District, the limits of which are shown in Exhibit 35.

From Gail Street to west of Ferrara Avenue, the recommended facilities are a 10-foot sidepath on the north side of Veirs MIll and an 11-foot sidepath on the south side, see Exhibit 36.

From Ferrara Avenue to Gridley Road, the recommended facilities are two-way separated bike lanes and a six-foot sidewalk on both sides of the road as shown in Exhibit 37. From Gridley Road to Edgebrook Road, the recommended facilities are a 10-foot two-way bike lane with a six-foot sidewalk on the north side, and a 10-foot sidepath on the south side as shown in Exhibit 38.

CROSSINGS & INTERSECTIONS

Centerhill Street and Bushey Drive should be considered for at least actuated beacons, and perhaps full signalization. In either case, these intersections should include pedestrian refuge medians that are as wide as allowed by the right-of-way. Existing signalized intersections must be upgraded, as needed, to include high-visibility crossings on each side of the intersection.

CHANGES TO TRAVEL LANES & MEDIANS

The intersection of Connecticut Avenue and Veirs Mill Road today is very wide, with channelized turn lanes that function like on-ramps to Connecticut Avenue. The long-term recommendation echoes that of the short-term: the channelized turn lanes should be removed, requiring all traffic movements to occur at the signalized intersection, with tighter turning radii to encourage slower turns as shown in Exhibit 39. With the addition of BRT stations at this intersection, and an assumed increase in pedestrian and bicycle traffic, safer and more intuitive crossings will become even more vital.

EXHIBIT 35. KEY MAP: LOCATION OF CONNECTICUT/RANDOLPH DISTRICT & EXHIBITS

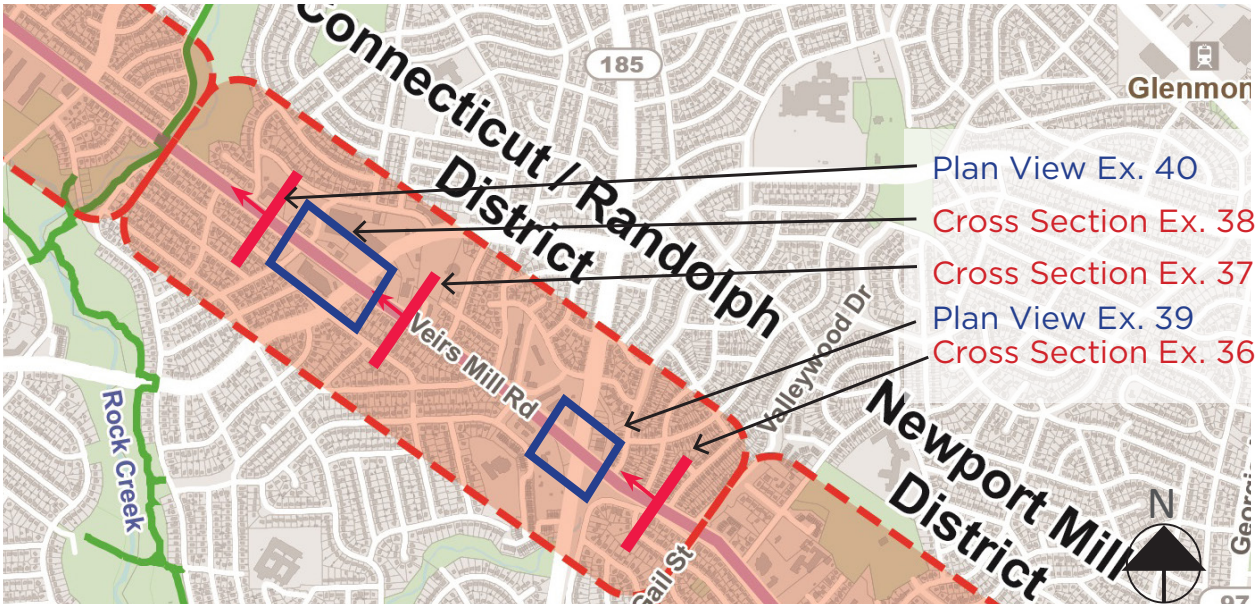
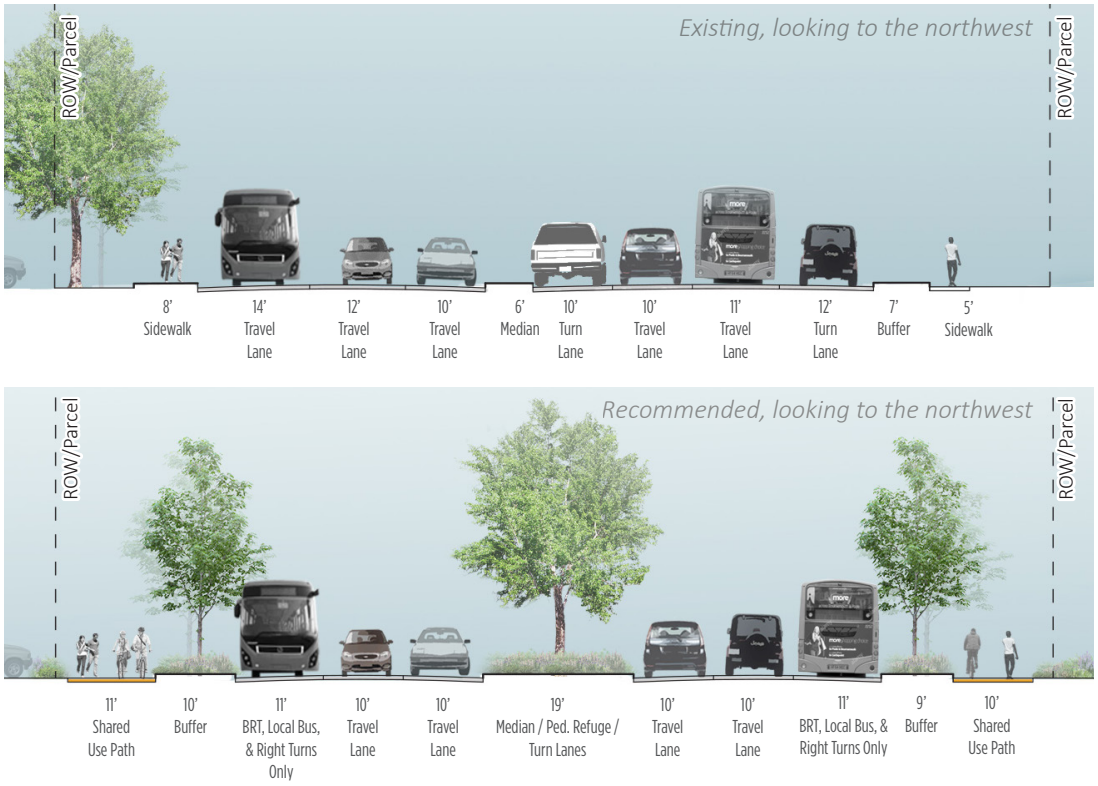


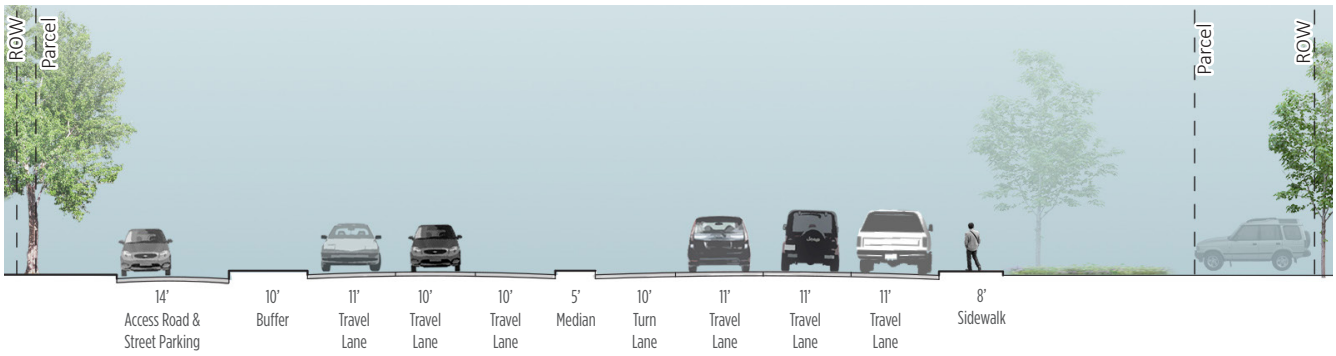
EXHIBIT 36. EXISTING AND RECOMMENDED CROSS SECTIONS, GAIL STREET TO WEST OF FERRARA AVENUE



The cross section recommended in Exhibit 36 falls within the existing right of way.

The cross section recommended in Exhibit 37 would require repurposing the space currently used for the commercial parking lot. This can be reconsidered in the future, and cross section elements can be narrowed, if this is not desired.

EXHIBIT 37. EXISTING AND RECOMMENDED CROSS SECTIONS, WEST OF FERRARA AVENUE TO GRIDLEY ROAD



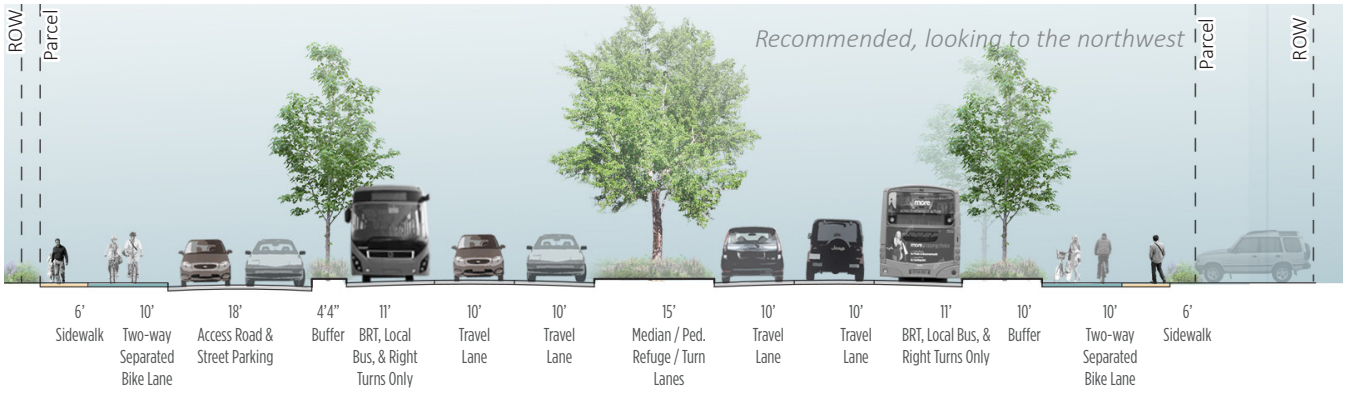
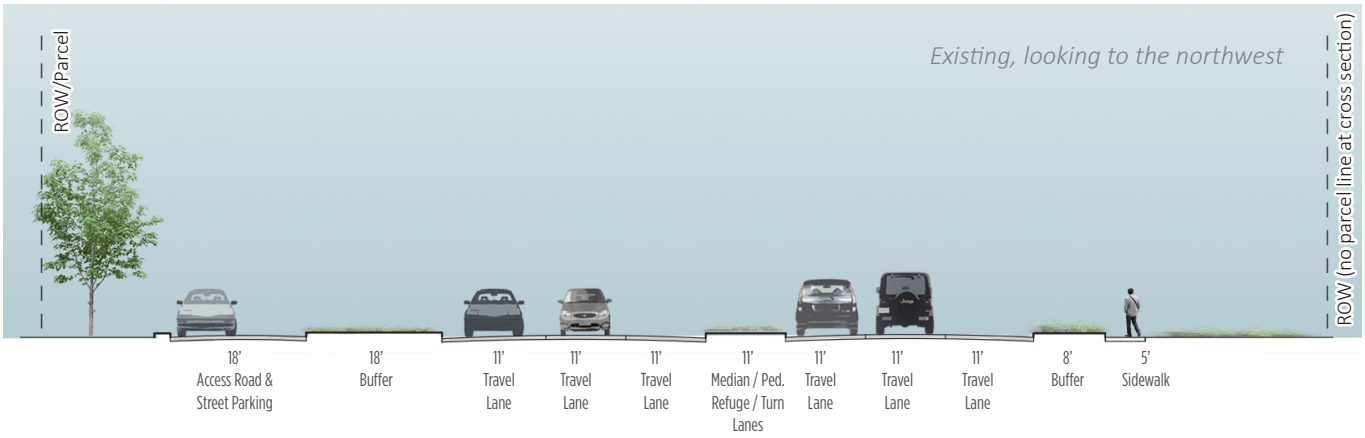
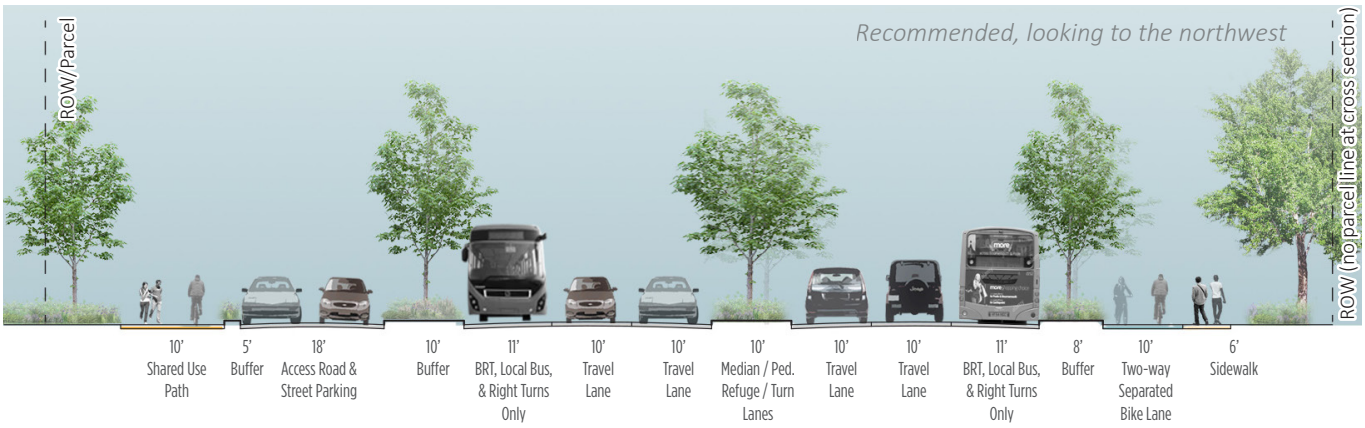


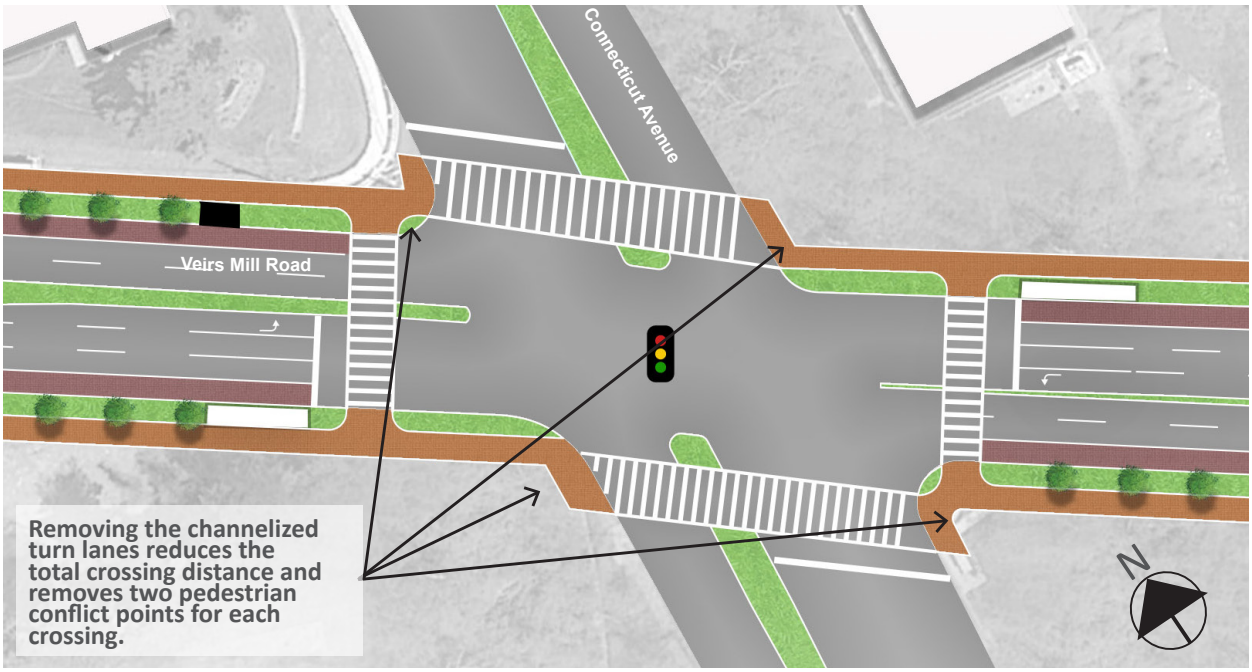
EXHIBIT 38. EXISTING AND RECOMMENDED CROSS SECTION, GRIDLEY ROAD TO EDGEBROOK ROAD





The available right of way data suggests that no additional right of way is needed for the cross section proposed in Exhibit 38.

EXHIBIT 39. RECOMMENDATIONS FOR THE CONNECTICUT AVENUE INTERSECTION



Connecticut Avenue & Veirs Mill Road today, from the air and from the ground (Photo credit: Google Maps)

- Shared-Use Path
- Planting Strip / Median
- Level Pedestrian/Bicycle Crossing of Driveway
- Bus Lane
- Planned Future BRT Station *(Also serves as a local bus stop at some locations)*
- Local Bus Stop

The double left turn lanes at Randolph Road should also be eliminated, leaving a single left-turn lane, to increase safety and reduce the crossing distance.

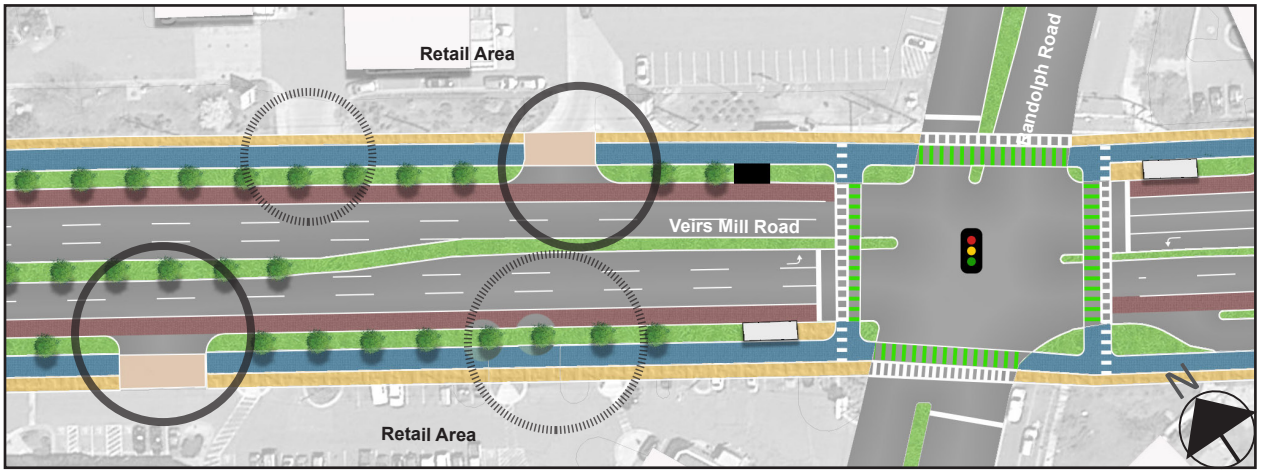
BRT CONSIDERATIONS

The BRT plan calls for a westbound station on the east side (near side) of Veirs Mill Road at Randolph Road, and an eastbound station on the east side (far side). It is recommended that the eastbound station be moved to the near side of the intersection of Veirs Mill Road and Randolph Road, in order to remove one crossing required to access the retail nodes, and to remove complications related to the access road entrance on the far side of the intersection as shown in Exhibit 40.

OTHER RECOMMENDATIONS

One recommended change is a consolidation of the entrances to the retail nodes on both sides of Veirs Mill Road, in order to reduce conflicts with the sidewalk and bicycle lanes as shown in Exhibit 40.

EXHIBIT 40. RECOMMENDATIONS FOR THE RANDOLPH ROAD AREA



- Sidewalk
- Two-Way Separated Bike Lane
- Planting Strip / Median
- Level Pedestrian/Bicycle Crossing of Driveway
- Bus Lane
- Planned Future BRT Station *(Also serves as a local bus stop at some locations)*
- Local Bus Stop
- Recommended narrowing of existing entrance
- Recommended removal of existing entrance

4.4 MONTROSE DISTRICT

4.4.1 RECOMMENDED IMPROVEMENTS

BICYCLE AND PEDESTRIAN FACILITIES

There are two recommended cross sections for the Montrose District, the limits of which are shown in Exhibit 41.

From Edgebrook Road to Parkland Drive, the recommended facilities are two-way 12-foot separated bike lanes and a six-foot sidewalk on the south side of the road and 11-foot separated bike lanes and a six-foot sidewalk on the north side, as seen in Exhibit 42. A similar cross section, without the access road is recommended for Parkland Drive to the area near Shrine of Saint Jude Thaddeus Catholic Church.

From Shrine of Saint Jude Thaddeus Catholic Church to the Rock Creek Trail crossing, the recommended facilities are 10-foot sidepath on both sides of the road, see Exhibit 43.

CHANGES TO TRAVEL LANES & MEDIANS

To clarify and facilitate movement, the median at Arbutus Avenue can be removed to create a signalized T-intersection. This would allow a formal spot to make u-turns, and could allow for closure of the median opening that previously existed to the east. In addition, consolidation of the entrances to Parklawn Local Park would remove one pedestrian/bicycle conflict point.

CROSSINGS & INTERSECTIONS

Arbutus Avenue and the entrance to Park Terrace Apartments, across from the Shrine of St Jude Thaddeus, should be considered for at least actuated beacons, and perhaps full signalization. In either case, they should include crossings and pedestrian refuge medians that are as wide as allowed by the right-of-way.

EXHIBIT 41. KEY MAP: LOCATION OF MONTROSE DISTRICT

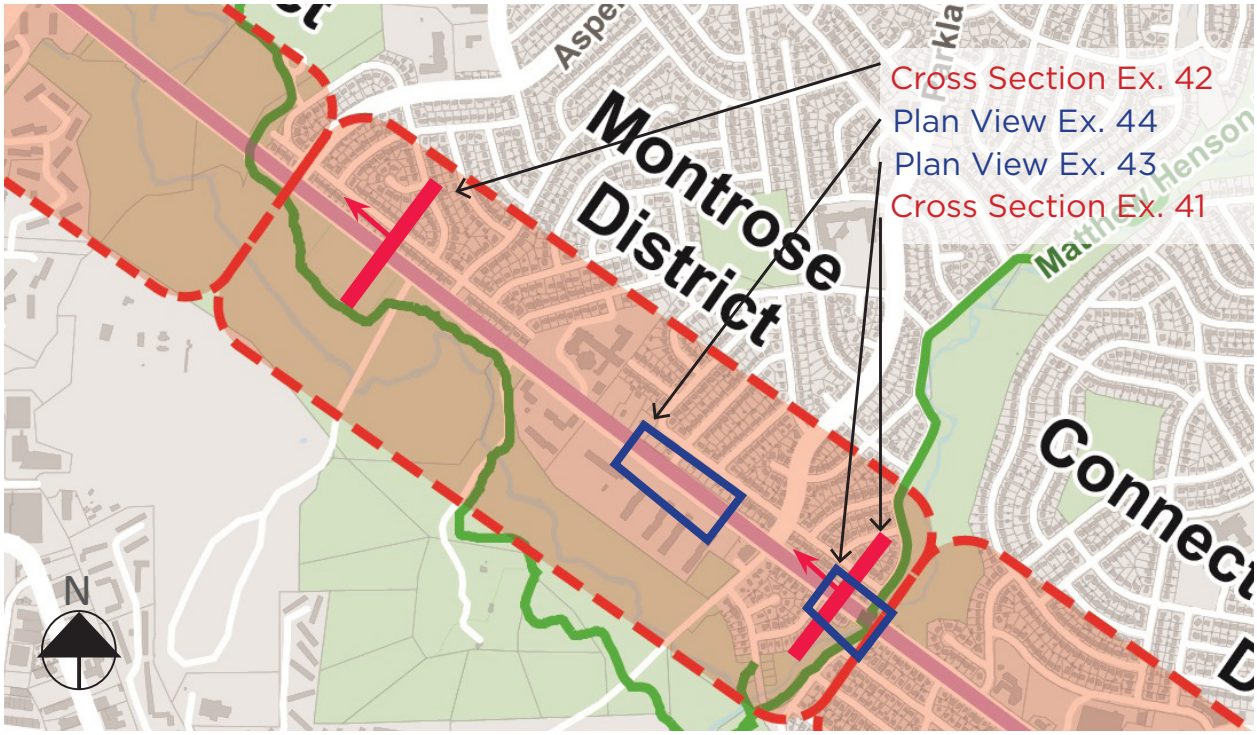


EXHIBIT 42. EXISTING AND RECOMMENDED CROSS SECTIONS, EDGEBROOK ROAD TO PARKLAND DRIVE

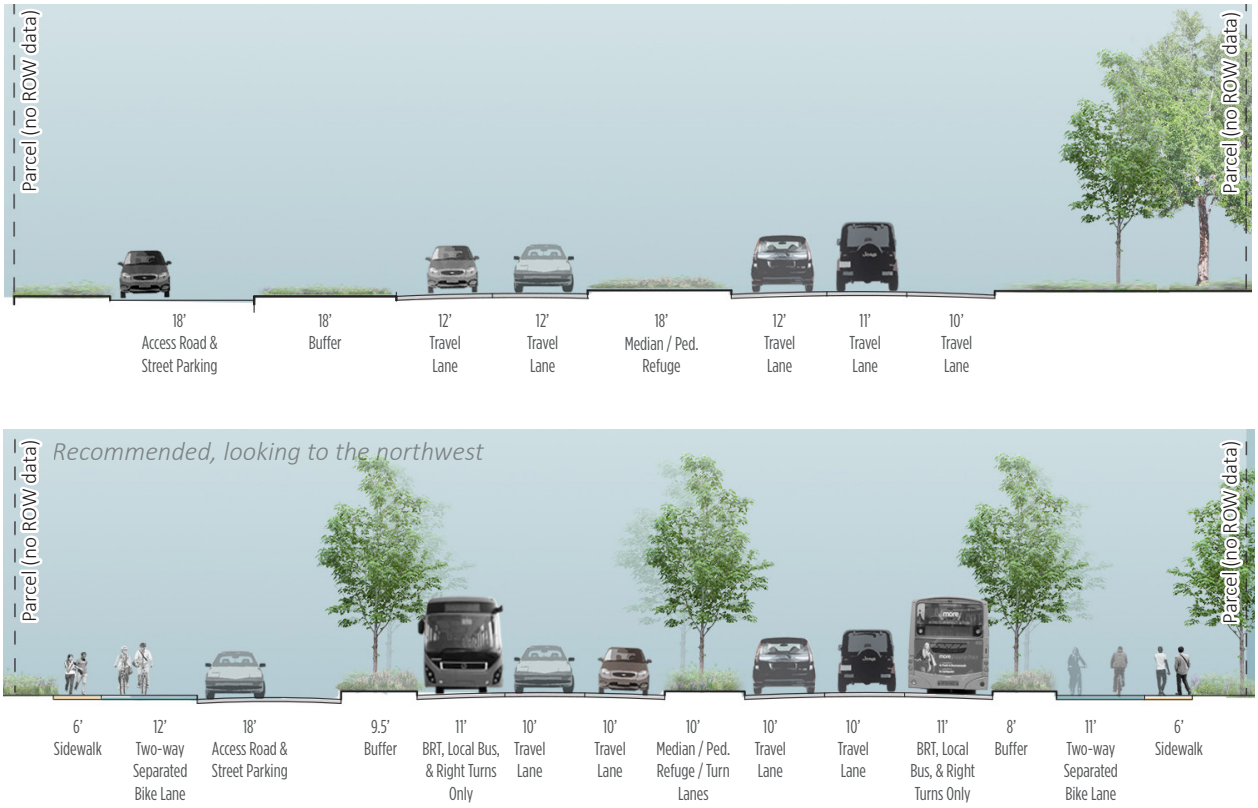
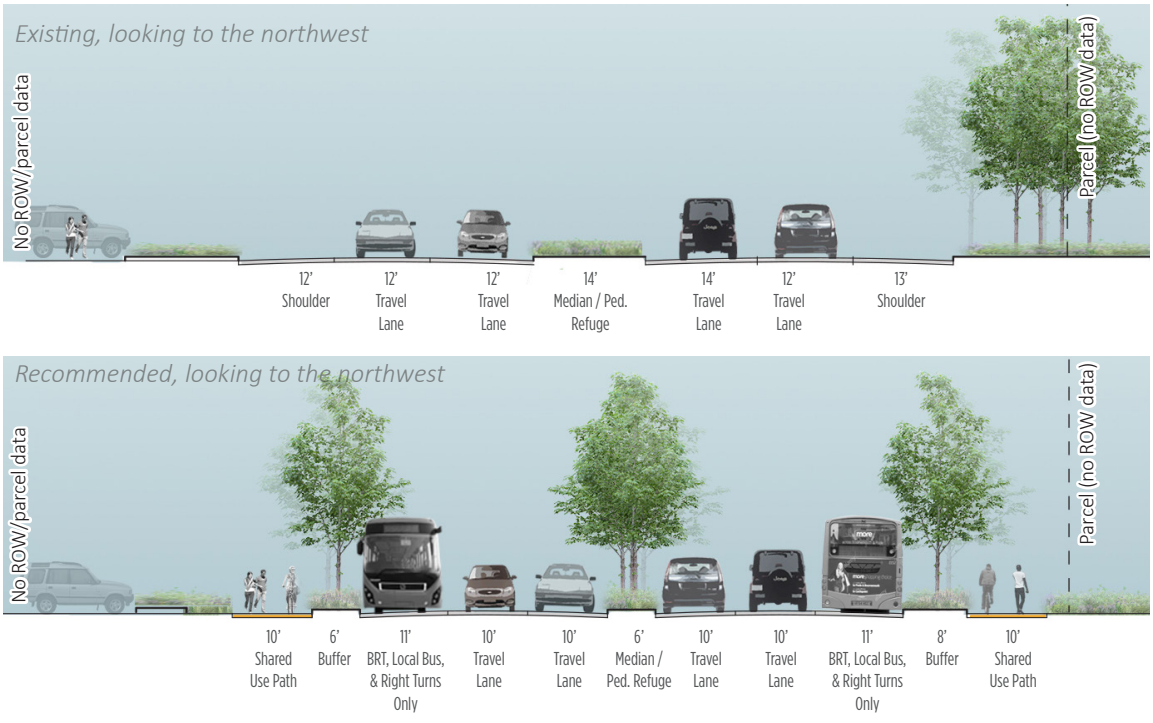
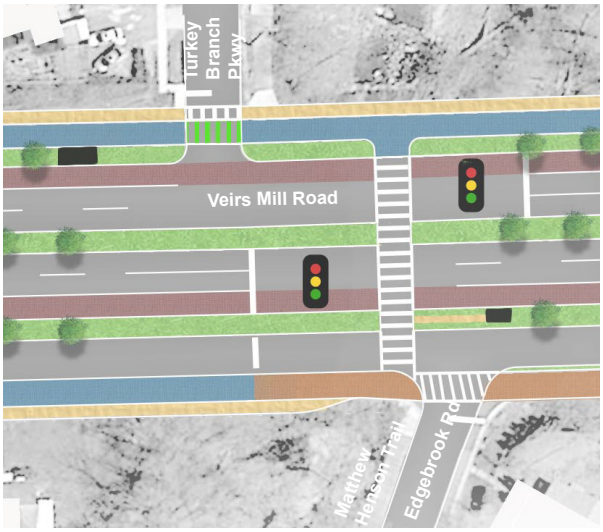


EXHIBIT 43. EXISTING AND RECOMMENDED CROSS SECTIONS, SHRINE OF SAINT JUDE THADDEUS CATHOLIC CHURCH TO ROCK CREEK TRAIL CROSSING

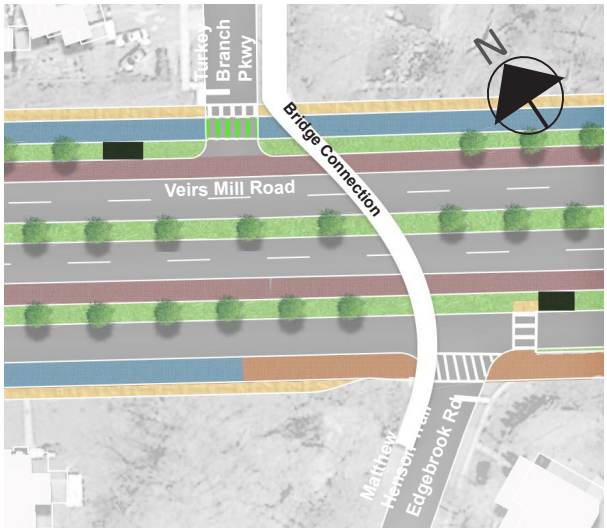


The available right of way data suggests that no additional right of way is needed for the cross section proposed in Exhibits 42 and 43.

EXHIBIT 44. MATTHEW HENSON TRAIL CROSSING OPTIONS



Recommended Crossing



Alternate Bridge Crossing Concept

- Sidewalk
- Two-Way Separated Bike Lane
- Shared-Use Path
- Planting Strip / Median
- Level Pedestrian/Bicycle Crossing of Driveway
- Bus Lane
- Planned Future BRT Station *(Also serves as a local bus stop at some locations)*
- Local Bus Stop

Existing signalized intersections must be upgraded, as needed, to include high-visibility crossings on each side of the intersection.

The existing bicycle and pedestrian crossing at the Matthew Henson Trail provides an important and well-used connection. The recommended short-term improvements would greatly improve that crossing, but another potential long-term solution is a bicycle and pedestrian bridge, as shown in Exhibit 44, similar to the one that exists near Aspen Hill Drive. Though engineering would be needed to determine the final facility design, and it would be more costly than an at-grade crossing, a bridge would provide even more separation and continuous flow for people walking and riding bicycles. A tunnel could also be considered, but the nearby stream valley may pose engineering challenges, and users often have personal security concerns with tunnel designs.

Further to the west, the existing connection to Rock Creek Trail at Aspen Hill Drive means that intersection is also already a hub for people walking and riding bicycles. Future BRT connections will only increase the number of people who need to cross Veirs Mill Road in order to reach various destinations. This long-term plan recommends protected intersections with refuge islands for all signalized intersections in the corridor; they are especially vital for crossings that may be expected to have heavy bicycle and pedestrian traffic, such as Veirs Mill Road and Aspen Hill Drive.

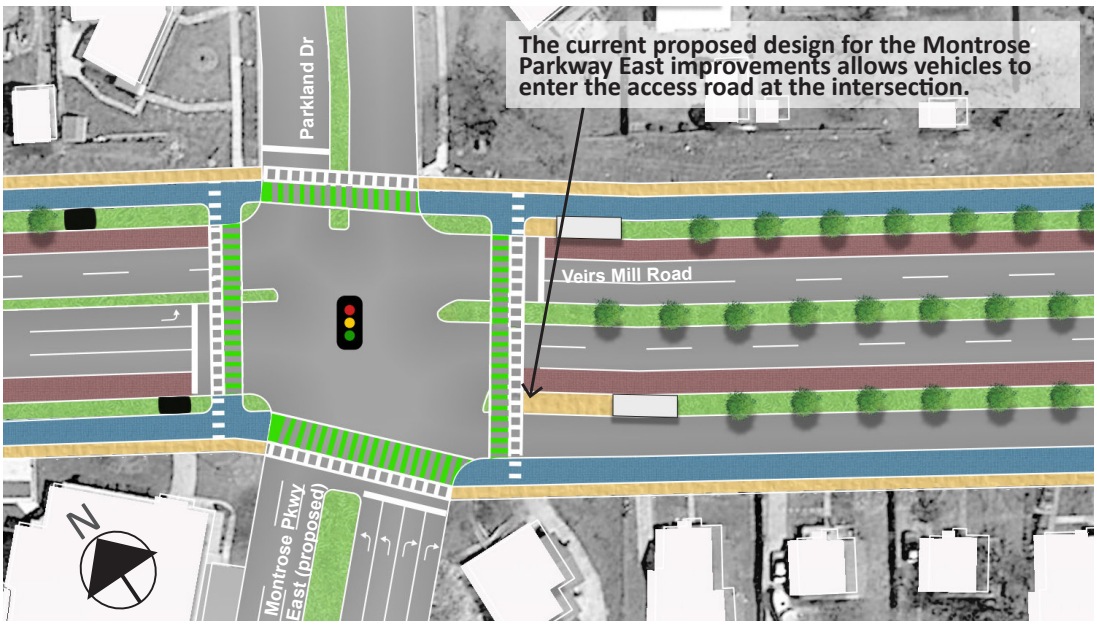
OTHER RECOMMENDATIONS

Future planning must incorporate the design for Montrose Parkway East, a planned roadway that will connect Parklawn Drive to Veirs Mill Road at the point where Gaynor Road now connects. The enhanced automobile accessibility will bring more traffic and more turning movements. Since the Montrose Parkway East and Veirs Mill Road intersection is planned to have BRT stations, it will likely see increased pedestrian and bicycle traffic as well.

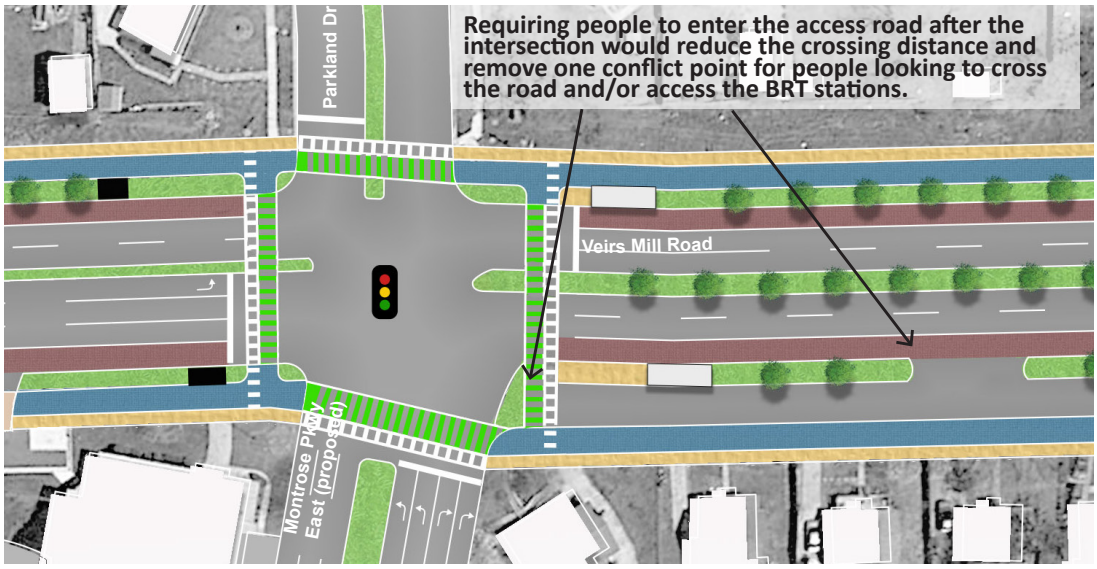
Protected crossings will help to promote safe and intuitive travel for all users. Current plans call for entrance to the access road to occur at the intersection. To further remove conflict points, one option would be to require entrance to the access road after the intersection, removing one of three potential

conflict points for pedestrians and bicyclists crossing on the east side of Parkland Drive, which is the location for both BRT stations, as shown in Exhibit 45.

EXHIBIT 45. MONTROSE PARKWAY EAST ACCESS ROAD OPTIONS



Planned Configuration (access road connection at the intersection)



Alternate Configuration (access road connection after the intersection)

- Sidewalk
- Two-Way Separated Bike Lane
- Shared-Use Path
- Planting Strip / Median
- Level Pedestrian/Bicycle Crossing of Driveway
- Bus Lane
- Planned Future BRT Station *(Also serves as a local bus stop at some locations)*
- Local Bus Stop

4.5 TWINBROOK DISTRICT

4.5.1 RECOMMENDED IMPROVEMENTS

BICYCLE AND PEDESTRIAN FACILITIES

The limits of the relatively small Twinbrook District are shown in Exhibit 46. One cross section is recommended for the Twinbrook District, as shown in Exhibit 47. From the Rock Creek Trail crossing to Twinbrook Parkway, the recommended facilities are 11-foot sidepaths on both sides of the road.

CHANGES TO TRAVEL LANES & MEDIANS

The double left turn lanes at Twinbrook Parkway should be reduced to one turn lane, to increase safety and reduce the crossing distance, as shown in Exhibit 48.

OTHER RECOMMENDATIONS

Many portions of Veirs Mill Road are currently very wide, but this section of the corridor feels particularly wide, due to both a wide shoulder and the surrounding park land use. Rows of trees on either side of the road will help to create a narrower roadway, encouraging people to drive more slowly, as shown in Exhibit 48.

EXHIBIT 46. LOCATION OF TWINBROOK DISTRICT

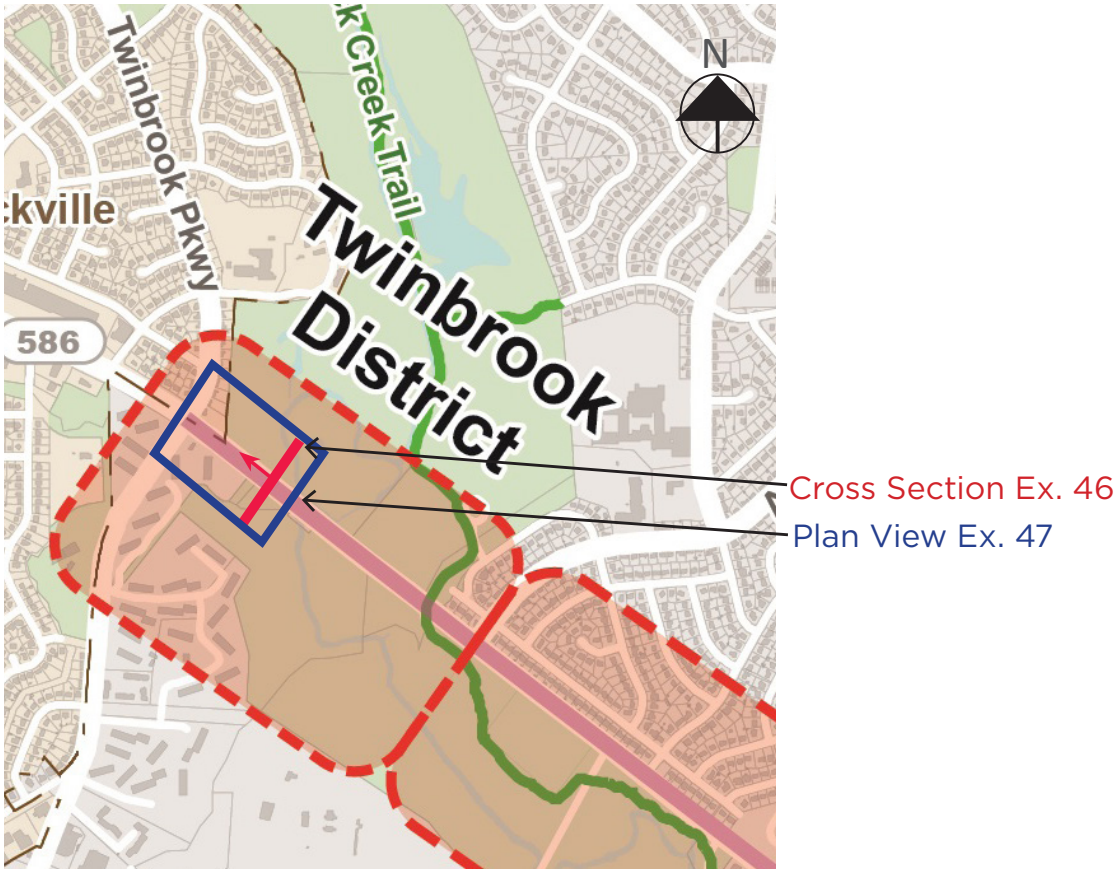


EXHIBIT 47. EXISTING AND RECOMMENDED CROSS SECTIONS, ROCK CREEK TRAIL CROSSING TO TWINBROOK PARKWAY

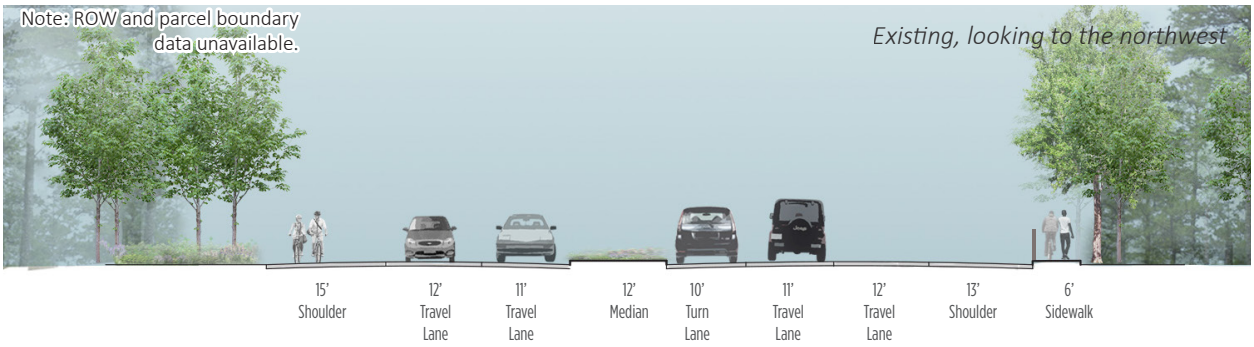


EXHIBIT 48. RECOMMENDATIONS FOR EAST OF TWINBROOK PARKWAY

- Shared-Use Path
- Planting Strip / Median
- Level Pedestrian/Bicycle Crossing of Driveway
- Bus Lane
- Planned Future BRT Station *(Also serves as a local bus stop at some locations)*

Appendix C:
Transportation

INTRODUCTION

This Transportation Appendix summarizes the methodology and analysis used to evaluate the recommendations in the Veirs Mill Corridor Master Plan. The overall transportation goal of the Veirs Mill Corridor Master Plan is to transform Veirs Mill Road from a motor-vehicle dominated corridor to a safe, efficient and comfortable complete street that serves pedestrians, bicyclists, transit users and motorists, and connects communities to transit, neighborhood uses and community facilities. The supporting recommendations seek to increase safety, enhance connectivity and prioritize improvements for pedestrians, bicyclists and transit users. The transportation goals and recommendations of this master plan prioritize the safety of all road users, consistent with the Vision Zero policy adopted by the Montgomery County Council in 2016.

VEIRS MILL ROAD CHARACTERISTICS

Veirs Mill Road was constructed in the mid-1930s and expanded to a divided highway in the mid-1950s. It is an important east-west connection that extends 5.78 miles from MD 97 (Georgia Avenue) in Wheaton, west to the intersection of MD 28 (East Jefferson Street) and MD 355 (Rockville Pike) in the City of Rockville. Veirs Mill Road is also known as Maryland Route 586 (MD 586) and is a state highway. The Maryland Department of Transportation State Highway Administration (MDOT SHA) manages and maintains the roadbed, drainage and lighting, while the Montgomery County Department of Transportation (MCDOT) manages the traffic signalization and maintenance of the abutting residential service roads. Funding of sidewalks, signals and other infrastructure are shared by the state and the county.

Veirs Mill Road carries approximately 43,000 vehicles per day within the master plan area. Unlike many corridors in the county, the road does not have a peak direction; traffic volumes are nearly balanced in both directions throughout the day. It is also a transit corridor with significant bus ridership. While it is a major highway and transit corridor, Veirs Mill Road also functions as a residential street with a combination of residential service roads and direct driveway access for many single-family homes.

The typical cross-section of Veirs Mill Road varies with four-, five- and six-lane segments. In addition to the variation in the number of travel lanes, segments of the road also include extensive right-turn only lanes, a median of varying width, wide shoulders and residential service roads that provide separate access to adjacent land uses. The service roads provide access control along Veirs Mill Road and allow on-street parking for the adjacent residential properties.

MDOT SHA and MCDOT have completed recent improvements at select locations along Veirs Mill Road to improve conditions for pedestrians and transit users. These improvements include covered bus stops with short sidewalk connections, accessible curb ramps with channelized walkways at intersections, and mast arms at signalized intersections with pedestrian activated signals. While these improvements were recently completed, significant infrastructure improvements are still necessary to improve safety and enhance connectivity on and along Veirs Mill Road.

VEIRS MILL ROAD – SEVERE AND FATAL CRASHES

The Veirs Mill Corridor Master Plan is the first master plan to commence following the Montgomery County Council's adoption of Vision Zero in 2016. Montgomery County's *Vision Zero Action Plan*, released in November 2017, identifies Veirs Mill Road as a high-risk roadway and includes the road in the county's high injury network. Veirs Mill Road, between the intersections of Newport Mill Road and Connecticut Avenue, is identified as a high priority corridor for engineering improvements based on the total number of severe and fatal crashes, the number of crashes per mile per year and the number of crashes per vehicle miles traveled.

As shown in Figure 1, between 2015 and 2017, there were five fatal and seven severe injury crashes on Veirs Mill Road. Although travel by motor vehicle represents the majority of person trips along the corridor, pedestrians and bicyclists accounted for 66 percent of these crashes, including four fatalities and four severe injuries. In comparison, approximately 30 percent of the fatal and severe crashes in the county between 2015 and 2017 involve a pedestrian or a bicyclist. This increases to 45 percent in the areas that Montgomery County defines as urban for purposes of the road code (Chapter 49 of the County Code) and further increases to 63 percent in the major urban areas of Bethesda, Silver Spring, Wheaton, White Flint, Friendship Heights and Rockville Town Center. This high-level analysis suggests that infrastructure improvements are critical to improve safety on Veirs Mill Road, particularly for vulnerable users such as pedestrians and bicyclists.

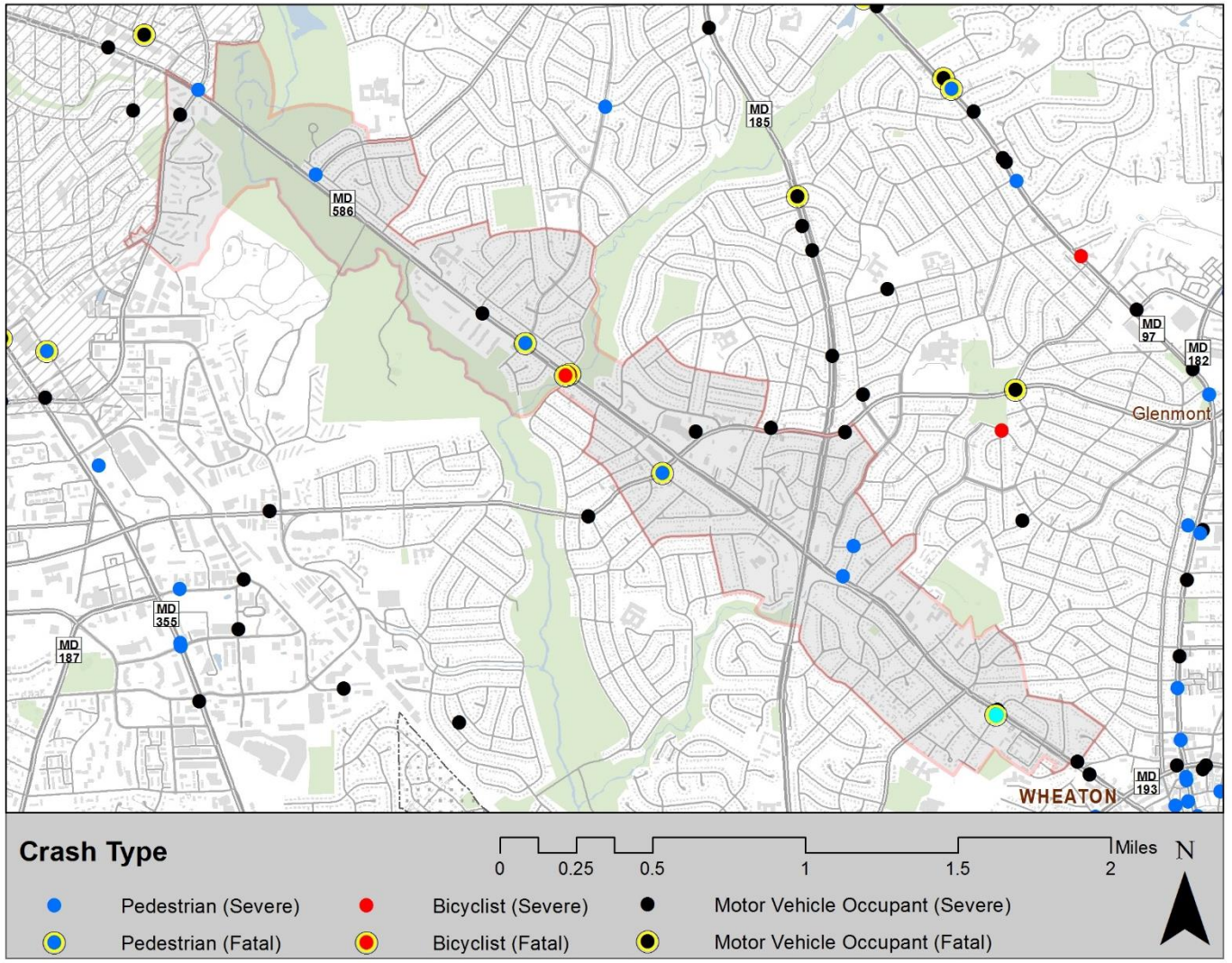


Figure 1: Severe and Fatal Crashes on and Near Veirs Mill Road (2015-2017)

COMPLETE STREETS

This master plan recommends the transformation of Veirs Mill Road to a multimodal complete street that increases safety and provides efficient travel through and across the corridor for all transportation modes. The transformation of Veirs Mill Road to a multimodal complete street, or a street designed, operated and maintained to provide safe accommodations for people who walk, bicycle, use transit and drive, is a long-term vision. As the operation and maintenance of Veirs Mill Road is a shared responsibility between the state and the county, the complete streets policies of each agency are relevant to the implementation of this long-term vision.

The MDOT SHA adopted a Complete Streets Policy in 2011 that requires the consideration and incorporation of all transportation modes when developing or redeveloping the state's transportation system. The policy is committed to a safe, efficient and multimodal network as well as partnerships with local governments, transit providers and stakeholders to develop and maintain a complete street network.[1]

The Montgomery County Complete Streets Policy and Standards, included in Section 49-25 of the Montgomery County Code, seek to safely and conveniently accommodate all users of the roadway system. Included in Montgomery County's Road Design and Construction Code, the Complete Streets Policy and Standards "guide the planning, design, and construction of transportation facilities in the public right-of-way."[2]

With the planning, design and construction of long-term redevelopment or infrastructure projects, such as bus rapid transit (BRT), it is critical to implement the complete streets policies of the state and the county to facilitate the safe and efficient movement of all transportation modes. Major transportation projects such as BRT can only be successful if they are accompanied by a safe and comfortable walking environment.

Creation of a New Street Type and Design Standards for High-Quality Transit Corridors

The Veirs Mill Corridor Master Plan Planning Board Draft recommends the creation of a new street type and design standards for high-quality transit corridors in residential communities through the development of Montgomery County's Complete Streets Design

[1] "Complete Streets Policy, Maryland State Highway Administration." (http://roads.maryland.gov/OPPEN/SHA_Complete_Street_Policy.pdf)
[2] "Montgomery County Road Design and Construction Code." (Mont. Co. Code 1965, § 103-8; 2007 L.M.C., ch. 8, § 1; 2007 L.M.C., ch. 8, § 1; 2014 L.M.C., ch. 37, § 1.)

Guide. A new street type is needed because roads such as Veirs Mill Road do not fit into the existing urban, suburban and rural classification system. While Veirs Mill Road is suburban in land use, it is more urban in its activity level, due to a large amount of walking, bicycling and especially transit use. The intent of the recommended new street type is to create an environment that prioritizes walking, bicycling and transit use consistent with the urban road classification described in Section 49 of the Montgomery County Code, which reduces target speeds and lane widths and improves pedestrian and bicycle infrastructure to increase safety for all road users.

ROADWAY SAFETY

As discussed in greater detail in Appendix B, the *Veirs Mill Vision Zero Initiative* report, roadway safety is achieved through the reduction of crash frequency and severity. Methods to reduce crash frequency include providing clearly designated space for each road user, as accomplished through a complete street, and regulating the interaction of road users through traffic signals or other traffic control measures. The reduction of crash severity is primarily achieved through reduced vehicle speeds.

The speed of vehicles on Veirs Mill Road contributes to the inadequate quality of the environment for all road users and is inconsistent with the county's Vision Zero policy. The posted speed on Veirs Mill Road within the master plan boundary is currently 40 miles per hour from the eastern plan boundary to Turkey Branch Parkway and 45 miles per hour from Turkey Branch Parkway to the western plan boundary in Rockville. The observed top vehicle speeds often well exceed the posted speed. Since research has shown that pedestrians have an 80 percent chance of survival if they are hit by a motor vehicle at 20 miles per hour, and an 80 percent chance of death if they are hit at 40 miles per hour, reducing traffic speeds is the most important change that is needed to eliminate traffic fatalities and severe injuries in the corridor. While traffic signals can improve safety by controlling conflicts at crossings, a principle tenant of Vision Zero is understanding that people make mistakes and sometimes fail to follow traffic control devices. Roads should be designed so these mistakes do not result in death or severe injury.

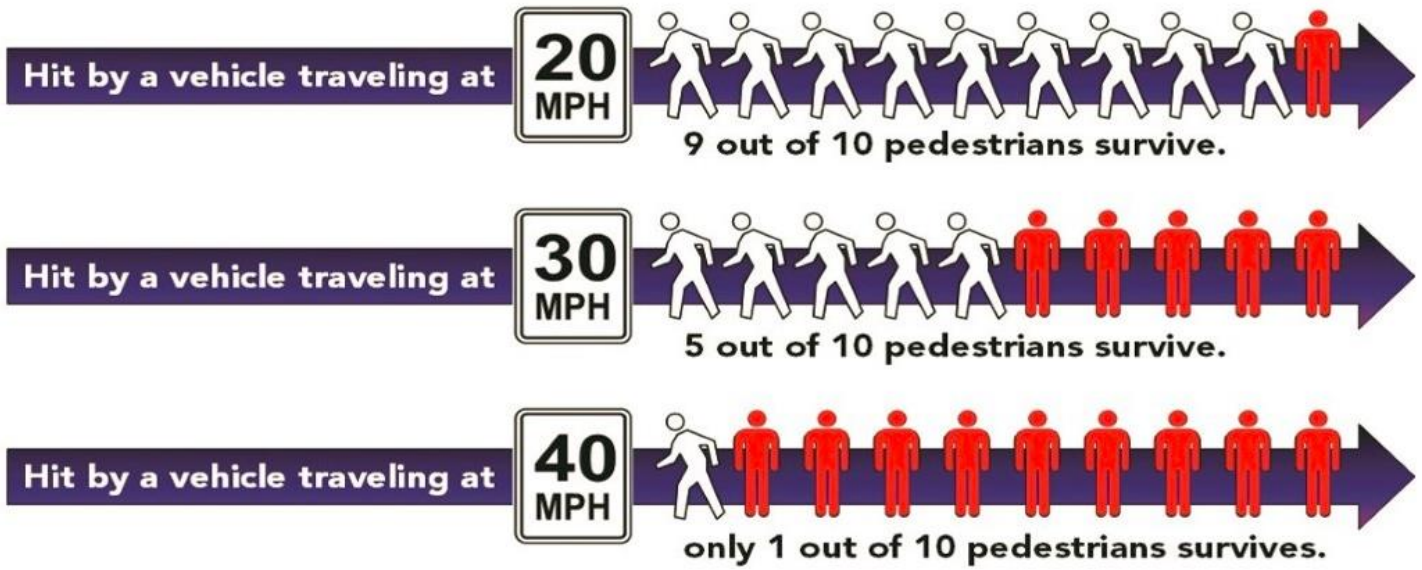


Figure 2: Pedestrian Death Risk Declines at Lower Vehicle Speeds (Courtesy of World Resources Institute)

Several strategies can be applied to reduce vehicle speeds, including reducing the posted speed and increasing automated enforcement. As discussed in greater detail below, these strategies can be effective and should be pursued. However, this master plan also recommends engineering solutions, including reducing lane widths.

Design standards for urban and suburban arterial roadways generally specify 12-foot wide travel lanes. However, transportation officials, including the American Association of State Highway and Transportation Officials (AASHTO) and the National Association of City Transportation Officials (NACTO) have suggested the use of 10- or 11-foot wide lanes to promote slower driving speeds and

reduce the severity of crashes without impacting traffic operations. Shrinking the width of travel lanes also provides an opportunity to reallocate space to other modes of transportation and streetscape improvements.[3] [4] [5]

With the long-term transformation of Veirs Mill Road to a complete street, this master plan recommends 10-foot-wide travel lanes and 11-foot-wide transit lanes. The reduction in lane widths provides an opportunity to increase safety for road users by slowing speeds and reducing pedestrian crossing times. It also allows reallocation of right-of-way to improve safety for all users by providing adequate width for sidewalks, bikeways, medians, and buffers.

Reducing Speed

Target speeds serve as a key factor for determining design speeds, influencing operating speeds, and serving as a reference for establishing speed limits. Chapter 49 of the Montgomery County Code identifies target speeds to provide consistency among the design characteristics of a roadway, its operating speed, the speed limit, and the required safety and mobility for all road users. The target and design speed ranges identified in Chapter 49 are intended to capture a broad range of conditions, are not suitable to every situation and may be periodically revised to meet the needs of the county.

Although Veirs Mill Road is a state road, the county's road standards provide context to evaluate appropriate speeds on a multimodal corridor such as Veirs Mill Road, which is classified as a major highway in the *Master Plan of Highways and Transitways*. Chapter 49 of the County Code identifies the target speed on a major highway in an urban area as 25 miles per hour and 35-to-40 miles per hour in a suburban area. This master plan recommends the reduction of target speeds on Veirs Mill Road to 35 miles per hour, consistent with the lower range of the target speed identified in the County Code.

Pursuant to Maryland State Law Subtitle 8 Section 21-803, a local authority may alter speed limits on a state highway with the approval of the SHA if, based on an engineering and traffic investigation, the local authority determines that the maximum speed

[3] National Association of City Transportation Officials, *Urban Street Design Guide:* 34.
[4] Ingrid Potts, Douglas W. Harwood, and Karen R. Richard, "Relationship of Lane Width to Safety on Urban and Suburban Arterials," accessed April 5, 2018, https://nacto.org/docs/usdg/lane_width_potts.pdf.
[5] Kay Fitzpatrick, Paul Carlson, Marcus Brewer and Mark Wooldridge, "Design Factors that Affect Driver Speed on Suburban Arterials," accessed April 5, 2018, https://nacto.org/docs/usdg/design_factors_that_affect_driver_speed_fitzpatrick.pdf.

limit exceeds or is less than reasonable or safe under existing conditions. The local authority may then establish a reasonable and safe maximum speed limit with the approval of MDOT SHA.[6]

School Zones

Within a half-mile radius of any school, the MDOT SHA or a local authority may establish a school zone and maximum speed limits in the school zone. In school zones designated and posted by the local authorities of any county, the county may decrease the maximum speed limit to 15 miles per hour during school hours, provided the county pays the cost of placing and maintaining the necessary signs.[7] (Please refer to *Maryland State Highway Administration Guidelines for Automated Speed Enforcement Systems in School Zones, Safer Speeds – Safer Schools, An Integrated Approach to Changing Diver Behavior in School Zones, Revised January 2011.*)

This master plan recommends the implementation of a school speed zone on Veirs Mill Road between Galt Avenue and Connecticut Avenue to improve safety for the children who walk along Veirs Mill Road to access Highland Elementary School, Newport Mill Middle School and Albert Einstein High School. The plan further recommends a school zone speed limit of 25 miles per hour when flashing.

Automated Enforcement

The Montgomery County Police Department's Safe Speed program is an automated speed enforcement program that enforces speeds in residential areas through speed cameras. Currently, there are no speed cameras on Veirs Mill Road. This master plan encourages the Montgomery County Police Department to add Veirs Mill Road as a Speed Camera Corridor as part of the Safe Speed Enforcement program. Other Maryland State Highways, including Colesville Road, Georgia Avenue and Connecticut Avenue are designated speed camera corridors.

[6] Maryland Code Transportation., Alteration of Maximum Speed Limit by Local Authorities §21-803.
[7] Maryland Code Transportation., School Zones §21-803-1.

Multiple-Threat Conflicts

Pedestrians crossing Veirs Mill Road regularly encounter dangerous conflicts with vehicles, transit buses, and commercial trucks. Limiting conflict between pedestrians and vehicles and eliminating injuries is a key component of both the Veirs Mill Corridor Master Plan and the Plan's Vision Zero Initiative.

The level of protection and safety provided by pedestrian facilities in the Veirs Mill corridor varies widely by intersection. Multiple-threat pedestrian conditions exist where crosswalks span multilane roads, requiring vehicles in multiple travel lanes to stop for pedestrians. Although multiple-threats are most common at mid-block and unsignalized pedestrian crossings, they can also occur at fully signalized and protected crossings.

Driver awareness and pedestrian visibility are critical factors in preventing multiple-threat conflicts. Motorists should be alerted to the presence of pedestrian crossings through signage (e.g. rapid pedestrian flashing beacons) and advance stop/yield lines (20-30 feet from the crosswalk). When crossing, pedestrians should actively scan for vehicles in outside lanes that are not slowing or observing cautionary signage. Identifying and improving crossings that include multiple-threat conflicts is key to achieving Montgomery County's Vision Zero objectives.

During the planning process multiple-threat conflicts were noted at three unsignalized pedestrian crossings on Veirs Mill Road:

- **Turkey Branch Parkway (Matthew Henson Trail):** This two-stage midblock crossing is designed to ensure safe crossings for pedestrians and those using the Matthew Henson Trail. Despite featuring a pedestrian-activated signal, 41 vehicle crashes and four bicycle crashes, including two fatal bicycle crashes, were recorded from 2015 to 2017.

- **Valleywood Drive and Gail Street:** This midblock crosswalk located one-quarter mile south of the intersection of Veirs Mill Road and Connecticut Avenue is a critical connection for pedestrians accessing Metrobus and Ride On. From 2015 to 2017, 20 vehicle crashes and two pedestrian crashes were recorded at the intersection (including Gail Street).

- **Pendleton Drive:** One-half mile south of the intersection of Veirs Mill Road and Connecticut Avenue, this crossing is a critical connection for pedestrians accessing Metrobus and Ride On, Wheaton Claridge Park, and multiple places of worship.

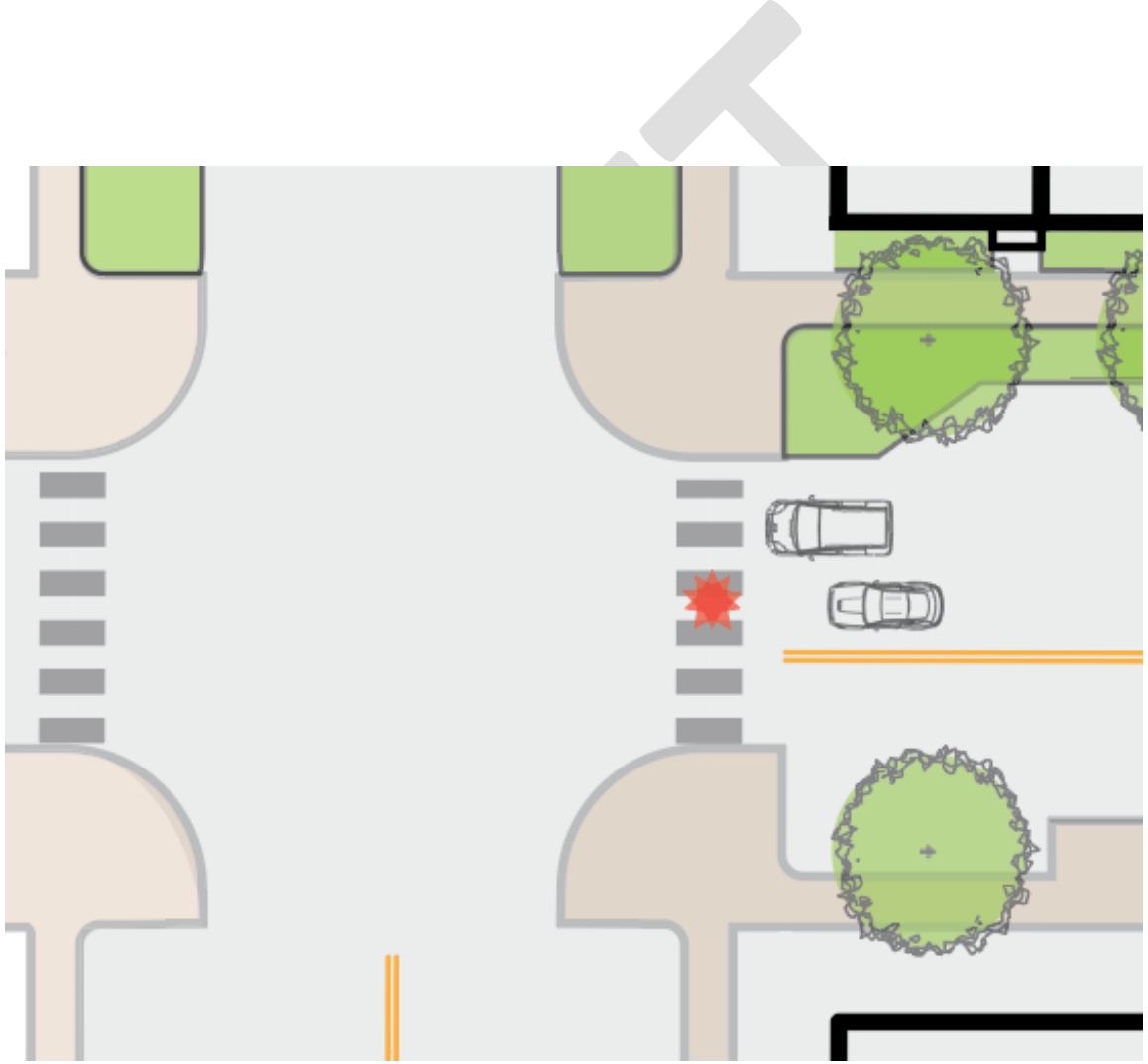


Figure 3: Multi-Threat Scenario

VEIRS MILL ROAD AND RANDOLPH ROAD INTERCHANGE

The 2004 *Amendment to the Master Plan of Highways (Transportation) Within Montgomery County* recommended a grade-separated interchange at Veirs Mill Road and Randolph Road to improve vehicular mobility. While the 2004 amendment did not include a specific interchange design, it was envisioned as a tight urban diamond interchange to minimize private property impacts, with Randolph Road diverting below Veirs Mill Road (similar to the new interchange on Georgia Avenue with Randolph Road). The interchange has not proceeded to planning or design and is not included in the county's capital improvement program.

The Veirs Mill Corridor Master Plan Public Hearing Draft recommends considering the elimination of the interchange from the Master Plan of Highways and Transitways. The grade-separated interchange at this intersection is inconsistent with the overall transportation goals of the plan, which seek to improve safety and connectivity for pedestrians, bicyclists and transit users. An interchange, even a tight urban diamond, prioritizes vehicular mobility and minimizes connectivity for other transportation modes.

It is important to note that the intersection of Veirs Mill Road and Randolph Road is located at the center of an existing Bicycle and Pedestrian Priority Area (BiPPA), designated by the 2013 *Countywide Transit Corridors Functional Master Plan*. With this designation, bicycle and pedestrian safety and mobility are the highest priority. This intersection currently experiences significant pedestrian volumes, which are anticipated to grow with the implementation of bus rapid transit on both Veirs Mill Road and Randolph Road, as well as the potential for walkable, transit-oriented redevelopment.

In addition to the inherent conflict between the plan's overall transportation goals and a grade-separated interchange, an interchange at this location does not appear to fully consider the relationship between the interchange and Montrose Parkway. With the implementation of Montrose Parkway, it is anticipated that vehicular movements may shift from Randolph Road to Montrose Parkway. At the intersection of Montrose Parkway with Veirs Mill Road, it is anticipated that vehicles would travel eastbound on Veirs Mill Road and then northbound on Randolph Road to continue northeast. The diversion of these vehicular movements suggests limited utility in an interchange that prioritizes the through movement of vehicles on Veirs Mill Road and Randolph Road.

Also, as acknowledged in the 2004 amendment, an interchange at this location would likely impact private property. The properties at the intersection of Veirs Mill Road and Randolph Road are the only commercially zoned properties in the plan area. These properties provide valuable neighborhood serving uses today and are envisioned to transform to a walkable, transit-oriented redevelopment in the long-term. The construction of an interchange, even a tight urban diamond, would have impacts to the

properties – both during a lengthy construction process and after completion – and would compromise the long-term character envisioned for this location. For these reasons, the Veirs Mill Corridor Master Plan recommends considering the elimination of the planned interchange at Veirs Mill Road and Randolph Road from the Master Plan of Highways and Transitways. The plan further recommends that if such an interchange is constructed, that it be constructed to not inhibit pedestrian, bicyclist and transit accessibility and minimize disruption to local businesses and homes.

PEDESTRIAN AND BICYCLE INFRASTRUCTURE

Veirs Mill Road lacks basic pedestrian and bicycle facilities. A primary focus of this master plan is to develop a well-connected network of convenient and safe pedestrian and bicycle facilities to improve safety, enhance connectivity and further support alternatives to vehicles. The Planning Board Draft of the Veirs Mill Corridor Master Plan proposes a combination of short-term and long-term recommendations to provide this essential infrastructure, including sidewalks, sidepaths, bikeways and safe crossing opportunities.

The master plan recommends prioritizing pedestrian and bicycle infrastructure that provides connectivity to Veirs Mill Road from area schools, parks and other community facilities, as well as improved connectivity to existing and future transit. While a well-connected network of sidewalks, sidepaths, bikeways and safe crossing opportunities are desired throughout the plan area, the master plan acknowledges the need to prioritize this infrastructure for project planning and funding purposes.

Priorities for Sidewalk and Sidepath Installation

The priorities for sidewalk and sidepath installation are locations where pedestrian and bicycle infrastructure do not currently exist on either side of Veirs Mill Road, such as between Gridley Road and Gaynor Road, and locations that provide improved access to transit and community uses, such as between Ferrara Avenue and Randolph Road or between Schoolhouse Circle and Glorus Place. Additional detail on the priority, extent and approximate cost of sidewalk and sidepath installation is provided in Table 1. The extent and approximate costs were adapted from planning-level cost estimates provided by Kittelson and Associates, Inc. as part of the *Veirs Mill Road Vision Zero Initiative*. The planning-level cost estimates include a 35 percent contingency and engineering fee to capture the potential need for grading and construction of retaining walls with the sidewalk and sidepath installation.

Table 1: Planning Level Cost Estimates for Sidewalk / Sidepath Installation

Priority	Type	Location / Approximate Extent	Approximate Length (ft)	Width Assumption (ft)	Cost (per square foot)	Approximate Cost
1.	Sidewalk	Gridley Rd to Gaynor Rd (South Side of Veirs Mill Rd)	2625	6	$15.00	$318,938
2.	Sidepath	Schoolhouse Cir to Glorus Pl (South Side of Veirs Mill Rd)	3580	8	$30.00	$1,159,920
3.	Sidewalk	Ferrara Ave to Randolph Rd (South Side of Veirs Mill Rd)	1600	6	$15.00	$194,400
4.	Sidepath	Havard St to Aspen Hill Rd (North Side of Veirs Mill Rd)	6600	8	$30.00	$2,138,400
5.	Sidepath	Rock Creek Trail to Twinbrook Pkwy (South Side of Veirs Mill Rd)	4500	8	$30.00	$1,458,000
6.	Sidepath*	Newport Mill Rd to Ferrara Ave (North Side of Veirs Mill Rd)	4470	8	$30.00	$1,448,280
7.	Sidepath*	Galt Ave to Sherrie Ln (North Side of Veirs Mill Rd)	270	8	$30.00	$87,480

*Widen the existing sidewalk to a sidepath.

Priorities for New Protected Crossings

Crossing Veirs Mill Road is challenging for pedestrians and bicyclists for several reasons, including the lack of continuous walkways and bikeways, high traffic volumes, high vehicle travel speeds, long distances between signalized crossings, and wide crossings that cause pedestrians to traverse several vehicle travel lanes. Some of the pedestrian crossings on Veirs Mill Road are located at signalized intersections aided by pedestrian-activated traffic signals. However, there are a few road crossings that are not signalized due to the existing conditions of the road. Signalized intersections along the corridor are spaced at wide intervals (some as much as

3,000 feet), which is a concern because there are many intersections that pedestrians utilize to connect to the bus stops and other uses along the corridor.

The recommendations for new protected crossings are prioritized based on several factors, including the distance between existing signalized crossings, proximity to community uses and transit stops, existing transit ridership (boarding and alighting), and limited crash data. The highest priority protected crossing locations, factors and prioritization are summarized in Table 2, although additional protected crossings are identified in the Veirs Mill Corridor Master Plan Planning Board Draft. The approximate cost to install a new protected crossing is highly variable due to the associated traffic analyses and investments in engineering and equipment. However, the planning-level cost estimates provided by Kittelson and Associates, Inc. as part of the *Veirs Mill Road Vision Zero Initiative* indicate that the approximate cost for a full traffic signal is $80,000 to $225,000 per signal.

Table 2: Factors Considered to Prioritize New Protected Crossings

Priority	Location	Proximity to a Bus Stop	Bus Ridership	Crash Rate	Proximity to School / Community Facility
1	Turkey Branch Pkwy. (Matthew Henson Trail)	Edgebrook Rd. and Turkey Branch Pkwy.	Edgebrook Rd. EB (32 Stops) Turkey Branch Pkwy. WB (26 Stops)	Turkey Branch Pkwy. (45 crashes, including 4 bicyclists, 2 of which were fatal)	Matthew Henson State Park, Winding Creek L.P.
2	Valleywood Dr.	Valleywood Dr., Andrew St. and Centerhill St.	Valleywood Dr. EB (86 Stops) Andrew St. WB (218 Stops) Centerhill St. EB (145 Stops)	Gail St. (14 crashes, 1 of which was pedestrian) Valleywood Dr. (6 crashes, including 1 pedestrian)	N/A
3	Norris Dr.	At Bus Stop	Norris Dr. WB (70 Stops) Norris Dr. EB (67 Stops)	Norris Dr. (6 crashes, including 1 pedestrian fatality)	Newport Mill M.S., Albert Einstein H.S., Pleasant View L.P.
4	Arbutus Ave.	West of Arbutus Ave.	Arbutus Ave. WB (49 Stops) Arbutus Ave. EB (50 Stops)	Arbutus (1 crash) Cemetery / Park Entrance (4 crashes)	Parklawn L.P.

Notes:
Bus Ridership: Stops include total boarding and alighting for WMATA routes only in 2015.
Crash Data includes crashes between January 1, 2015 and October 26, 2017.

Detailed traffic studies were performed for each of the locations referenced in Table 2 to evaluate the need for a full traffic signal or other traffic safety measure based on the traffic control criteria specified by the Maryland Manual on Uniform Traffic Control Devices (MUTCD). Appendix I includes detailed technical memoranda on each location. While the locations do not meet the MUTCD warrants today for full traffic signals, additional protected crossings are necessary to maximize the safety of vulnerable road users, increase connectivity to existing transit and community facilities and plan for additional pedestrian and bicycle activity with the introduction of Bus Rapid Transit.

Furthermore, the MUTCD criteria for pedestrian-activated signals and pedestrian beacons are not as robust as the criteria for full-color traffic signals. For this reason, the Veirs Mill Corridor Master Plan has evaluated the need for additional protected crossings with planning judgement and recognizes that additional technical studies are required prior to implementation. The locations recommended for protected crossings are based on the proximity to schools, parks, community facilities and bus stops, distance between existing signalized crossings, and pedestrian, bicycle and vehicular crashes. The highest priority protected crossings are also discussed in greater detail below.

Table 3: Protected Crossing Recommendations

Priority	Location
1	Veirs Mill Road and Turkey Branch Parkway (Matthew Henson Trail)
2	Veirs Mill Road and Andrew Street
3	Veirs Mill Road and Norris Drive
4	Veirs Mill Road and Arbutus Avenue
5	Veirs Mill Road and Galt Avenue
6	Veirs Mill Road and Bushey Drive
7	Veirs Mill Road and Pendleton Drive
8	Twinbrook Parkway and Halpine Road
9	Twinbrook Parkway and Vandegrift Avenue
10	Veirs Mill Road and Havard Street

Turkey Branch Parkway (Matthew Henson Trail Crossing)

The Matthew Henson Trail Crossing is located in the Turkey Branch stream valley at the base of two hills along Veirs Mill Road. The existing crossing is characterized by a switchback design to emphasize the visibility of pedestrians, bicyclists and motorists. According to the Maryland State Police, there were 45 crashes at this location between January 2015 and December 2017, including four crashes involving bicycles, two of which were fatalities.

Following the two bicycle fatalities, the Montgomery County Department of Parks formed an interagency work group to evaluate, recommend and implement additional safety measures at the trail crossing. The work group included representatives of the Maryland National Capital Park and Planning Commission, Maryland Department of Transportation State Highway Administration (MDOT SHA), Montgomery County Department of Transportation and Montgomery County Police.

Simultaneously, the MDOT SHA upgraded the existing trail crossing from a pedestrian beacon to a pedestrian-activated signal. Despite the installation of the pedestrian-activated signal, challenges remain. For example, the existing signal poles reduce visibility for pedestrians to see oncoming traffic and for traffic to see pedestrians.

According to data provided by MDOT SHA, compliance with the pedestrian-activated signal is also a challenge. Observations in May 2018 indicated that 71 percent of pedestrians and bicyclists pushed the button to activate the signal, but 46 percent proceeded into the crossing before the signal was activated. Only 30 percent of motorists complied with the traffic control. These rates of compliance represent a failure to address the safety issues at the crossing.

Based on the number of traffic-related severe injuries and fatalities, limited compliance with the existing pedestrian-activated signal and the vulnerability of pedestrians and bicyclists crossing in this location, additional refinements are necessary. The Veirs Mill Corridor Master Plan recommends the installation of a full traffic signal to improve safety. The Plan further recommends the relocation of the existing crosswalk to provide a direct connection across Veirs Mill Road to reduce the crossing distance and delay for motorists. In the long-term, consistent with the recommendations of the Bicycle Master Plan, the Veirs Mill Corridor Master Plan recommends a grade-separated crossing.

The MDOT SHA District 3 Traffic and Travel Forecasting and Analysis Division recently recommended the conversion of the existing pedestrian-activated signal to a full traffic signal at the Matthew Henson Trail Crossing, consistent with the recommendation of this

master plan. While the commitment to convert the existing pedestrian-activated signal to a full traffic signal demonstrates progress, this plan continues to encourage MDOT SHA to consider implementation of the plan's short-term recommendations for the crossing, including the realignment of the existing crosswalk to provide a direct connection across Veirs Mill Road.

Andrew Street

The intersection of Veirs Mill Road with Valleywood Drive and Gail Street includes a high-visibility marked crosswalk with pedestrian-warning signs. The westbound bus stop on Veirs Mill Road between Valleywood Drive and Andrew Street is heavily used, as are the eastbound bus stops located on Veirs Mill Road at Centerhill Street and Gail Street. While the marked crosswalk and warning signs provide some protection for pedestrians and bicyclists to access the bus stop at Gail Street, field observations and worn pedestrian paths in the median of Veirs Mill Road suggest that pedestrians are crossing Veirs Mill Road mid-block (outside the marked crosswalk) to access the bus stop at Centerhill Street.

A traffic study conducted in coordination with the Veirs Mill Corridor Master Plan, included in Appendix I, recommends the consolidation of bus stops, the relocation of the existing marked crosswalk and the installation of a pedestrian-activated signal at Andrew Street to improve the safety for pedestrians, bicyclists and transit users. The Veirs Mill Corridor Master Plan recommends a protected crossing at Andrew Street, which may include a full traffic signal or a pedestrian-activated signal.

Norris Drive

Norris Drive provides a direct connection between Veirs Mill Road and two Montgomery County Public Schools: Newport Mill Middle School and Albert Einstein High School. In addition, eastbound and westbound bus stops are also located at the intersection of Veirs Mill Road and Norris Drive. As discussed in Appendix I and witnessed during field observations, students regularly cross Veirs Mill Road at this intersection to access the middle school and high school. As Norris Drive is located between the signalized crossings of Veirs Mill Road at University Boulevard (approximately 2500 feet to the east) and Veirs Mill Road at Newport Mill Road (approximately 650 feet to the west), pedestrians elect to cross at Norris Drive. Due to the distance between signalized crossings and the proximity to the schools, the Veirs Mill Corridor Master Plan recommends a protected crossing at the intersection of Veirs Mill Road and Norris Drive, which may include a full traffic signal or a pedestrian-activated signal.

Arbutus Avenue

Arbutus Avenue provides a connection between the Aspen Hill community, Parklawn Local Park and the Rock Creek Trail. However, the nearest protected crossing opportunities of Veirs Mill Road are approximately 1,500 feet west of Arbutus Avenue at Aspen Hill Road and approximately 2,100 feet east of Arbutus Avenue at Robindale Drive. This represents a total distance of approximately 3,600 feet between protected crossings on a heavily used transit corridor.

As discussed in greater detail in Appendix I, this location does not meet the existing warrants for a traffic signal, but a protected crossing should be considered to increase connectivity between the community, transit and community facilities including Parklawn Local Park and the Rock Creek Trail. The existing distance between protected crossing opportunities encourages pedestrians, bicyclists and transit users to cross mid-block, which is life-threatening on a corridor with the high volume, high-speed traffic of Veirs Mill Road. For this reason, the Veirs Mill Corridor Master Plan recommends a protected crossing at the intersection of Arbutus Avenue and Veirs Mill Road. A protected crossing could be integrated with the redesign of Parklawn Local Park to provide improved access for pedestrians, bicyclists and motorists.

Vehicle Travel Times and Average Speed with New Traffic Signals

The Veirs Mill Corridor Master Plan recognizes that vehicular mobility is critical along Veirs Mill Road. For this reason, the vehicle travel times and average speed were analyzed to provide a comparison between existing conditions and a future with four new full traffic signals. The existing and future vehicle travel times and average speeds, which are inclusive of the time spent at a red light, are outlined in Table 4.

Table 4: Vehicle Travel Times and Average Speed with New Traffic Signals

Vehicle Travel Times (minutes) and Average Speed (mph) Veirs Mill Road from MD Route 355 to MD Route 97			
Scenario	Peak Hour	Eastbound	Westbound
Existing	AM	18.1 min 21 mph	17.9 min 21 mph
	PM	19.3 min 19 mph	18.8 min 20 mph
Future with Four New Signals	AM	19.8 min 19 mph	18.5 min 20 mph
	PM	19.4 min 19 mph	21.9 min 20 mph

It is important to note that pedestrian beacons and pedestrian-activated signals have limited if any effect on vehicular mobility, as the signals are only operational when activated on demand. Furthermore, the vehicle travel times and average speed remain largely consistent with the introduction of four new traffic signals, suggesting that vehicular mobility is maintained even with the introduction of protected crossings which improve connectivity and safety for pedestrians, bicyclists and transit users.

Pedestrian Level of Comfort

The pedestrian level of comfort analysis was created by the Montgomery County Planning Department to identify locations in the walking network that are uncomfortable due to inadequate or incomplete sidewalks and crossings and to quantify how different investments will increase connectivity. The analysis was inspired by the Bicycle Level of Traffic Stress analysis conducted for the 2018 *Bicycle Master Plan.*

The pedestrian level of comfort (PLOC) analysis is a work in progress that is being applied to the short-term and long-term pedestrian network recommendations of the Veirs Mill Corridor Master Plan. The Planning Department anticipates retaining assistance from a private contractor in FY 2019 to refine the methodology and metrics used to evaluate pedestrian connectivity.

The methodology, metrics, and pedestrian level of comfort for the short-term and long-term recommendations of the Veirs Mill Corridor Master Plan are described in greater detail in the following paragraphs.

Pedestrian Connectivity Methodology

PLOC scores range from High-Quality to Unacceptable.

- High-Quality: This walking environment enables parents to walk with young children with a moderate level of supervision.
- Acceptable: This walking environmental is comfortable for families, but parents would hold the hands of young children.
- Unacceptable: This walking environment is uncomfortable, and most adults will only walk if they have no other option.

Sidewalks and crossings are scored based on a "weakest link" approach in which the comfort of a segment of the network is governed by its most uncomfortable characteristic. For example, along the north side of Randolph Road, south of Selfridge Road, the lack of an adequate width buffer between the sidewalk and the road gave the walking routes on both sides of the street an "unacceptable" rating.

Sidewalk and street crossings are evaluated using different methodologies. Sidewalk scoring considers the following inputs:

- Adjacent Planned Land Uses
    - Urban
        - Mixed-use or high-density land use zones
        - Within ½ mile of rail or 1/4-mile from bus rapid transit stations
    - Suburban
- Walkway Width (sidewalk or sidepath):
    - Less than 3.5 feet
    - 3.5 to less than 5 feet
    - 5 feet to less than 8 feet
    - 8 feet or more
- Walkway Type
    - Pedestrians only
    - Shared with bicyclists
- Walkway Quality:
    - Presence of a buffer that is at least 5 feet wide
    - Frequency of obstructions
- Traffic Volume on Adjacent Roadway

Each leg of the intersection is analyzed as a separate street crossing. Street crossings are scored using the following inputs:

- Adjacent Planned Land Uses
        - Mixed-use or high-density land use zones
        - Within ½ mile of rail or 1/4-mile from bus rapid transit stations
- Presence of Traffic Control
    - Traffic Signal
    - Stop Sign
    - No Traffic Control

- Presence of a Right Turn on Red Restriction
- Cross Street Characteristics
    - Number of Lanes
    - Posted Speed Limit
- Presence of a Median
- Presence of a Crosswalk Marking

Veirs Mill Corridor Master Plan Pedestrian Scenarios

In addition to evaluating existing conditions, pedestrian connectivity is evaluated upon implementation of the short-term recommendations and the long-term recommendations. The short-term recommendations include the installation of walkways on Veirs Mill Road and on residential streets that provide a connection between existing and proposed transit and schools, parks and community facilities. The long-term recommendations include improvements such as pedestrian refuge islands, elimination of dual left-turn lanes, channelized right-turn lanes and additional protected crossing opportunities.

Pedestrian Connectivity Analysis

Two approaches are used to evaluate pedestrian connectivity:

1. An areawide analysis that evaluates how well specific areas are connected based on estimates of pedestrian travel; and
2. A destination analysis that evaluates how well dwelling units within a certain distance of the destination are connected to specific locations, including schools and transit stops.

Areawide Connectivity Methodology

The areawide connectivity analysis identifies how short and long-term transportation recommendations impact pedestrian access within specific areas. Connectivity is measured by comparing the number of dwelling units accessible within an area in each scenario (existing conditions, short term and long term) to the number of dwelling units accessible to a destination in the “fully walkable” scenario. The network for each scenario is based on those segments of the pedestrian environment that are considered to have at least an “acceptable” PLOC score. The objective of this approach is to understand how short and long-term transportation

recommendations impact pedestrian connectivity throughout the master plan area and for many types of pedestrian trips[8]. See the section "Pedestrian Travel Estimation" for a discussion of the methodology for estimating pedestrian trips.

The table below shows the pedestrian connectivity rates by scenario for each of the four districts identified in the Veirs Mill Corridor Master Plan, as well as the overall connectivity for the plan area. Under existing conditions, overall connectivity is 52%. This grows to 59% with the short-term recommendations in the plan and to 84% with the plan's long-term recommendations. The greatest pedestrian connectivity improvements occur in the Connecticut / Randolph District, which shows a pedestrian connectivity increase of 48%. While the Robindale and Connecticut / Randolph reach connectivity rates of nearly 100% in the long-term scenario and the Newport Mill District reaches 86% greater, the Twinbrook District only reaches 66% connectivity. This is because many of the pedestrian trips that start or end in the Twinbrook District are traveling to and from nearby areas of the City of Rockville and Twinbrook that are outside of the plan area, where pedestrian connectivity is not improved by the Veirs Mill Corridor Master Plan.

Table 5: Areawide Pedestrian Connectivity Analysis

District	Existing	Short Term	Long Term
Twinbrook	54%	51%	73%
Robindale	61%	81%	96%
Connecticut/Randolph	42%	65%	98%
Newport Mill	52%	81%	87%
Overall	50%	65%	87%

[8] Home Based and Non Home Based work, personal business, dining, shopping, leisure and school trips.

Destination Connectivity Methodology

The destination connectivity analysis identifies how short and long-term transportation recommendations impact pedestrian access to specific destinations. Connectivity is measured by comparing the number of dwelling units accessible to a destination in each scenario (existing conditions, short term and long term) to the number of dwelling units accessible to a destination in the "fully walkable" scenario. A distance of 0.5 miles from the destination along the "fully walkable" pedestrian network is used to generate the catchment area for all scenarios. As with the areawide connectivity analysis, the network for each scenario is based on those segments of the pedestrian environment that are considered to have at least an "acceptable" PLOC score.

Since people need to access bus stops on both sides of the road, bus stop pairs that serve opposing directions are evaluated together. For each bus stop pair, the number of residential units within the 0.5-mile catchment area that are connected to both bus stops is determined for each phase of the plan. These figures are then compared to the "fully walkable" scenario to determine the level of connectivity. The results in Table 6 show that due to the lack of acceptable crossings on Veirs Mill Road, no dwelling units currently have an acceptable level of connectivity to their closest bus stop pair. With the recommendations in the short-term phase of the plan, pedestrian connectivity grows to 2% and in the long term with the provision of additional protected crossings, such as signalized intersections and other intersection improvements, pedestrian connectivity grows to 82%.

Table 6: Bus Stop Pedestrian Connectivity Analysis

	Existing	**Short Term**	**Long Term**
Twinbrook Pkwy	0%	0%	100%
Aspen Hill Rd	0%	8%	100%
Arbutus Ave / Parklawn Memorial	0%	100%	100%
#12704/#12701	0%	100%	100%
Robindale Rd	0%	0%	100%
Gaynor Rd / Parkland Dr	0%	0%	100%
Turkey Branch Pkwy / Edgebrook Rd	0%	83%	83%

Havard St	0%	0%	0%
Gridley Rd	0%	0%	96%
Randolph Rd	0%	0%	73%
Bushey Dr	0%	0%	0%
Ferrara Ave	0%	0%	88%
Connecticut Ave	0%	0%	81%
Centerhill St / Gail St	0%	0%	94%
Claridge Rd	0%	0%	100%
Pendleton Dr	0%	0%	100%
Newport Mill Rd	0%	0%	99%
Monterrey Dr / Norris Dr	0%	100%	100%
Monterrey Dr / Schoolhouse Cir	0%	0%	1%
Galt Ave / College View Dr	0%	0%	0%
Total		13%	82%

Pedestrian Travel Estimation

Pedestrian travel is estimated using an adaptation of the "Pedestrian Flow Modeling for Prototypical Maryland Cities" report developed by the University of Maryland National Center for Smart Growth on behalf of the Maryland Department of Transportation.[9]

[9] Clifton, K. J., Davies, G., Allen, W. G., & Radford, N. (2004). Pedestrian Flow Modeling for Prototypical Maryland Cities. College Park, MD: University of Maryland National Center for Smart Growth. Retrieved from http://smartgrowth.umd.edu/pedestrianflowmodeling.html

The pedestrian flow analysis requires three major inputs:

1. A walking network is developed for each scenario comprised of all sidewalks and crossings with PLOC values of an "acceptable" or higher rating.
2. Trip production and attraction zones (census blocks).
3. Land use information derived from parcels summarized at the census block level.

There are four steps to estimating pedestrian travel:

Step 1: Estimating Productions: The pedestrian flow analysis first estimates the number of productions generated by each census block. Separate production rates are calculated for work, eat, shop, leisure and personal business for both home and non-home-based trips. The production rates are largely based on the accessibility of "opportunities" from each census block. Accessibility is a function of the intensity of the opportunity discounted by the time it takes to reach the opportunity. Production rates for each trip type are then multiplied by the number of residential units (home-based trips) or total floor space (non-home-based trips).

Step 2: Estimating Attractions: Trip attractions are estimated by multiplying the geography's total floor area for land uses germane to the particular trip type being estimated, by a factor. For this exercise, land use is static among all scenarios requiring this step to be estimated only once.

Step 3: Trip Distribution: Trip distribution creates a zone-to-zone matrix of pedestrian flows for each trip type in which all trip productions are linked to an attraction. Trip distribution is conducted using a gravity model that assumes that the "number of trips between zone *i* and zone *j* is proportional to the number of trips produced in zone *i*, the number of trips attracted to zone *j*, and inversely proportional to the impedance separating the two zones". Trips flows for each individual trip purpose are added together to obtain the total pedestrian flow between census blocks. Each flow is then assigned a production and attraction district based on the location of the census geography's centroid. As with the trip production step, trip distribution is completed using the walking network for each scenario.

Step 4: Pedestrian connectivity is then determined for each district by dividing the estimated number of pedestrian trips for each pedestrian network scenario (existing conditions, after implementing short-term recommendations and after implementing long-term recommendations) by the estimated number of pedestrian trips in the "fully walkable" pedestrian network scenario.

Bicycle Level of Traffic Stress

The Veirs Mill Corridor Master Plan recommends a bicycle network that enables people of all ages and bicycling abilities to ride to school, run errands, and commute to work on a network that is safe, comfortable, and accessible. The plan creates this environment by connecting the existing low-stress bicycling network, composed of trails and residential streets, with interim and long-term bicycle improvements on higher-volume and high-speed roads.

As shown by the blue lines in Figure 4, most of the streets within the plan area are considered low-stress today as they are characterized by an environment in which people of all ages and abilities feel comfortable and safe bicycling. However, Veirs Mill Road, Aspen Hill Road, Randolph Road, Connecticut Avenue and Newport Mill Road, shown in red in Figure 4, interrupt the low-stress network and deter bicycling as a safe, convenient mode of transportation. Approximately 15 percent of the potential bike trips in the plan area are possible on a low-stress network today due to these high-volume, high-speed roads which bisect the low-stress network.

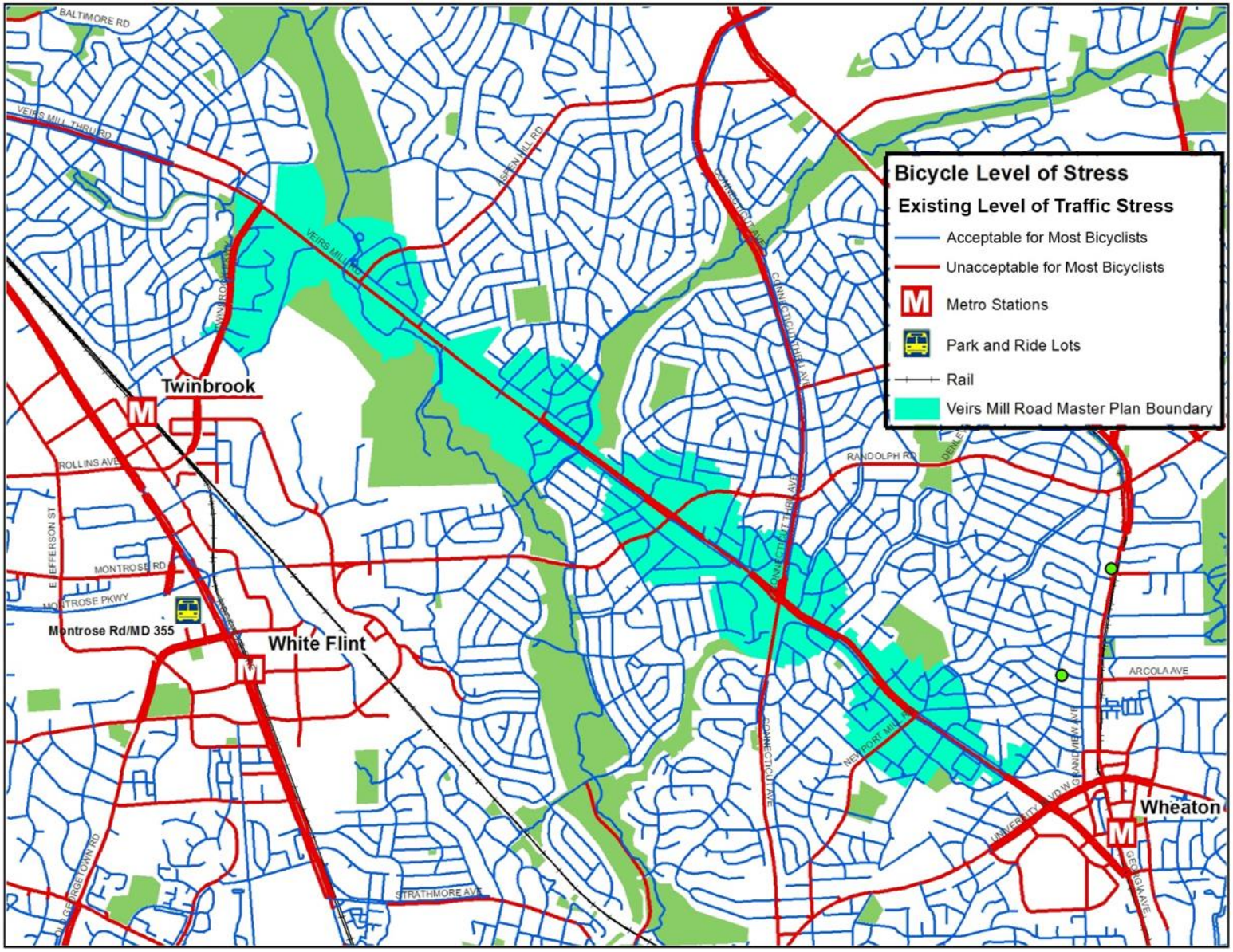


Figure 4: Bicycle Level of Stress

The Veirs Mill Corridor Master Plan recommends interim improvements to provide a continuous low-stress connection for the length of the plan area and encourage bicycle use. The interim improvements include a combination of facilities, such as neighborhood greenways, sidepaths and improved trail connections to provide critical connections for a parallel interim network.

With the design and implementation of long-term redevelopment or infrastructure projects, such as bus rapid transit, the Veirs Mill Corridor Master Plan recommends dedicated bikeways on Veirs Mill Road and select intersecting streets to align with the 2018 *Bicycle Master Plan.* The long-term recommendations include a sidepath on the north side of Veirs Mill Road that transitions to a two-way separated bike lane and sidewalk at areas with commercial land use, including the Stoneymill Square Shopping Center. In addition, the plan recommends two-way separated bicycle lanes and a sidewalk on the south side of Veirs Mill Road. The two-way separated bike lanes and sidewalk are recommended to transition to a sidepath between the future Montrose Parkway and the western plan boundary. With the implementation of the long-term recommendations, approximately 77 percent of the potential bike trips in the plan area will be possible on a low-stress network.

Bikeshare

Bikeshare, both docked and dockless, are available in select locations of Montgomery County. The county is a member of the Capital Bikeshare system, which includes a connected network of bikes and docking stations throughout the Washington Metropolitan area. Capital Bikeshare stations are currently located in the Wheaton Central Business District, Twinbrook and White Flint, but no stations are currently located along Veirs Mill Road. However, as bus rapid transit is implemented along Veirs Mill Road, additional bikeshare stations may be implemented to provide last-mile service for residents to access Metrorail, BRT and local bus. Stations may be most appropriate near the commercial center of Veirs Mill and Randolph Road, at existing high-ridership bus stops, future BRT stops and within the community to provide a reliable last mile connection.

Montgomery County has also signed agreements with dockless bikeshare companies for a demonstration project in Silver Spring and Takoma Park. Dockless bikeshare does not rely on fixed bike stations, but rather allows users to park bikes on publicly-owned land within the area specified in the agreements. The expansion of dockless bikeshare to other areas of the county provides additional opportunities for a reliable last mile connection from Metrorail, BRT and local bus.

BICYCLE AND PEDESTRIAN PRIORITY AREA

To further prioritize the bicycle and pedestrian enhancements along Veirs Mill Road, the Planning Board Draft of the Veirs Mill Corridor Master Plan recommends the expansion of the current Veirs Mill Road and Randolph Road Bicycle and Pedestrian Priority Area (BiPPA), designated by the 2013 *Countywide Transit Corridor Functional Master Plan*. The intersection of Veirs Mill Road and Randolph Road experiences substantial pedestrian volumes. The 2017 *Mobility Assessment Report* ranked the intersection as one of the highest pedestrian counts in the county (24 out of 50). These volumes are anticipated to grow with the implementation of BRT proposed on both Veirs Mill Road and Randolph Road, as well as the potential for walkable, transit-oriented development.

The current Veirs Mill Road Bicycle and Pedestrian Priority Area report was completed in June 2015. The report was a collaboration of agency officials, community stakeholders, planners, engineers, and specialists in geographic information systems (GIS). The project team initially reviewed recommendations from existing master plans, followed by field investigations and the development of the report. The report recommended short-term, mid-term, and long-term improvements. Since the time of the report, improvements have been planned, but implementation has not yet occurred.

The Veirs Mill Corridor Master Plan recommends an expansion of the existing BiPPA area to include the area between Robindale Drive and Parkland Drive, as well as the area between Claridge Road and the Wheaton Central Business District, due to the higher amount of walking and bicycling in these areas today and due to the growth in walking and bicycling that is anticipated with the implementation of BRT in the corridor.

TRANSIT

Existing Transit Services

Local bus service along Veirs Mill Road is currently provided by the Washington Metropolitan Area Transit Authority's (WMATA) Metrobus and Montgomery County's Ride On. Veirs Mill Road is included in WMATA's Priority Corridor Network, as the Veirs Mill routes (C4 and Q routes) have some of the highest ridership in the Metrobus system. According to the Priority Corridor Network Plan, "Veirs Mill Road is the largest bus transit market in Montgomery County, serving as a critical cross-county connection that links two ends of the Metrorail Red Line."[10] Approximately 13,000 passengers ride these Metrobus bus routes along Veirs Mill Road each

[10] https://www.wmata.com/initiatives/plans/upload/110926_PCN_Report_Final.pdf

weekday. Ride On bus routes 26, 34, 38, 44, and 48 travel on a segment of Veirs Mill Road within the plan area and serve approximately 8,000 passengers each weekday.

WMATA's Metrobus services are defined by two lines that operate along Veirs Mill Road: the Veirs Mill Road Line and the Greenbelt-Twinbrook Line. Metrobus's Veirs Mill Road Line (including the Q1, Q2, Q4, Q5 and Q6 routes) travel the full length of Veirs Mill Road from the Wheaton Metrorail Station to Rockville Pike. Major destinations on the Veirs Mill Road Line include Montgomery College, the Wheaton Central Business District, the Silver Spring Central Business District and the Shady Grove, Rockville, Wheaton, Forest Glen and Silver Spring Metrorail stations.

WMATA identifies the Veirs Mill Road Line as a priority corridor in its Priority Corridor Network Plan, which outlines a "strategy for improving bus service in the Washington region quickly and efficiently" through improvements to "bus service travel times, reliability, capacity, productivity, and system access." The Priority Corridor Network Plan includes improvements that can be implemented incrementally, but ultimately provide elements such as signal priority for transit vehicles, real-time traveler information, new buses with low floors for improved boarding and branding, consistent with several features common to BRT. The Priority Corridor Network Plan identifies a future limited-stop peak period service between Shady Grove and Wheaton, the Q9 Route.[11]

While the Q9 Route has not been implemented, Metrobus did restructure the Q2 Route in late 2009 to relieve passenger crowding, bus bunching, schedule adherence and long travel times. The restructure divided the Q2 Route into two overlapping routes: the Q4 and the Q6. Both routes serve Veirs Mill Road, with the Q4 providing service between Silver Spring and Rockville and the Q6 providing service between Wheaton and Shady Grove.

Metrobus' Greenbelt-Twinbrook Line (C4 Route) provides service on Veirs Mill Road between the Wheaton Metrorail Station and Randolph Road. The Greenbelt-Twinbrook Line connects western Montgomery County with the eastern portion of the county as well as western Prince George's County. Major destinations include Wheaton, Takoma Park, Langley Park, University of Maryland, Four Corners, The Mall at Prince George's, College Park, and Greenbelt, as well as the Twinbrook, Wheaton, Prince George's Plaza and Greenbelt Metrorail stations.

Metrobus' College Park-White Flint Line (C8) and the Connecticut Avenue-Maryland Line (L8) also provide service to the master plan area, intersecting Veirs Mill Road at Randolph Road and Connecticut Avenue, respectively.

[11] https://www.wmata.com/initiatives/plans/upload/110926_PCN_Report_Final.pdf

Metrobus ridership data was obtained from WMATA in the form of average daily ridership for fiscal year 2017 for the Veirs Mill Road Line and the Greenbelt-Twinbrook Line. Additional WMATA ridership data, processed by Ridecheck Plus, was also obtained for fiscal year 2017 which identified the average daily boarding and alighting by direction at each of the bus stops in the Veirs Mill Corridor Master Plan area.

Metrobus' Q Line routes (Q1, Q2, Q4, Q5, Q6) provide frequent service on Veirs Mill Road and are heavily utilized. Including north- and south-bound bus stops within one block of Veirs Mill Road, Metrobus generated 6,099 average daily boardings and alightings in the study area in 2017. Metrobus stops with the highest quantities of boarding and alighting each day occur at the intersection of Veirs Mill Road and Randolph Road (more than 1,200 daily boardings and alightings) as well as Veirs Mill Road and Connecticut Avenue (more than 400 daily boardings and alightings). Combined, these four stops account for nearly 30% of Metrobus' ridership in the Veirs Mill corridor.

The highest ridership Metrobus stop located off Veirs Mill Road, but still within the study area, is Randolph Road at Selfridge Road, with 326 average daily boardings and alightings). Individual Metrobus stops that recorded more than 100 average daily boardings and activities include: Veirs Mill Road at Andrew Street (218 daily), Veirs Mill Road at Centerhill Street (145 daily), Veirs Mill Road at Parkland Drive (102 daily), and Veirs Mill Road at Gridley Road (101 daily).

Stop Location (Eastbound and Westbound)	Average Daily Stop Activity	Percent of Study Area Ridership
Veirs Mill Road/Randolph Road	1,279	21%
Veirs Mill Road/Connecticut Avenue	478	8%
Veirs Mill Road/Twinbrook Parkway	311	5%
Veirs Mill Road/Ferrara Avenue	308	5%
Veirs Mill Road/Robindale Drive	308	5%

Montgomery County Ride On bus ridership information was obtained in the form of ridership by bus route. Ride On bus routes 26, 34, 38, 44, and 48 each travel on a segment of Veirs Mill Road within the plan area and served over 8,000 average daily riders in FY17. Route 48 provides the primary Ride On service within the plan area and provides a connection between the Rockville and Wheaton Metrorail stations. Stop-level ridership data for Ride On in the Veirs Mill corridor was not available.

Table 7. FY 2017 Ride On Bus Ridership by Bus Routes

Route	Route Description	AM Average Headway (Minutes)	PM Average Headway (Minutes)	Average Daily Riders	Sat. Service	Sun. Service
26	**Glenmont-Aspen Hill-Twinbrook-Montgomery Mall**	15	15	**2,806**	X	X
34	**Aspen Hill-Wheaton-Bethesda-Friendship Heights**	15	15	**2,523**	X	X
38	**Wheaton-White Flint**	20	25	**821**	X	X
44	**Twinbrook-Rockville***	30	30	**134**	N/A	N/A
48	**Rockville-Wheaton**	25	25	**1,896**	X	X

**Operates during AM and PM Peak Periods Only*

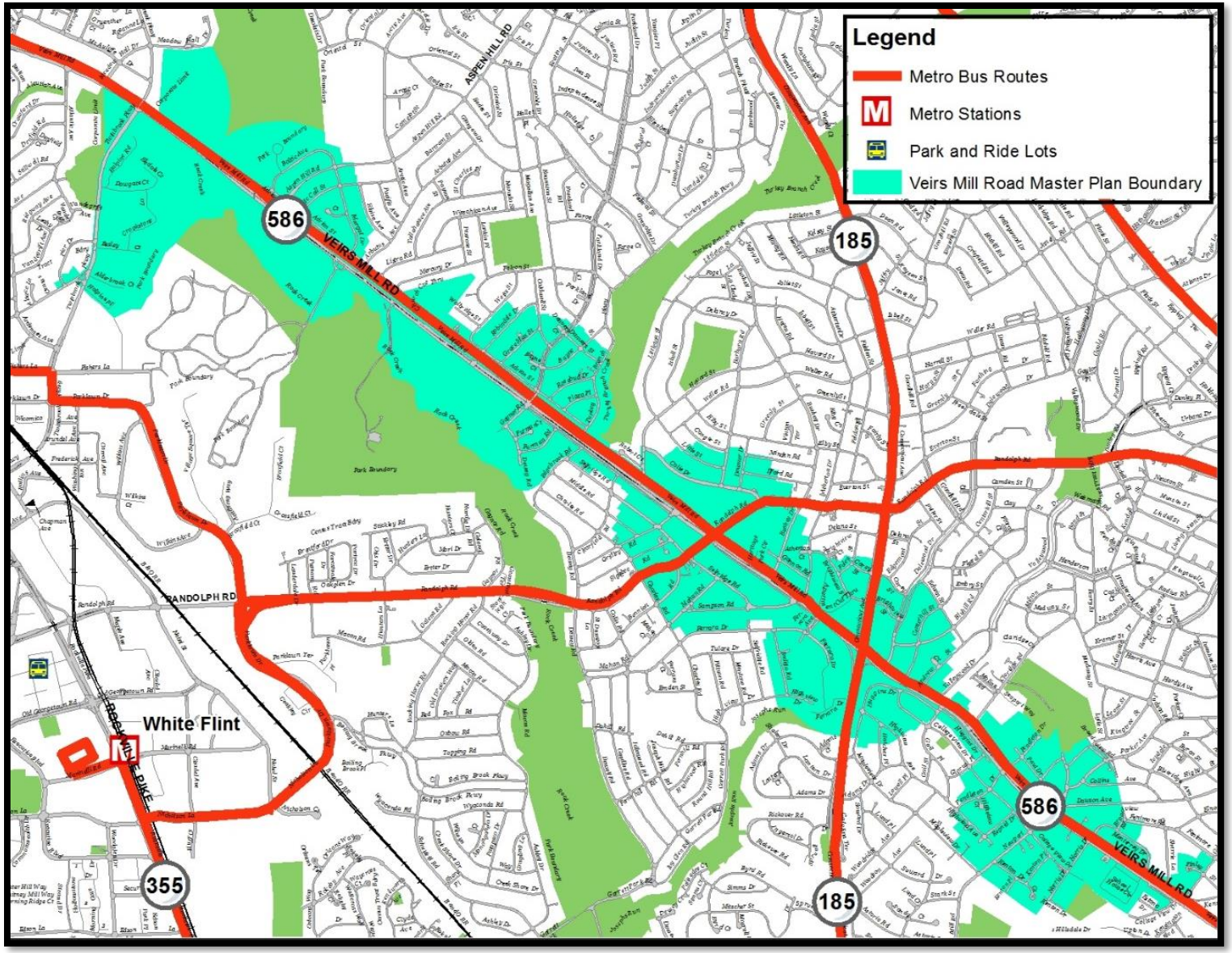


Figure 5: FY 2017 Metrobus Routes

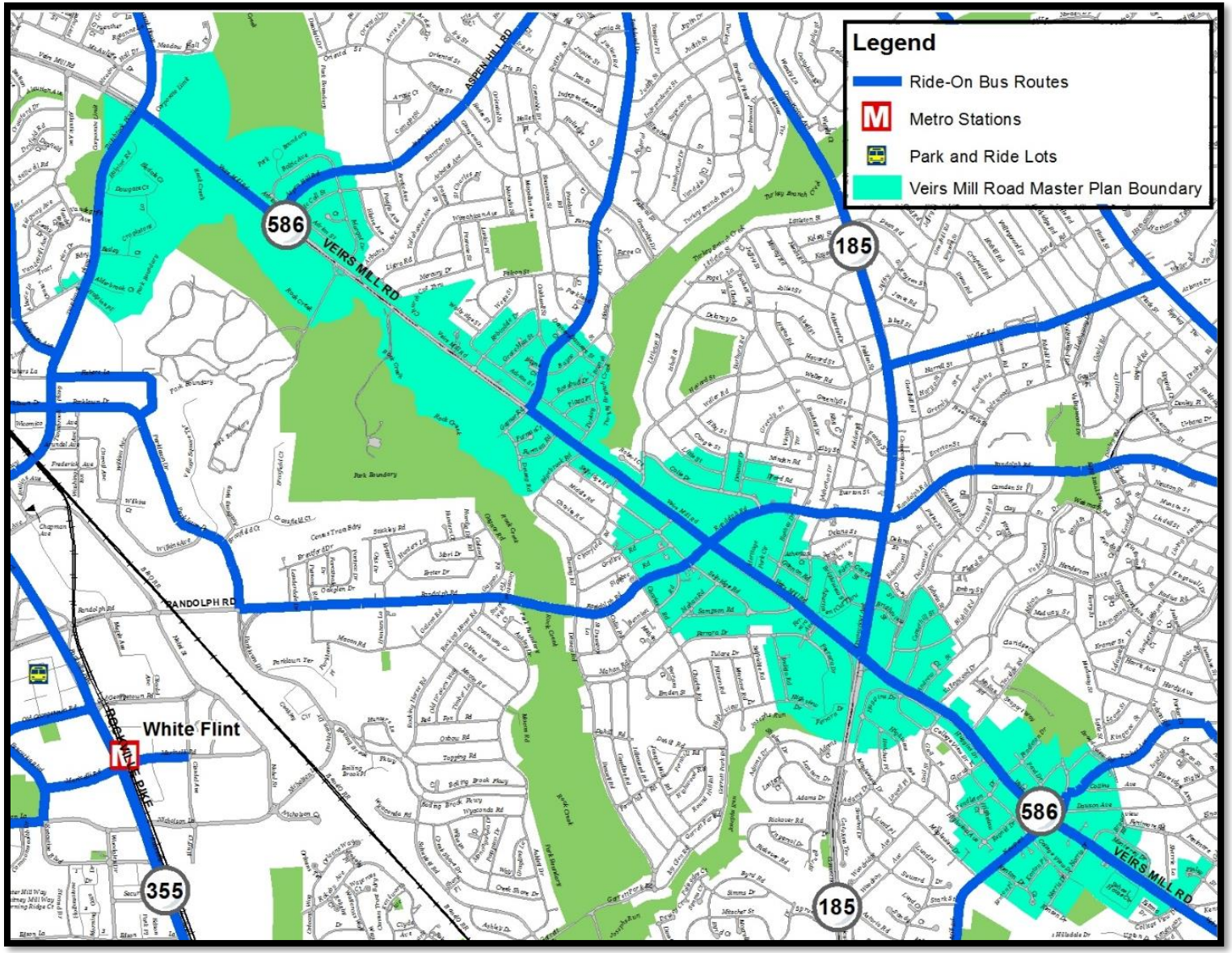


Figure 6: FY 2017 Ride On Routes

TRANSIT ANALYSIS

Transportation Policy Area Review (TPAR) was the transportation adequacy test developed and adopted in the context of the 2012 Subdivision Staging Policy. TPAR measured the impacts of development on traffic flow and transit capacity by policy area, established standards for roadway and transit adequacy and determined which policy areas achieved the established standards. TPAR was eliminated by the County Council following the adoption of the 2016 Subdivision Staging Policy. The Local Area Transportation Review (LATR) Guidelines are now used to prepare and review transportation studies for development in Montgomery County.

While TPAR is no longer used in subdivision review, the transit adequacy test continues to have some utility for master plan analysis. For this reason, this Transportation Appendix includes a summary of the transit adequacy for the Veirs Mill Corridor Master Plan area based on TPAR. As discussed in greater detail below, roadway adequacy is analyzed with the Local Area Transportation Review, consistent with the recommendations of the 2016 Subdivision Staging Policy.

The Veirs Mill Corridor Master Plan area traverses three policy areas: North Bethesda, Kensington-Wheaton, and Aspen Hill. While the plan area extends through these policy areas, it represents small segments of each policy area and it is challenging to extrapolate the transit adequacy results from the 2012 TPAR report exclusively for the Veirs Mill Corridor Master Plan area. However, as the plan area generally extends approximately ¼ mile on the north and south sides of Veirs Mill Road, it is assumed that the coverage of transit service generally aligns with the 2012 TPAR results. It is also important to note that the local transit information reported in the 2012 TPAR report reflects observed conditions as of January 2011. As TPAR was eliminated with the adoption of the 2016 Subdivision Staging Policy, this information has not been updated to reflect more current conditions.

As described in the 2012 Subdivision Staging Policy, TPAR considers all transit services in Montgomery County: Metrorail, commuter rail, existing local bus service, future light rail transit, and future bus rapid transit. TPAR evaluates the quality of local bus service through the measurement of three "performance factors" including coverage of service (proximity of potential users to the transit service), peak headways (frequency of service) and span of service (duration during a typical weekday when service is available to potential users).

The following paragraphs summarize the performance factors for the policy areas applicable to the Veirs Mill Corridor Master Plan area, including North Bethesda, Kensington-Wheaton, and Aspen Hill as discussed in the 2012 TPAR report.

North Bethesda Policy Area

The North Bethesda Policy Area is categorized as an Urban Policy Area, given the current level of transit service and development activity. The area includes three Metrorail stations (Grosvenor, White Flint and Twinbrook) and is characterized by high population and employment densities. The North Bethesda Policy Area has an overall transit coverage of more than 80 percent of its area.

Approximately 87 percent of the North Bethesda Policy Area is located within one mile of a Metrorail station or 1/3 mile from one of the 15 bus routes that serve the area. The portion of the Veirs Mill Corridor Master Plan area within the North Bethesda Policy Area is within one mile of the Twinbrook Metrorail Station, adjacent to bus routes on Veirs Mill Road and Twinbrook Parkway and also within ½ mile of the future bus rapid transit station planned at the intersection of Veirs Mill Road and Twinbrook Parkway. The standard for coverage for an urban policy area is 80 percent; therefore, transit coverage in the North Bethesda Policy Area is adequate.

According to the 2012 TPAR report, buses in the North Bethesda Policy Area on average operate with 21.3 minutes between buses during the weekday evening peak period. Although select routes provide very frequent service, such as the C2 Metrobus, the standard for average bus peak headway in areas like North Bethesda where Metrorail and MARC are provided is 20 minutes or less. As such, the average bus peak headway for the North Bethesda Policy Area is not yet adequate. However, with the implementation of Bus Rapid Transit Alternative 2.5 (the County Council recommended option to proceed with preliminary design), the peak headway for the portion of the North Bethesda Policy Area located in the Veirs Mill Corridor Master Plan will be adequate. The anticipated headway during peak periods is six minutes and the headway anticipated during off-peak periods is 10 minutes.

According to the 2012 TPAR report, the average span of service is 17.7 hours per day for routes that operate all-day. The urban standard is 17.0 hours per day on average for all-day routes. Therefore, the span of service in the North Bethesda Policy Area is adequate.

Kensington-Wheaton Policy Area

The Kensington-Wheaton Policy Area is categorized as an Urban Policy Area, given the current level of transit services and development activity. The area includes three Metrorail stations (Forest Glen, Wheaton, and Glenmont) and is characterized by high population and moderate employment densities. The Kensington-Wheaton Policy Area has an overall transit coverage of more than 80 percent of its area.

Approximately 82 percent of the Kensington-Wheaton Policy Area is located within one mile of a Metrorail station or 1/3 mile from one of the 29 bus routes that serve the area. Portions of the Veirs Mill Corridor Master Plan area are within one mile of the Wheaton and Glenmont Metrorail Stations, adjacent to bus routes on Veirs Mill Road, Randolph Road and Connecticut Avenue and also within ½ mile of several future bus rapid transit stations. The standard for coverage for an urban policy area is 80 percent; therefore, transit coverage in the Kensington-Wheaton Policy Area is adequate.

According to the 2012 TPAR report, buses in the Kensington-Wheaton Policy Area on average operate with 20.7 minutes between buses during the weekday evening peak period. Although select routes provide very frequent service, such as the Q-Line Metrobus, the standard for average bus peak headways in areas like Kensington-Wheaton where Metrorail and MARC are provided is 20 minutes or less. As such, the average peak headway for the Kensington-Wheaton Policy Area is not yet adequate. However, with the implementation of Bus Rapid Transit Alternative 2.5 (the County Council recommended option to proceed with preliminary design), the peak headway for the portion of the Kensington-Wheaton Policy Area located in the Veirs Mill Corridor Master Plan will be adequate. The anticipated headway during peak periods is six minutes and the headway anticipated during off-peak periods is 10 minutes.

According to the 2012 TPAR report, the average span of service is 18.5 hours per day for routes that operate all-day. The urban standard is 17.0 hours per day on average for all-day routes. Therefore, the span of service in the Kensington-Wheaton Policy Area is adequate.

Aspen Hill Policy Area

The Aspen Hill Policy Area is categorized as a Suburban Policy Area, given the current level of transit service and development activity. The area is characterized by bus transit service, high population, and low employment densities. The Aspen Hill Policy Area has an overall transit coverage of more than 30 percent of its area.

Approximately 44 percent of the Aspen Hill Policy Area is located within 1/3 mile from one of the 11 bus routes that serve the area. The portion of the Veirs Mill Corridor Master Plan within the Aspen Hill Policy Area is adjacent to bus routes on Veirs Mill Road and also within ½ mile of several future bus rapid transit stations. The standard for coverage for an urban policy area is 30 percent; therefore, transit coverage in the Aspen Hill Policy Area is adequate.

According to the 2012 TPAR report, buses in the Aspen Hill Policy Area on average operate with 19.9 minutes between buses during the weekday evening peak period. Some routes provide very frequent service, such as the Q-Line Metrobus. In areas like Aspen Hill where only buses are provided, the standard for average Peak Headway is 20 minutes or less. Therefore, the average peak headway for the Aspen Hill Policy Area is adequate.

The average peak headway for the Aspen Hill Policy Area will improve with the implementation of Bus Rapid Transit Alternative 2.5 (the County Council recommended option to proceed with preliminary design). The anticipated headway during peak periods is six minutes and the headway anticipated during off-peak periods is 10 minutes.

According to the 2012 TPAR report, the average span of service is 19.3 hours per day for routes that operate all-day. The urban standard is 14.0 hours per day on average for all-day routes. Therefore, the span of service in the Aspen Hill Policy Area is adequate.

PLANNED BUS RAPID TRANSIT (BRT)

Veirs Mill Road experiences some of the highest transit volumes in Montgomery County, but bus service is often unreliable and low performing. For these reasons, Montgomery County and WMATA are actively working to improve bus service in the Veirs Mill corridor. Montgomery County and the City of Rockville have studied and supported BRT and traditional bus routes on Veirs Mill Road for nearly two decades, as demonstrated by the numerous initiatives completed since 1999, including:

- Federal Transit Administration BRT Demonstration Program Application, 1999.
- Montgomery County's Go Montgomery! Program, adopted the *Veirs Mill Road BRT Corridor Study,* resulting in its incorporation into the County Council's Transportation Plan, 2002.
- WMATA *Regional Bus Study*, 2003.
- Montgomery County Department of Transportation's *Veirs Mill Road Bus Rapid Transit Facility Planning – Phase 1 Report*, 2005.
- WMATA's *Veirs Mill Road Line Study*, 2009 and 2013.
- Montgomery County's *Countywide Bus Rapid Transit Study*, 2011.
- *Report and Recommendations of the County Executive's Transit Task Force,* 2012.
- The *Countywide Transit Corridors Functional Master Plan*, 2013.
- The Maryland Department of Transportation's *Draft Corridor Study Report, MD 586/Veirs Mill Road Bus Rapid Transit Study*, 2016.

The 2013 *Countywide Transit Corridors Functional Master Plan*, produced by the Montgomery County Planning Department, recommends enhanced transit opportunities, including a network of 11 BRT corridors and the designation of bicycle-pedestrian priority areas. The plan identifies Veirs Mill Road as an appropriate corridor for BRT due to the volume of existing transit ridership and the desire to increase transit reliability and service for existing residents and transit-dependent populations.

As shown in Figure 7, the Veirs Mill Road Corridor (Corridor 10) connects with several other corridors, including Georgia Avenue (Corridors 1 and 2), Rockville Pike (Corridors 3 and 4), Randolph Road (Corridor 7), and University Boulevard (Corridor 8), facilitating movement by transit to much of the eastern portion of the county.

Corridor 1: Georgia Avenue North
Corridor 2: Georgia Avenue South
Corridor 3: MD 355 North
Corridor 4: MD 355 South
Corridor 5: New Hampshire Avenue
Corridor 6: North Bethesda Transitway
Corridor 7: Randolph Road
Corridor 8: University Boulevard
Corridor 9: US 29
Corridor 10: Veirs Mill Road

Figure 7: 2013 Countywide Transit Corridors Functional Master Plan – BRT Corridors

The Countywide Transit Corridors Functional Master Plan classifies Veirs Mill Road as a Commuter Corridor, which is characterized by a disproportionately high percent of travel during peak travel periods as opposed to travel that is spread out throughout the day. Commuter Corridors typically connect moderate-density residential areas to employment centers. The functional master plan recommends BRT station areas prioritize multimodal access for pedestrians, bicyclists and transit users. The functional master plan also recommends six BRT stations within the Veirs Mill Corridor Master Plan area, including:

1. Twinbrook Parkway
2. Aspen Hill Road
3. Parkland Drive
4. Randolph Road
5. Connecticut Avenue
6. Newport Mill Road

Veirs Mill Road Bus Rapid Transit Study

In 2016, the MDOT SHA and the Maryland Transit Administration (MTA), in cooperation with MCDOT, released the Draft Corridor Study Report titled the *MD 586 / Veirs Mill Road Bus Rapid Transit Study* to document the evaluation of alternatives for BRT along Veirs Mill Road. The draft report identifies BRT as a solution for the corridor "because it would increase transit reliability and opportunities for low-income and minority populations, as well as provide access to a larger supply of affordable housing. Enhanced transit access could also play a role in revitalizing adjacent neighborhoods, relieving congestion, supporting land conservation, and improving safety for bicyclists and pedestrians."[12]

The draft report analyzes several alternatives to improve transit on Veirs Mill Road, including a "no build" alternative (no improvements in infrastructure or service) and three "build" alternatives including:

- Alternative 2 (Transportation System Management with Intersection Queue Jumps and Enhanced Bus Service): consists of minor infrastructure improvements at select intersections and the implementation of a limited-stop, enhanced bus service. Minor infrastructure improvements include: enhanced bus stops with shelters, real time information, off-board fare collection, transit signal priority and intersection widening for queue jump installation.

[12] Maryland Department of Transportation and Montgomery County Department of Transportation. "Draft Corridor Study Report: MD 586/Veirs Mill Road Bus Rapid Transit Study." September 2016: 1.

- Alternative 3 (New BRT Service in Dedicated Curb Lanes): consists of widening or repurposing existing travel lanes and shoulders to provide dedicated, curb-running bus lanes and BRT service; dedicated lanes proposed in areas where the improvements would result in minor right-of-way impacts and result in increased travel speeds.
- Alternative 5B (New BRT Service in the Median): consists of new BRT service in a dedicated, bi-directional median lane or two dedicated median lanes.[13]

The alternatives were presented to the Montgomery County Planning Board on November 3, 2016, and the board expressed support for Alternative 3. The Montgomery County Council's Transportation, Infrastructure, Energy and Environment (T&E) Committee reviewed the draft report on December 1, 2016 and eliminated alternative 5B from further consideration due to the cost and marginal improvement in travel times when compared to other build alternatives. The committee also requested the evaluation of an additional alternative that combined elements of Alternatives 2 and 3. The hybrid alternative, termed Alternative 2.5, included BRT buses, larger stations, level boarding, real-time information, off-board fare collection, transit signal priority, and queue jump lanes at the corridor's busiest intersections – rather than a continuous dedicated transit lane.

MDOT analyzed Alternative 2.5 and determined that it would achieve similar travel times to Alternative 3 but would cost significantly less. The committee proposed to proceed with Alternative 2.5 into preliminary design but retained Alternative 3 as the long-term vision. The County Council concurred with the recommendations of the committee and adopted a resolution on June 13, 2017, which stated:

"The council selects Alternative 2.5 as the recommended option to carry forward into preliminary design and identifies Alternative 3 to be retained as the master plan option, protecting the right-of-way for a potential upgrade to a continuous dedicated lane in the long term, if it is eventually warranted."[14]

[13] Maryland Department of Transportation and Montgomery County Department of Transportation. "Draft Corridor Study Report: MD 586/Veirs Mill Road Bus Rapid Transit Study." September 2016: 1.

[14] County Council for Montgomery County, Maryland Resolution No: 18-844: *Selection of Recommended Alternative for the MD 586 / Veirs Mill Road Bus Rapid Transit Study*. 13 June 2017. Available from https://www.montgomerycountymd.gov/COUNCIL/Resources/Files/res/2017/20170613_18-844.pdf.

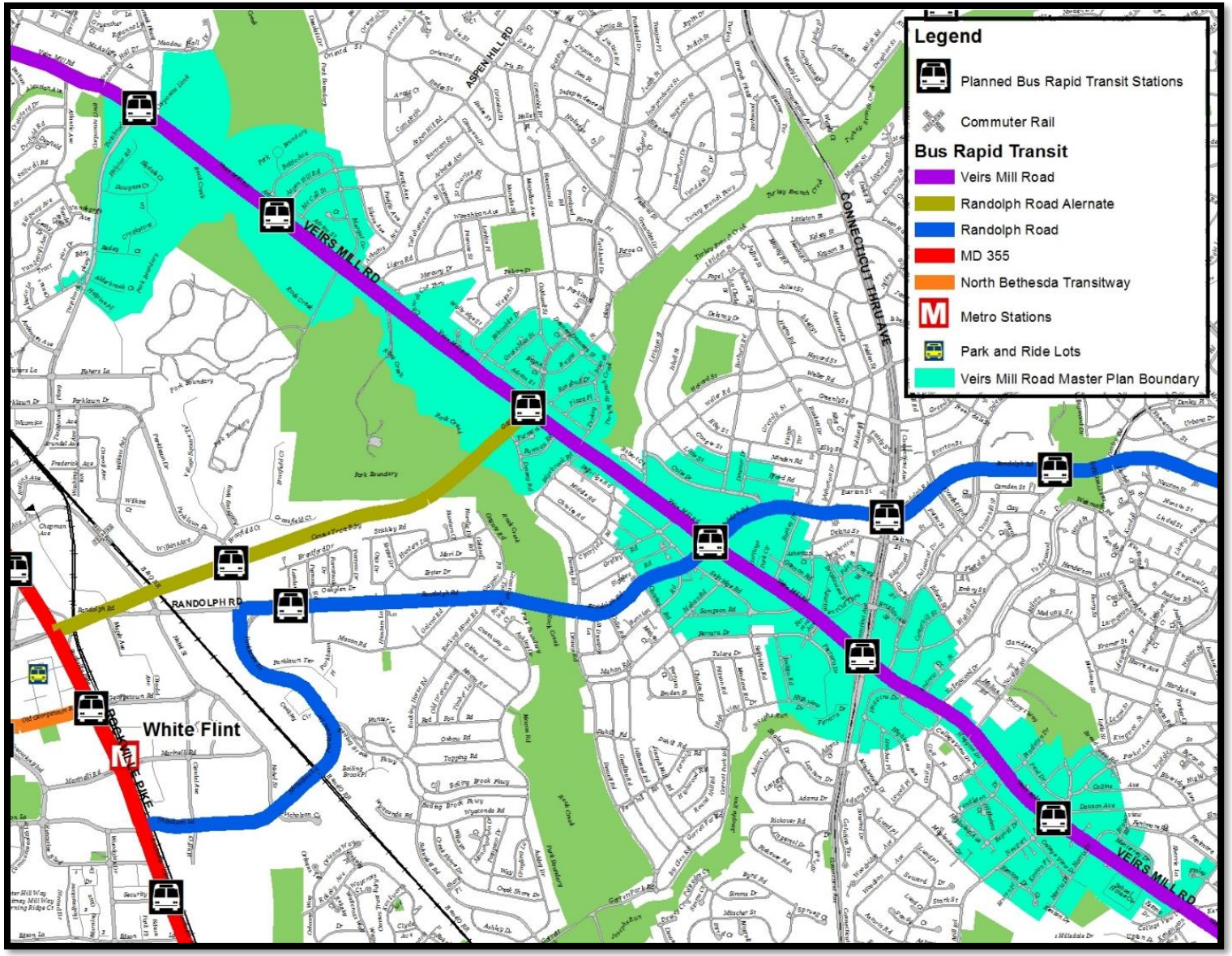


Figure 8: Master Planned Bus Rapid Transit Lines and Stations

The Countywide Transit Corridors Functional Master Plan also recommends BRT on Randolph Road to connect the major activity centers of White Flint, Glenmont, and White Oak. There are two alternative transit routes in the westernmost portion of the corridor. One alternative is in a dedicated right-of-way following the Veirs Mill Road BRT from Randolph Road to its station at Parkland Drive, then proceeding west along Montrose Parkway over Rock Creek to the White Flint Metrorail Station. The second alternative would proceed in mixed traffic along Randolph Road to the White Flint Metrorail Station via Parklawn Drive and Nicholson Lane, or Nebel Street rather than Parklawn Drive.

A 2015 MCDOT study evaluated three alternative routes to reach the BRT route terminus at the White Flint Metro Station, including Montrose Parkway to MD 355, Randolph Road to Nebel Street to Marinelli Road, and Randolph Road to Nicholson Lane to MD 355. The Randolph Road to Nebel Street to Marinelli Road route was selected as the preferred alternative with the lowest overall travel times.

NON-AUTO DRIVER MODE SHARE

The existing non-auto driver mode share (NADMS) in the Veirs Mill Corridor Master Plan area is approximately 24 percent for home-based work trips, compared to approximately 28 percent countywide. The master plan generally seeks to preserve and maintain the existing residential scale and character and recommends limited redevelopment near existing and future transit. As the redevelopment potential is limited the Veirs Mill Corridor Master Plan does not include specific NADMS goals.

However, it is important to note that the major purpose of the Veirs Mill Corridor Master Plan is to safely connect community members to transit, neighborhood uses and community facilities through improved pedestrian and bicycle infrastructure. The plan's transportation goals seek to transform Veirs Mill Road from a motor-vehicle dominated corridor to a safe, efficient and comfortable complete street that serves pedestrians, bicyclists, transit users and motorists. While the plan does not identify NADMS goals, successful implementation of the plan's recommendations will provide improved mobility which can facilitate travel by means other than single-occupancy vehicles.

TRAVEL FORECASTING – MASTER PLAN AND STUDY AREA

Figure 9 depicts the spatial relationship of the Veirs Mill Corridor Master Plan area relative to nine county policy areas. The plan boundary roughly corresponds to a 1/4-mile area around each of the planned BRT stations along Veirs Mill Road identified in the

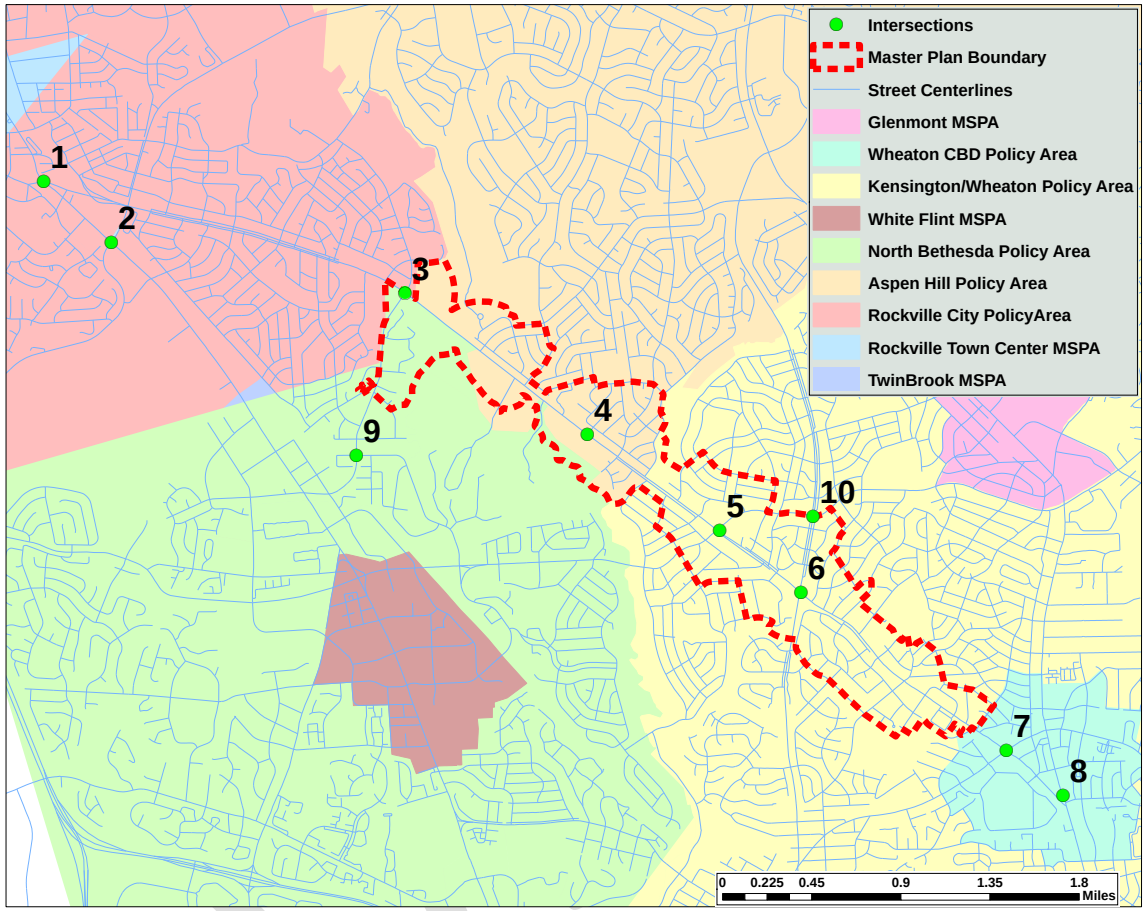


Figure 9: Relationship of Master Plan Boundary to Policy Areas and Study Area Intersections

2013 *Countywide Transit Corridors Functional Master Plan*[15]. The master plan area is primarily located within the Kensington/Wheaton and Aspen Hill policy areas. A portion of the master plan area also covers a small portion of the northeast corner of the North Bethesda policy area. The larger study area covers portions of four neighboring policy areas: Wheaton Central

[15] http://www.montgomeryplanning.org/transportation/highways/documents/countywide_transit_corridors_plan_2013-12.pdf

Business District, Rockville City, Rockville Town Center Metro Station Policy Area (MSPA), and Twinbrook MSPA. The White Flint and Glenmont MSPAs are located within close proximity to the master plan area – to the southwest and northeast, respectively.

Two major arterials, Veirs Mill Road and Connecticut Avenue (MD 185), traverse the master plan area oriented in the north/south direction. A third major arterial, Randolph Road, traverses the master plan area oriented in the east/west direction. The study area is comprised of the traffic analysis zones (TAZs) which are within and contiguous to the master plan area. The geographical definition of the master plan area is important in that it is the first step in establishing the interface between the Planning Department's regional travel demand model (Travel/4) and the subarea master-plan specific local area travel demand model (referred to as Travel/4MP[16]).

Existing Conditions Local Intersection Traffic Analysis

Using information derived from the department's intersection traffic count database (http://www.mcatlas.org/Intersections/), observed intersection turning movements at selected locations within the master plan and study areas were gathered and observed (generally reflecting existing conditions) traffic congestion at these locations was evaluated. Observed counts of vehicles, pedestrians and bicycles per 15-minute intervals (the minimum time interval unit used in traffic engineering analysis), were also collected.

Figure 9 also depicts the location of the ten intersections identified for performance evaluation. It should be noted that five intersections beyond the master plan area boundary were included in the traffic analysis, recognizing these are major intersections that serve as "gateways" to and from the master plan area.

The 2016-2020 Subdivision Staging Policy (SSP) changed the Local Area Transportation Review (LATR) test for new subdivisions and created a multimodal transportation adequacy test. The new process requires the application of the delay-based Highway Capacity Manual (HCM) methodology to evaluate the operational performance of local intersections. In addition, the new process evaluates the adequacy of transit, pedestrian and bike facilities for new development. The performance of these non-auto modes is not evaluated in the master plan context.

[16] Travel/4MP reflects a more detailed traffic analysis zone and transportation network structure relative to Travel/4.

The relevant policy area HCM delay congestion standards are used to evaluate traffic conditions for the ten study area intersections in the context of the existing conditions and alternative master plan scenarios. Table 8 shows the policy area HCM delay congestion standards used in support of the intersection performance evaluation.

Table 8. Subdivision Staging Policy Intersection Congestion Standards

Policy Area	HCM Volume-to-Capacity Standard	HCM Average Vehicle Delay Equivalent (seconds/vehicle)	Intersection IDs
Aspen Hill	*0.92*	*59*	*4*
Rockville City	*0.94*	*63*	*2, 3*
North Bethesda	*0.97*	*71*	*3*
Kensington/Wheaton	*1.00*	*80*	*5, 6, 10*
Rockville Town Center	*1.13*	*120*	*1, 2*
Wheaton CBD	*1.13*	*120*	*7, 8*
Twinbrook	*1.13*	*120*	*9*

It should be noted that two intersections are located on the boundary shared by two policy areas. Rockville Pike (MD 355) at First Street (ID 2) is located on the boundary between the Rockville City and Rockville Town Center policy areas. Veirs Mill Road (MD 586) at Twinbrook Parkway (ID 3) is located on the boundary between the Rockville City and North Bethesda policy areas. In these circumstances, county policy dictates the application of the higher congestion delay standard when evaluating intersection performance adequacy.

Table 9 summarizes the analysis results of the year 2016 (existing conditions) HCM delay during the AM and PM peak hours for 10 selected signalized intersections depicted in Figure 9. Traffic delay (measured in seconds) represents the estimated average vehicle delay for vehicles that travel through an intersection. Intersections estimated to operate at or above the congestion delay threshold reflected by the applicable policy area HCM delay standards are considered “failing” (i.e., the delay is estimated to be above the adequacy standard for the relevant policy area). The ratio of estimated HCM delay relative to the applicable policy area congestion delay standard above 1.0 represents a failing traffic condition.

Table 9. Existing Condition (Year 2016) Traffic Delay

ID	E-W Road	N-S Road	Delay Standard	AM		PM	
				Delay	Ratio	Delay	Ratio
1	Veirs Mill Rd (MD 586 / MD 28)	Rockville Pike (MD 355)	*120*	39.9	0.33	76.2	0.64
2	Rockville Pike (MD 355)	First Street	*120*	51.9	0.43	44.5	0.37
3	Veirs Mill Rd (MD 586)	Twinbrook Pkwy	*71*	77.7	1.09	75.5	1.06
4	Veirs Mill Rd (MD 586)	Robindale Rd	*59*	7.1	0.12	3.8	0.06
5	Veirs Mill Rd (MD 586)	Randolph Rd	*80*	70.1	0.88	57.1	0.71
6	Veirs Mill Rd (MD 586)	Connecticut Ave (MD 185)	*80*	74.5	0.93	103.4	1.29
7	Veirs Mill Rd (MD 586)	University Blvd (MD 193)	*120*	52.4	0.44	64.7	0.54
8	Veirs Mill Rd (MD 586)	Georgia Ave (MD 97)	*120*	27.2	0.23	25.1	0.21
9	Parklawn Dr	Twinbrook Pkwy	*120*	39.6	0.33	37.2	0.31
10	Randolph Rd	Connecticut Ave (MD 185)	*80*	84.0	1.05	87.7	1.10

Three intersections in the master plan area exhibited failing conditions during either the AM or PM, or both the AM and PM peak hour(s) of travel:

- Veirs Mill Rd (MD 586) at Twinbrook Pkwy (Intersection 3), exceeded the North Bethesda policy area congestion standard during the AM and PM peak hour of travel.
- Veirs Mill Rd (MD 586) at Connecticut Ave (MD 185) (Intersection 6), exceeded the Kensington/Wheaton policy area congestion standard during the PM peak hour of travel.
- Randolph Rd at Connecticut Ave (MD 185) (Intersection 10), exceeded the Kensington/Wheaton policy area standard during the AM and PM peak hours of travel.

Figure 10 shows the intersection level of service (LOS) “dot map” based on the ratio of estimated HCM delay and the applicable policy area delay standard during AM and PM peak period as shown above in Table 9. The colors of the dots depicted on the map is determined by the ratio between the estimated HCM delay and the relevant policy area congestion delay standard as described below. The left-hand side of the dot shows LOS during the AM peak period. The right-hand side of the dot shows LOS during the PM peak period.

- **Green**: less than 0.25
- **Yellow**: between 0.25 and 0.69
- **Orange**: between 0.69 and 1.0
- Red: greater than 1.0

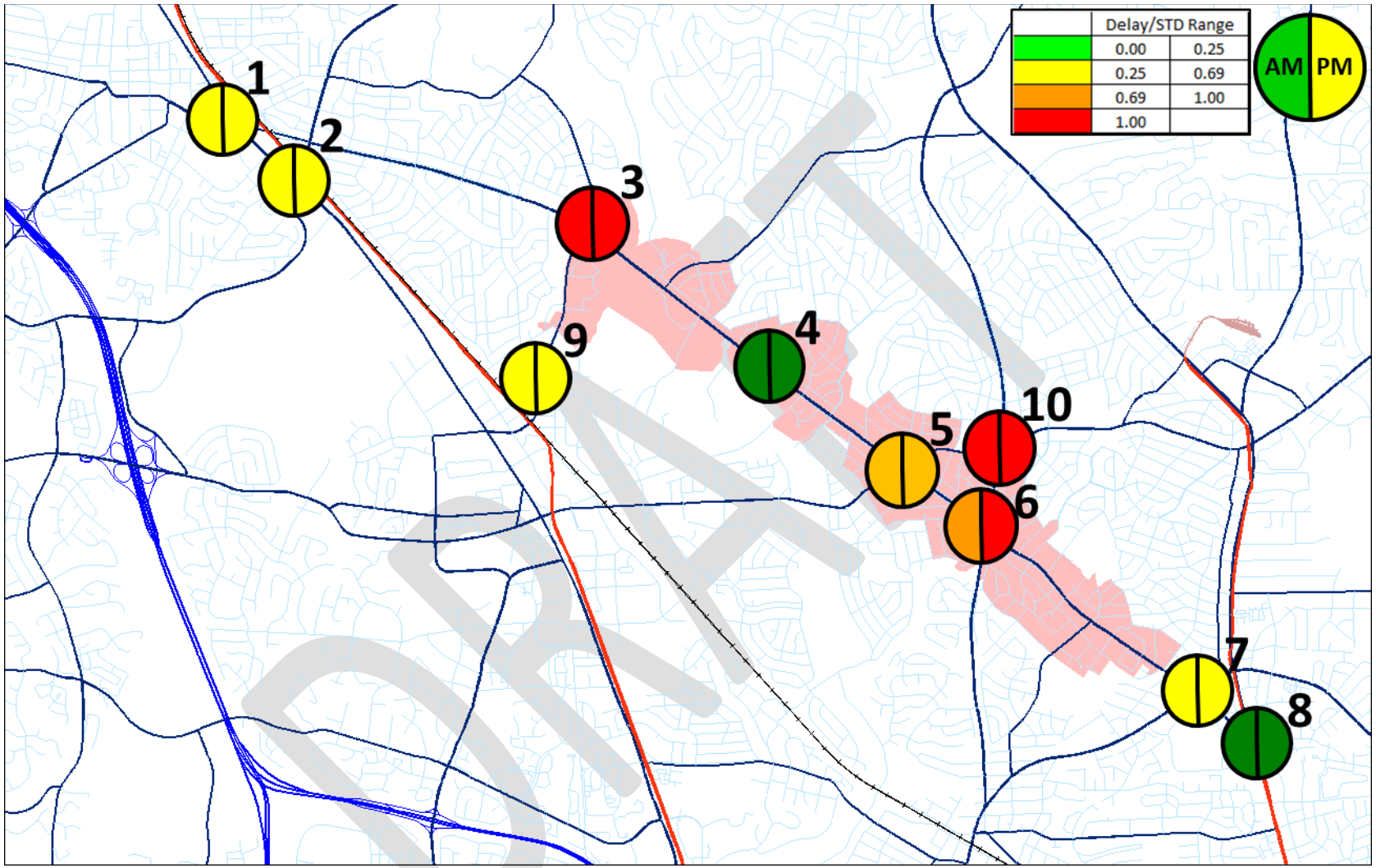


Figure 10. Traffic Congestion Scenario - Existing Traffic Condition (2016)

TRAFFIC ANALYSIS METHODOLOGY

Travel Demand Forecasting Process and Assumptions

The department's regional travel demand forecasting model, TRAVEL/4, is used to develop forecast travel demand results for weekday travel and evening peak periods. The application of Travel/4 included the validation of 2010 base-year traffic conditions and the forecast of future traffic conditions in the county and the Washington metropolitan region. Travel/4 is a traditional four-step regional travel demand model, consisting of:

- **Trip generation:** the number of person trips that are generated by given types and densities of land uses within each transportation analysis zone (TAZ).
- **Trip distribution:** how many person trips generated by each TAZ will travel to each of the other TAZs within the metropolitan area.
- **Mode split:** which mode of travel the person will use, including single-occupant auto, multiple-occupant auto, transit, or a non-motorized mode such as walking or bicycling.
- **Traffic assignment:** the roadways that will be used for vehicular travel between TAZs.

The TRAVEL/4 model incorporates land use and transportation assumptions for the metropolitan Washington region, using the same algorithms as applied by the Metropolitan Washington Council of Governments (MWCOG) regional travel demand modeling tool, Version 2.3.57.

Figure 11 shows the relationship of Montgomery County in the regional travel demand network, featuring the coding of street network characteristics to reflect the general level of adjacent development density.

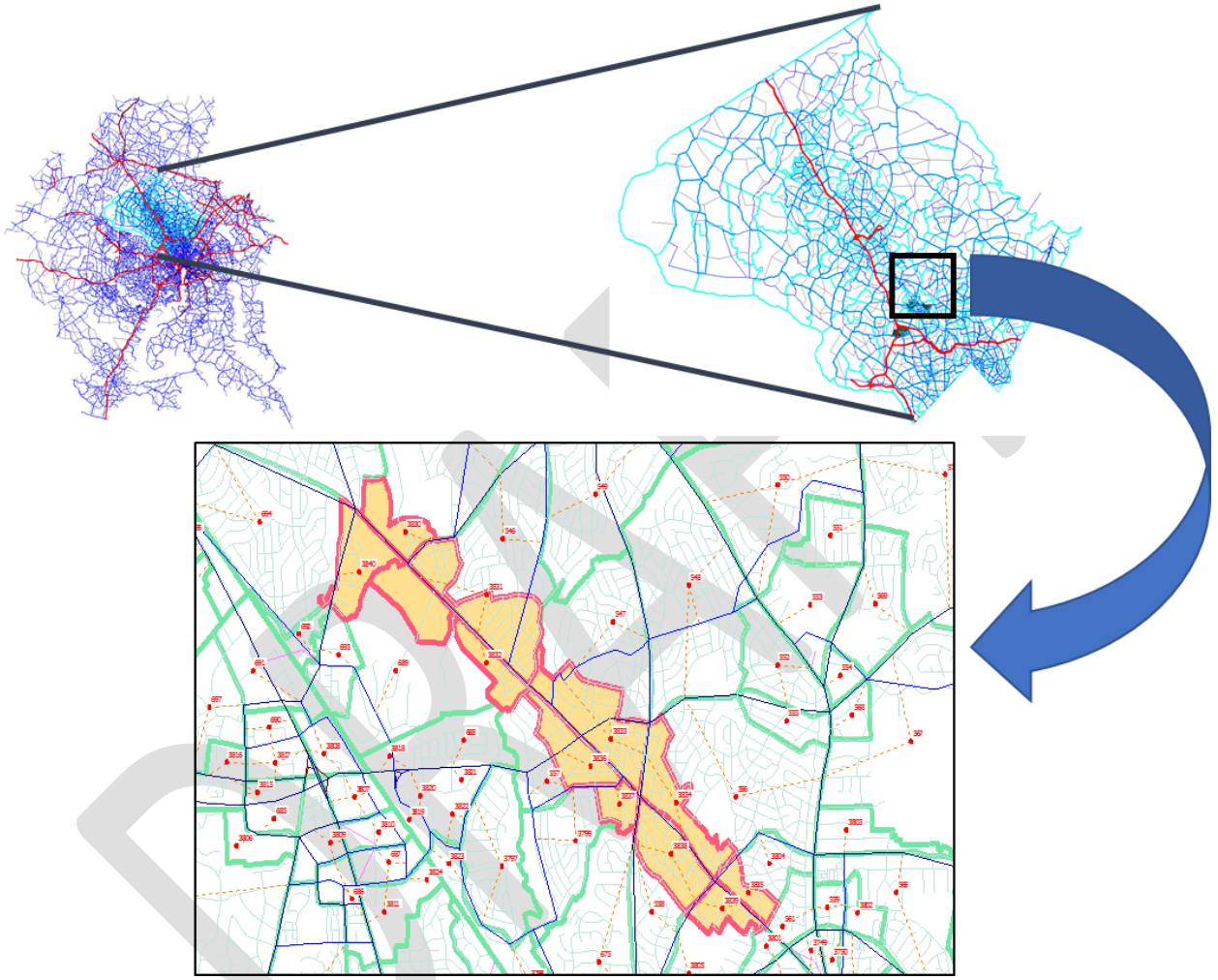


Figure 11. Study Area Network Reflected in the Travel Demand Model, Travel/4MP

Travel/4 for Countywide Traffic Analysis

Travel/4 is used to reflect countywide and regional traffic effects. This tool is an adaptation of Metropolitan Washington Council of Government's (MWCOG) regional travel demand forecasting model reflecting a more detailed transportation system network

structure coupled with refined model inputs that are compliant with the more detailed structure. In addition, a more detailed TAZ structure is incorporated into Travel/4 reflecting the expansion from 376 to 466 TAZs in Montgomery County (an increase of 90 TAZs). Consequently, this change resulted in an expansion from 3,709 TAZs reflected in the MWCOG regional travel demand model to 3,799 TAZs in Travel/4.

The baseline 2010 and 2040 future year model applications incorporated land use data from the Round 8.3 Cooperative Forecasts reflected in the MWCOG V2.3.57a regional travel demand forecasting model. Additional model run scripting enhancements were made to the model code. Aside from these specific adjustments to the network and zone structure, other inputs, such as aggregate socio-demographic data, lookup tables, and model parameters were used. When network and TAZ structures in Montgomery County area were expanded, the regional sum total of socio-demographic data (e.g., population, employment) in the model remained consistent with MWCOG Cooperative Forecasts.

The MWCOG model algorithm structure was retained in Travel/4, including the year 2020 transit constraint and two-step assignment feature for High-Occupancy Toll (HOT) lanes. Intra-step distributed processing was included in the model run applications with four sub-nodes.

Travel/4MP for Local Area Traffic Analysis

The additional model revisions described above, referred to as "Travel/4MP", were incorporated into Travel/4 in support of the traffic impact analysis of the Veirs Mill Corridor Master Plan area by applying a subarea modeling approach. Travel/4MP provides system-level results that are used as inputs to the finer grain analytic tools described below. The second level of analysis consists of post processing techniques applied to the Travel/4MP forecasts, as described in the National Cooperative Highway Research Program (NCHRP) Report 255. These techniques include refining the morning and evening peak hour forecasts to reflect a finer grain of land use and network assumptions than those included in the regional model, such as the location of local streets and localized travel demand management assumptions. The NCHRP 255 techniques are used to produce the cordon line analyses. The third level of analysis includes an evaluation of local intersection congestion, using the HCM methodologies described in the department's *2017 Local Area Transportation Review Guidelines*[17].

[17] http://montgomeryplanning.org/wp-content/uploads/2017/12/LATR-Guidelines-Production-Final_122017-PRODUCTION-WEB.pdf

Travel/4MP Model Refinements Incorporated into Travel/4

To address the limitations of applying the Travel/4 model in a subarea context, the TAZ structure in the Veirs Mill Corridor Master Plan area was expanded by block-level land use development plans. Network and centroid connectors were revised based on the expanded TAZ structure, accordingly. The Travel/4MP model represents Veirs Mill Corridor Master Plan study area as 11 TAZs based on block groupings separated by major roads within the master plan area boundary. It should be noted that the Travel/4MP model also included the subarea network and subzone TAZ system used in support of the recently adopted White Flint II Sector Plan. Figure 12 depicts the revised TAZ structure of study area in Travel/4MP. Ten TAZs in Travel/4 were disaggregated to 21 TAZs in Travel/4MP based on 21 blocks in the Veirs Mill Corridor Master Plan area. The key subarea model refinements are summarized below.

- Land use data for the new 21 TAZs were prepared for each development scenario by replacing the original land use data with new land use data pertaining to the master plan.
- Eleven TAZs (TAZ 3830-TAZ 3840) were defined within the master plan area.
- Land use data pertaining to 11 of the newly defined TAZs were split along the master plan boundary and adjusted accordingly.
- The subarea network and 14-subzone TAZ land use assumptions used in support of the White Flint II Sector Plan were assumed.
- The traffic implications of a preliminary design for a long-term BRT alternative operating in dedicated lanes along Veirs Mill Road is reflected in the traffic analysis.[18]

[18] Alternative 3 - *DRAFT Corridor Study Report* – MD 586/Veirs Mill Road Bus Rapid Transit Study, September 2016

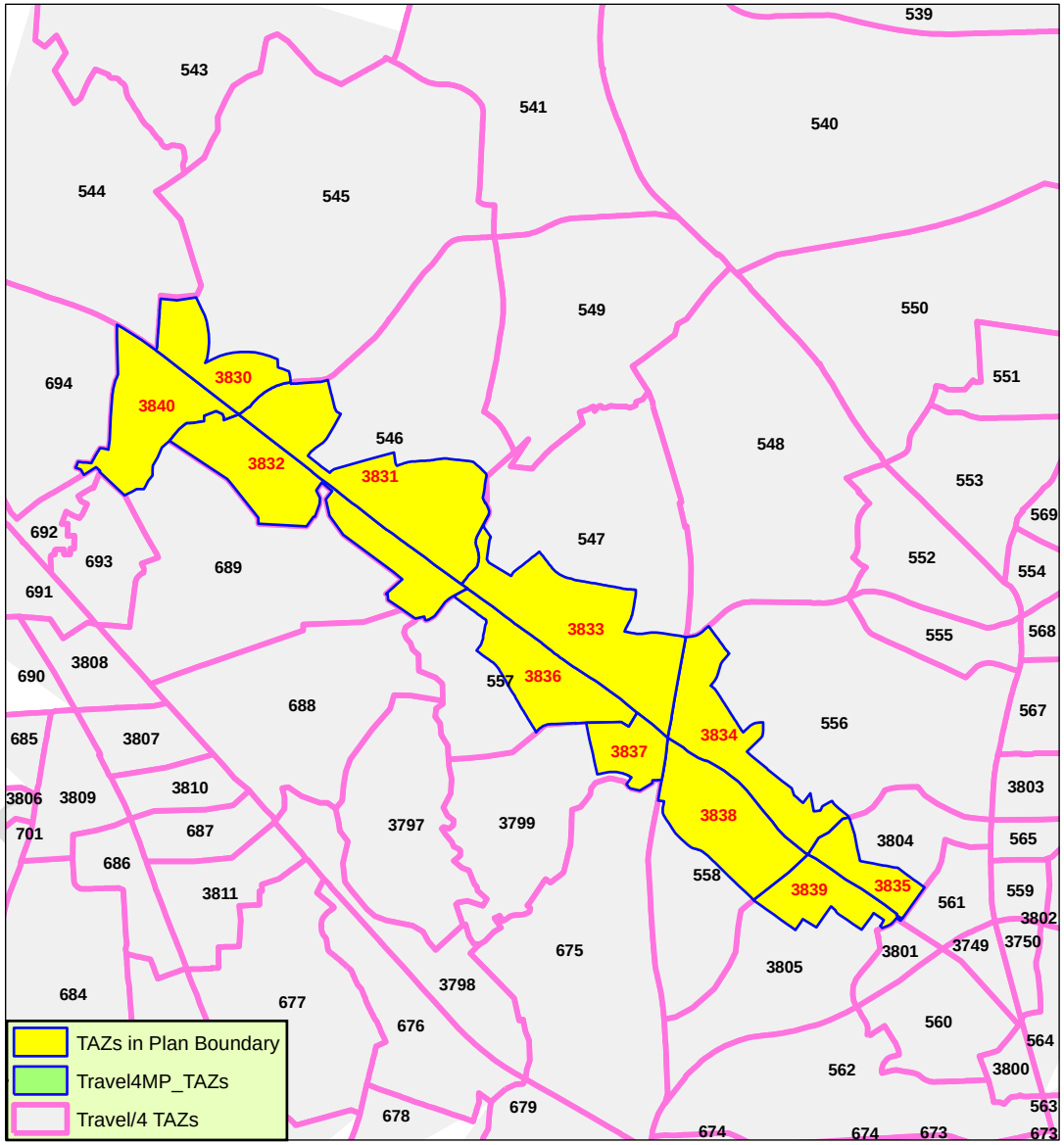


Figure 12. Traffic Analysis Zone Structure of Study Area

Master Plan Local Intersection Traffic Analysis Master Plan Scenarios

Intersection performance was evaluated within the plan study area in the context of two master plan land use/transportation network scenarios:

- No Build
- Corridor Plan (Planning Board Recommendation)

The TAZ-level land use assumptions for these scenarios are shown in Table 10 and Table 11, respectively. Th major assumptions reflected in these scenarios are briefly described below.

"No Build": 2040 Adopted Master Plan Land Use and Transportation Network

- Includes existing development, pipeline development, some additional development in the master plan area based on existing zoning and adopted White Flint II land use and transportation network recommendations.

- Includes the adopted Visualize 2045 Regional Long-Range Transportation Plan transportation network (reflecting five Montgomery County BRT lines – including dedicated land operations along Veirs Mill Road.)

Corridor Plan: 2040 Proposed Land Use by Planning Board

- Assumes the "No Build": 2040 Adopted Master Plan scenario land use and transportation network assumptions described above plus modest increment of additional development in in the master plan area based on the Planning Board Draft Plan land use recommendations.

Table 10. Land Use Inputs for 2040 "No Build" (Adopted Master Plan) Scenario

TAZ	Residential				Employment				
	Household	Household Population	Group Quarters	Total	Industrial	Retail	Office	Other	Total
3830	35	103	0	104	0	0	0	0	0
3831	552	1631	0	1633	0	0	0	92	124
3832	636	1318	0	1319	0	0	0	11	15
3833	514	1518	0	1536	0	233	380	169	790
3834	651	2135	0	2136	0	0	0	74	139
3835	162	474	0	474	0	0	0	0	0
3836	444	1599	0	1599	0	88	0	1	73
3837	120	353	0	353	0	0	94	109	186
3838	448	1583	0	1583	0	0	0	0	0
3839	196	596	0	606	0	0	0	0	0
3840	997	2258	0	2266	0	0	0	0	0

Table 11. Land Use Inputs for 2040 Veirs Mill Corridor Plan" Master Plan Scenario

TAZ	Residential				Employment				
	Household	Household Population	Group Quarters	Total	Industrial	Retail	Office	Other	Total
3830	35	103	0	104	0	0	0	0	0
3831	552	1631	0	1633	0	0	0	92	124
3832	636	1318	0	1319	0	0	0	11	15
3833	1268	3325	0	3325		605	291	98	993
3834	651	2135	0	2136	0	0	0	74	139
3835	162	474	0	474	0	0	0	0	0
3836	523	1500	0	1500	0	99	90	104	203

3837	120	353	0	353	0	0	94	109	186
3838	448	1583	0	1583	0	0	0	0	0
3839	196	596	0	606	0	0	0	0	0
3840	2251	4708	0	4708	0	100	0	0	100

Background on Modeling Assumptions

Daily traffic forecasts were estimated utilizing procedures from the *NCHRP Report 765: Analytical Travel Forecasting Approaches for Project-Level Planning and Design. NCHRP Report 255* techniques were used to convert the Travel/4MP system-level forecasts to intersection-level forecasts. In support of the travel demand modeling analysis using Travel/4MP, the following key assumptions were incorporated in the context of the 2040 horizon year traffic analysis:

- Highway and transit improvements reflected in the adopted Visualize 2045 Regional Long-Range Transportation Plan (including the five planned BRT lines in Montgomery County)
- BRT related service attributes including run time, station dwelling time, signalized intersection delay, signal prioritization option, time of day (peak vs. off-peak) were derived from the latest available GIS layers of transit data
- Adopted White Flint II Sector Plan land use and transportation network
- Beyond the plan study area, regional growth reflecting the MWCOG Round 8.3 Cooperative Forecast
- White Flint Transportation Projects
    - White Flint District West Workaround (No.501506)
    - White Flint West: Transportation (No.501116)
    - White Flint District East: Transportation (No.501204)
    - White Flint Traffic Analysis and Mitigation (No.501202)
- Montrose Parkway East
- The addition of new I-270 Spur HOV ramps on the south side of the Westlake Terrace Bridge in Rock Spring Sector Plan area

Future Conditions – Local Intersection Traffic Analysis

Consistent with other master plans, intersection performance within the plan area was also evaluated for the future. The intersection performance for the future was evaluated for a “no build” land use scenario reflecting existing zoning as well as a land use scenario reflecting the zoning recommendations discussed during Planning Board work sessions. The future conditions land use

assumptions that were analyzed included existing development, pipeline development and development anticipated based on the plan's land use and zoning recommendations.

In addition to the future conditions land use scenarios, the traffic analysis also assumed the plan's transportation recommendations that seek to increase safety, enhance connectivity and prioritize the safety of all road users consistent with Vision Zero – including some transportation recommendations that reduce intersection performance. These recommendations include: (1) bus rapid transit operating in the Veirs Mill Road right-of-way in dedicated, curb-running lanes; (2) two travel lanes along Veirs Mill Road in each direction; (3) a Veirs Mill Road target speed of 35 miles per hour; (4) reducing the number of left turn lanes to a single lane at selected intersections (where feasible)[19]; (5) implementing protected crossings, which may include full traffic signals, at selected intersections[20]; and (6) eliminating channelized right-turn lanes.

Tables 12 and 13 summarizes the AM and PM peak hour average intersection delay results of the future conditions analysis for each study area intersection in the context of the two scenarios described above. With respect to the Veirs Mill Corridor Plan scenario, the following two sets of results are reported in Tables 12 and 13 and are briefly described below:

- **2040 Veirs Mill Corridor Plan - No Mitigation:** Estimated year 2040 intersection delay results without mitigation.
- **2040 Veirs Mill Corridor Plan – Mitigated (increased standard to 100 seconds)**: Estimated year 2040 intersection delay results reflecting signal timing mitigation coupled with an assumed increase of delay standard to 100 seconds within the plan area.

Without mitigation, observation of these results indicates that unacceptable traffic congestion conditions are forecasted during the AM and/or PM peak hours of travel at the following study area intersections:

- Veirs Mill Road (MD 586) at Twinbrook Parkway
- Veirs Mill Road (MD 586) at Randolph Road
- Veirs Mill Road (MD 586) at Connecticut Avenue (MD 185)
- Connecticut Avenue (MD 185) at Randolph Road

[19] The intersections of Veirs Mill Road with the following roadways: (1) Connecticut Avenue (MD 185); (2) Randolph Road; (3) Aspen Hill Road; and (4) Twinbrook Parkway.

[20] The intersections of Veirs Mill Road with the following roadways; (1) Norris Drive; (2) Andrew Street; (3) Turkey Branch Parkway; and (4) Arbutus Avenue.

With the application of signal timing mitigation coupled with the policy assumption to increase the intersection delay standard to 100 seconds within the plan area, acceptable traffic congestion conditions can be achieved at most study area intersections. The notable exceptions are:

- Veirs Mill Road (MD 586) at Randolph Road – Forecasted delay is estimated to exceed the proposed 100 second delay standard by 15 seconds.
- Veirs Mill Road (MD 586) at Connecticut Avenue (MD 185) – Forecasted delay is estimated to marginally exceed the proposed delay standard by 1.6 seconds.
- Connecticut Avenue (MD 185) at Randolph Road – Forecasted delay is estimated to marginally exceed the proposed delay standard by 2.4 seconds.

Table 12. HCM Delay Results- 2040 Scenarios

ID	E-W Road	N-S Road	Delay Standard (seconds)	2040 No Build		2040 Veirs Mill Corridor Plan		2040 Veirs Mill Corridor Plan Mitigated **(Congestion standard increased to 100 secs in Plan Area)**	
				AM	PM	AM	PM		
1	Veirs Mill Rd (MD 586 / MD 28)	Rockville Pike (MD 355)	*120*	40.5	115.1	40.8	116.4	40.8	116.4
2	Rockville Pike (MD 355)	First Street	*120*	86.1	67.7	87.0	68.8	87.0	68.8
3	Veirs Mill Rd (MD 586)	Twinbrook Pkwy	*71*	190.9	149.6	191.6	159.1	98.2	82.0
4	Veirs Mill Rd (MD 586)	Robindale Rd	*59*	6.7	3.6	7.0	3.4	7.0	3.4
5	Veirs Mill Rd (MD 586)	Randolph Rd	*80*	124.2	87.6	122.1	88.2	115.0	75.0
6	Veirs Mill Rd (MD 586)	Connecticut Ave (MD 185)	*80*	75.6	102.9	74.7	101.6	74.7	101.6
7	Veirs Mill Rd (MD 586)	University Blvd (MD 193)	*120*	47.1	53.3	47.2	53.3	47.2	53.3
8	Veirs Mill Rd (MD 586)	Georgia Ave (MD 97)	*120*	28.1	24.6	28.1	24.8	28.1	24.8
9	Parklawn Dr	Twinbrook Pkwy	*120*	52.0	74.9	54.7	80.8	54.7	80.8
10	Randolph Rd	Connecticut Ave (MD 185)	*80*	117.9	111.7	120.4	112.7	102.4	74.0

Table 13. Ratio of HCM Delay Relative to Policy Area Congestion Standard: 2040 Scenarios

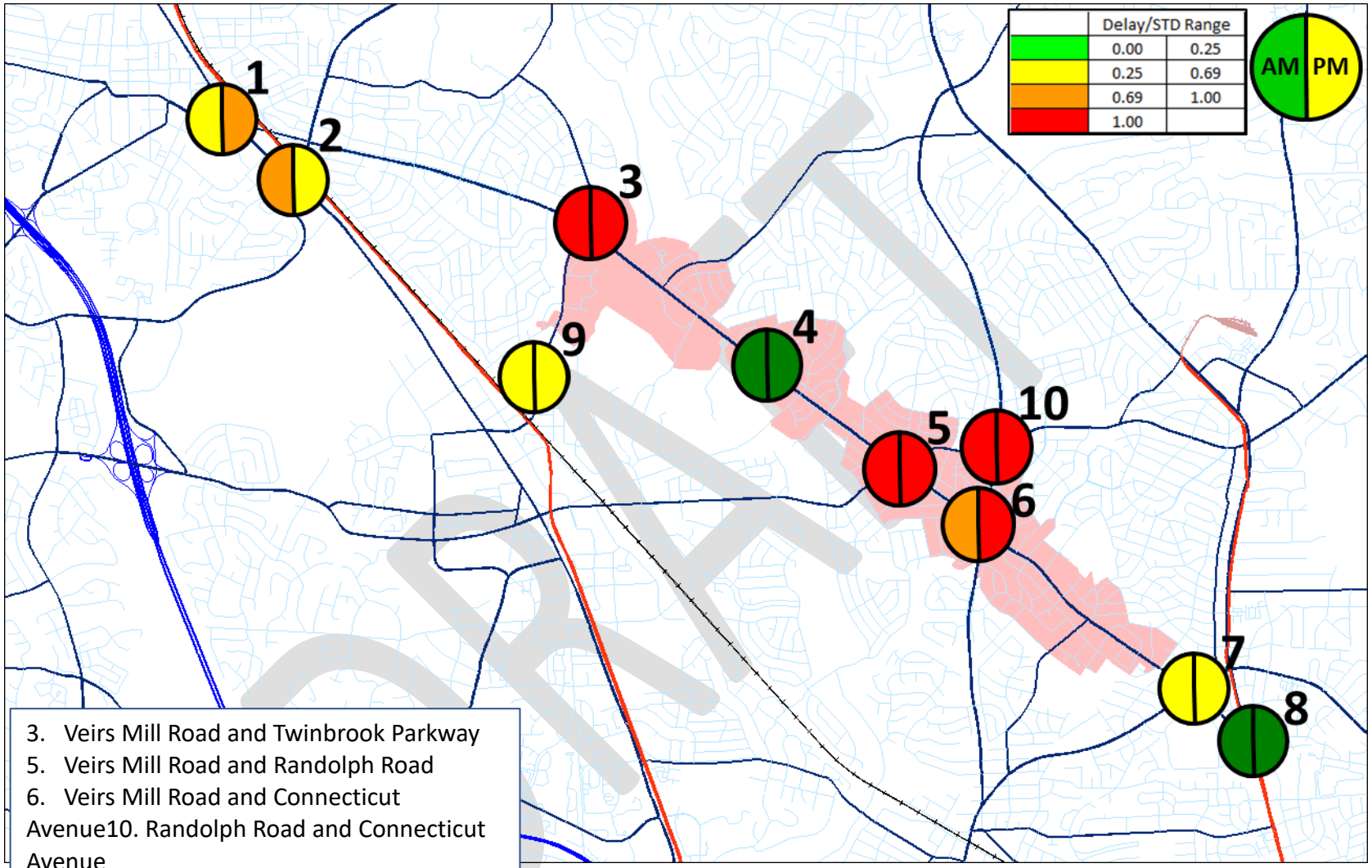
ID	E-W Road	N-S Road	Delay Standard (seconds)	2040 No Build		2040 Veirs Mill Corridor Plan		2040 Veirs Mill Corridor Plan Mitigated **(Congestion standard increased to 100 secs in Plan Area)**	
				AM	PM	AM	PM		
1	Veirs Mill Rd (MD 586 / MD 28)	Rockville Pike (MD 355)	*120*	0.34	0.96	0.34	0.97	0.34	0.97
2	Rockville Pike (MD 355)	First Street	*120*	0.72	0.56	0.73	0.57	0.73	0.59
3	Veirs Mill Rd (MD 586)	Twinbrook Pkwy	*71*	2.69	2.11	2.70	2.24	1.38	1.15
4	Veirs Mill Rd MD 586	Robindale Rd	*59*	0.11	0.06	0.12	0.06	0.12	0.06
5	Veirs Mill Rd MD 586	Randolph Rd	*80*	1.55	1.10	1.53	1.10	1.44	0.94
6	Veirs Mill Rd MD 586	Connecticut Ave (MD 185)	*80*	0.95	1.29	0.93	1.27	0.93	1.02
7	Veirs Mill Rd MD 586	University Blvd (MD 193)	*120*	0.39	0.44	0.39	0.44	0.39	0.44
8	Veirs Mill Rd MD 586	Georgia Ave (MD 97)	*120*	0.23	0.21	0.23	0.21	0.23	0.21
9	Parklawn Dr	Twinbrook Pkwy	*120*	0.43	0.62	0.46	0.67	0.46	0.67
10	Randolph Rd	Connecticut Ave (MD 185)	*80*	1.47	1.40	1.51	1.41	1.02	0.74

Figure 13 shows the 2040 No Build scenario HCM delay dot map for the ten study area intersections for both AM and PM peak periods. Comparing the 2040 No Build scenario relative to 2016 existing conditions, seven intersections reflect the same colors on the dot map even though the HCM delay ratio at these locations showed a modest increase. The three intersections showing increasing traffic delays as reflected by changes in dot map colors from yellow to orange or from orange to red based on congestion thresholds in both AM and PM peak hours are described below.

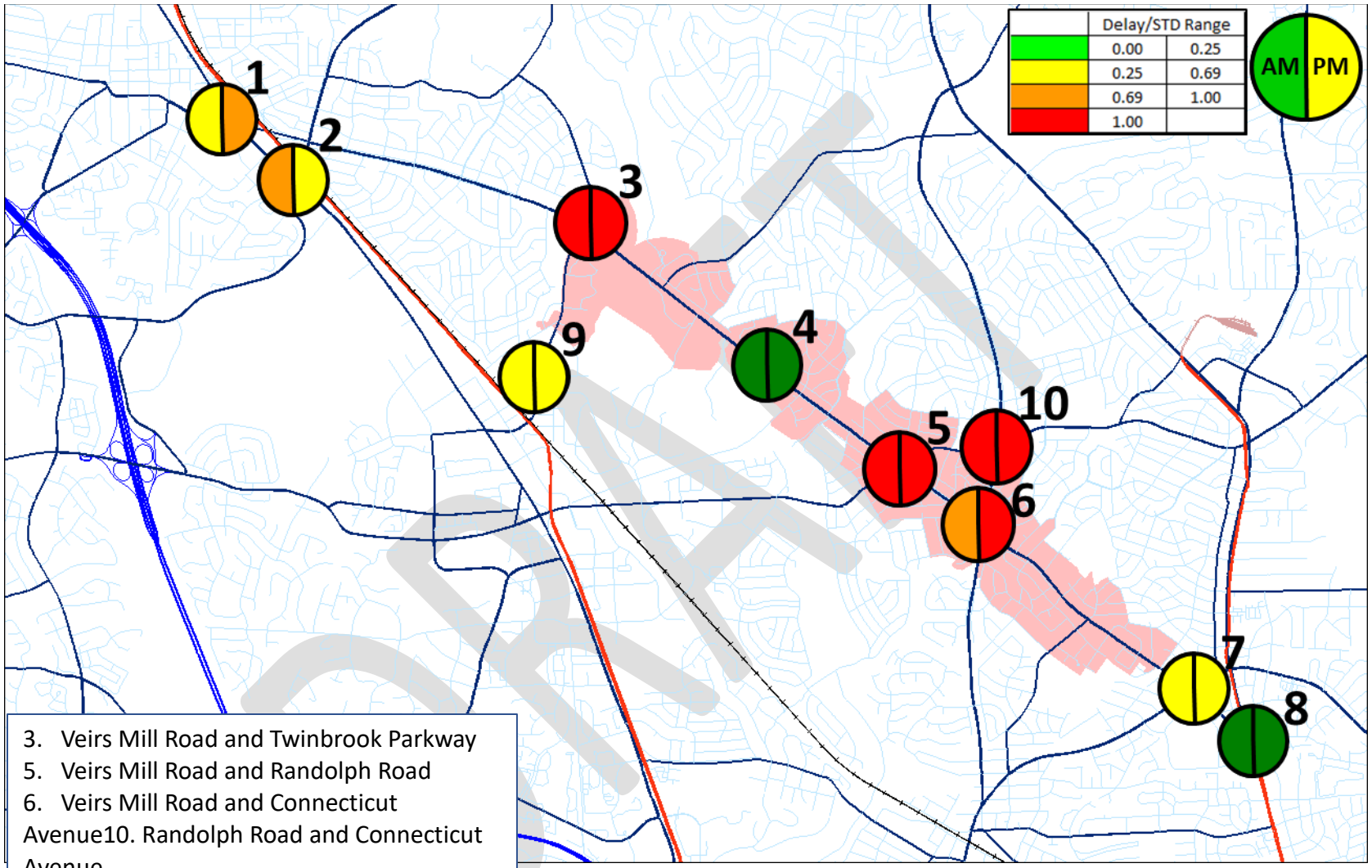
- Veirs Mill Road (MD 586 / MD 28) at Rockville Pike (MD 355) (Intersection 1): yellow to red in the PM peak hour
- Rockville Pike (MD 355) at First Street (Intersection 2): yellow to orange in the AM peak hour
- Veirs Mill Road (MD 586) at Randolph Road (Intersection 5): orange to red in the AM and PM peak hour

As shown as Figure 14, the results of the 2040 Veirs Mill Corridor Master Plan scenario are generally comparable to those described above for the 2040 No Build scenario.

In general, transportation system performance analysis results of these two scenarios showed that 2040 traffic conditions for roadways within the master plan and plan study area are forecasted to be generally similar or marginally worse relative to existing conditions. Five intersections show a HCM delay ratio greater than 0.8, indicating traffic conditions approaching or exceeding the relevant policy area congestion standard in AM and/or PM peak hour.



Traffic Condition Scenario - 2040 No Build



3. Veirs Mill Road and Twinbrook Parkway
5. Veirs Mill Road and Randolph Road
6. Veirs Mill Road and Connecticut Avenue10. Randolph Road and Connecticut Avenue

Congestion Scenario – 2040 Veirs Mill Corridor Plan

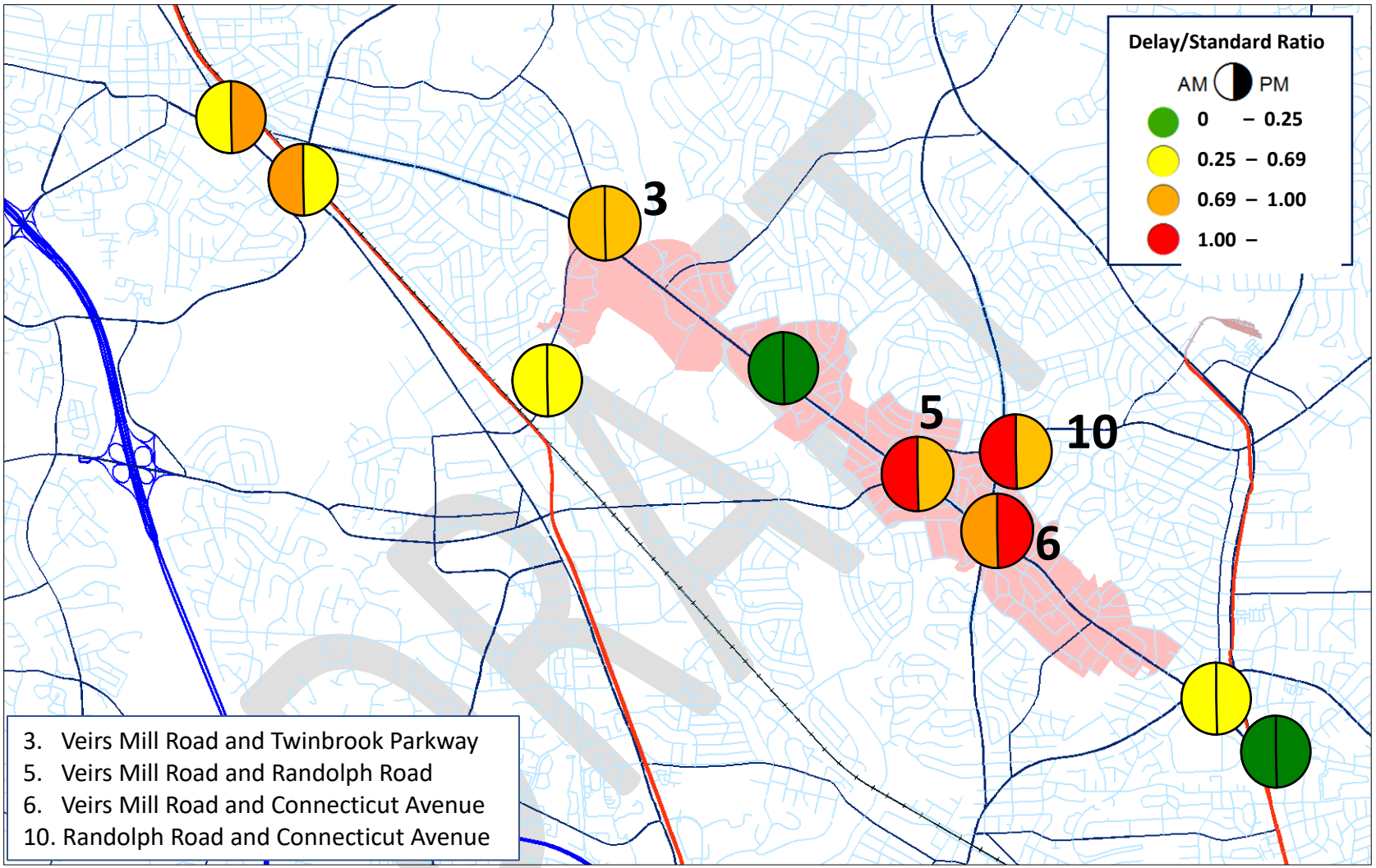


Figure 15: Traffic Congestion Scenario - 2040 Veirs Mill Corridor Plan Mitigated, Congestion Standard Increased to 100 Seconds

TRAFFIC IMPLICATIONS OF VISION ZERO RELATED RECOMMENDATIONS

While Veirs Mill Road was originally designed, constructed and operated to accommodate east-west travel by motor vehicle in a suburban context, it has evolved over the last 20 to 30 years into a heavily used transit corridor in an urbanizing area of the county. This evolution is apparent through Veirs Mill Road's designation as a bus rapid transit corridor and a Bicycle Pedestrian Priority Area in the 2013 *Countywide Transit Corridors Functional Master Plan*.

In addition to adopted plans and policies, the evolution is also apparent in the number of pedestrians and bicyclists increasingly present on and along Veirs Mill Road to access transit and other destinations. However, the plan area currently lacks basic pedestrian and bicycle facilities and experiences disproportionately high rates of pedestrian and bicycle fatalities and severe injuries in relation to the total number of person trips along Veirs Mill Road. As the use of Veirs Mill Road has evolved from motor vehicle travel to walking, bicycling and transit, it is critical to adapt to the changing character of the corridor and improve safety, walkability and connectivity for all road users, while balancing the acceptance of increased vehicular delay at signalized intersections within the plan area that are located along Veirs Mill Road.

Improving the safety of all road users is consistent with Vision Zero, an international strategy to eliminate traffic related fatalities and severe injuries, which was adopted by the County Council in 2016. The adoption of Vision Zero, just prior to the approval of the 2016 SSP, represents a significant change in County policy, as Vision Zero prioritizes the safety of all road users rather than focusing on vehicular mobility. As the first master plan to commence following the adoption of Vision Zero, the Veirs Mill Corridor Master Plan seeks to prioritize safety and asserts that increased vehicular delay is acceptable, particularly coupled with the availability of transit, as well as the pedestrian and bicycle recommendations for the plan area.

Achieving increased safety for all road users requires reducing speeds and eliminating conflicts. For example, the removal of channelized right-turn lanes decreases the speed of turning vehicles and eliminates conflicts between vehicles and pedestrians or bicyclists within the crosswalk. Further, the removal of channelized right-turn lanes and the reduction of double-left turn lanes to a single left-turn lane provides direct crossings for pedestrians and bicyclists and reduces their exposure to turning vehicles.

In previous master plans, transportation adequacy provides a higher tolerance for traffic congestion in areas with greater activity and transit service opportunities. In the context of the Veirs Mill Corridor Master Plan, the adoption of Vision Zero inevitably requires a higher tolerance for traffic congestion to achieve increased safety for all road users and to eliminate traffic related fatalities and severe injuries in line with the County's Vision Zero policy.

As mentioned above, the higher tolerance for traffic congestion can be achieved through the proposed introduction of a new traffic congestion standard for signalized intersections on multimodal transit corridors, such as Veirs Mill Road. Such a standard would increase the delay standard along Veirs Mill Road, which connects two Metro Station Policy Areas, to 100 seconds. As a high-ridership bus corridor and an emerging bus rapid transit corridor, a higher tolerance for traffic congestion should be considered. While the transit services opportunities are not commensurate with those of Metro Station Policy Areas, the transit service opportunities along multimodal transit corridors are robust and the delay standard should reflect the existing and planned services.

While the creation of a new traffic congestion standard for multimodal corridors to achieve increased safety is a new concept which has not been adopted yet, Veirs Mill is not the first master plan in which the traffic congestion standard was modified to achieve county objectives.

In the context of the 2014 *White Oak Science Gateway Master Plan,* the White Oak policy area was classified as "urban" from a policy area transportation test perspective in recognition of it being an emerging BRT area with existing high-quality local and commuter bus service along Colesville Road (US 29) and New Hampshire Avenue (MD 650). This classification allowed a higher tolerance of traffic congestion in the White Oak policy area relative to the surrounding Fairland/Colesville policy area that retained its "suburban" classification. The intent of this classification was largely to encourage economic development in the east county. While increases in traffic congestion standards are not contemplated along Veirs Mill Road to encourage economic development, such changes are contemplated to promote the objective of improved safety for all road users consistent with Vision Zero.

Traffic Evaluation Analysis Context

A major goal of the master plan is to improve safety for pedestrians, cyclists and transit users within the Veirs Mill corridor in accordance with the county's Vision Zero policy to reduce traffic-related fatalities and severe injuries. The plan also seeks to achieve a balance between land use density and transportation infrastructure by maintaining adequate transportation capacity in accordance with 2016 Subdivision Staging Policy (SSP). There is an inevitable tension between these goals that limits consideration of strategies designed to mitigate inadequate traffic conditions. These mitigation strategies are described below and conceptually depicted in Figure 16.

- **Geometric Improvements:** The addition of intersection geometric improvements (i.e., turn lanes and through lanes) conflict with the major plan to facilitate pedestrian and bike travel and improve safety for all travelers.

- **Mode Share Goals:** The consideration of mode share goals as a traffic mitigation strategy along the Veirs Mill Road travel corridor (rather than in a specific policy area or subarea) is problematic given the high proportion of through traffic over which the plan has little control, coupled with relatively limited non-auto travel options in the corridor area.

- **Traffic Redistribution/Balancing:** Traffic in the corridor is primarily served by a single major roadway, Veirs Mill Road. There is limited opportunity to assign alternative traffic routes or add new roadway connections to disperse traffic.

- **Traffic Operations/Management:** The implementation of signal timing/phasing improvements, shared lane traffic movements, and turn restrictions may be considered – as appropriate.

Figure 16. Menu of Traffic Mitigation Strategies

Synchro and Highway Capacity Manual methodologies are limited in their ability to quantify changes in capacity and/or intersection delay for many of the types of traffic calming, streetscape, and pedestrian-activated traffic calming improvements proposed in a "Vision Zero" context. Examples of these types of improvements are described below.

Midblock Pedestrian Hybrid Beacons/HAWK: These signals are only operational part time when activated on demand. The ability to coordinate these crossing maneuvers with adjacent signals limits the increases vehicular traffic delays. Furthermore, pedestrian activation makes these crossings "non-standard" in terms of signal timing plans and HCM reporting.

Pedestrian Median Refuges, Curb Extensions, and Right-Turn Channelization: In terms of vehicular traffic, reduction in curb radii and removal of channelization do not impact lane utilization and thus intersection capacity or delay.

Traffic Signal Upgrades/Minor Phasing Adjustments: High-visibility crosswalk markings, pedestrian countdown signal indicators, and Leading Pedestrian Intervals (typically 3-4 seconds) have limited effects on intersection vehicle capacity as they generally impact vehicle clearance time or start-up delays.

Challenges with Exclusive Reliance on Level of Service (LOS)

Ideally, every master plan should have a balance between its proposed land use and its proposed transportation network and services. For more than two decades this "balance" has been defined as what is needed to meet the current adequate public facilities (APF) requirements as described in the Subdivision Staging Policy (SSP). Achieving this balance in a master plan is not an academic exercise: if a plan is not balanced, then at some point in the future a proposed master-planned development will be unable to proceed because it will have no means to meet the APF requirements.

In the past quarter century there have been only two master plans adopted which did not achieve this balance. The Potomac Sub-Region Plan (most recently revised in 2002) stipulates that its two-lane roads would not be widened, except at intersections; the community is willing to accept congestion to retain its pastoral ambiance. The Council has rationalized this by recognizing that relatively little through-traffic flows on these roads, and so the future congestion would not significantly affect County residents living outside the sub-region.

The other plan is the Chevy Chase Lake Sector Plan (2013), which forecasts that three intersections will fail Local Area Transportation Review (LATR) at buildout. However, the failure will be at the margin, mainly because the Council included in the plan certain intersection improvements that would bring the sector plan area much closer to passing LATR at buildout.

According to the adopted 2016-2020 SSP, the congestion standard for signalized intersections in county policy areas is based on volume/capacity ratio (using the Highway Capacity Manual method), which translates to an average vehicle delay measured in seconds/vehicle (s/v) and equivalent level of service (LOS) for automobile travel.

To determine whether or not a master plan is in balance, the Council has applied the current SSP transportation test, but using a long-term time frame. This test consists of a Local Area Transportation Review (LATR) analysis reflecting a master plan buildout time horizon that evaluates the traffic generated by the buildout of planned development on a network that assumes certain intersection improvements.

The concept of LOS has been used by traffic and transportation engineers for over 50 years to describe operating conditions for automobile travel on existing or planned roads. LOS is most commonly measured using average vehicle delay at an intersection. It is expressed as a letter grade, ranging from LOS A to LOS F, where LOS A represents completely free-flow conditions, LOS E represents capacity conditions, and LOS F represents over-capacity conditions with considerable delay (Table 14).

This report-card grading is based on a driver's perspective and the notion that delay is to be minimized. The grading ignores intersection performance from the perspective of other users such as people who walk, people who bicycle and people that take transit. Further, LOS grades below LOS E also represent a low level of utilization, which normally would constitute a poor rating for public infrastructure. Many cities have adopted policies to maintain LOS D or better conditions during peak hours, based on guidance from *A Policy on Geometric Design of Highways and Streets* (American Association of State Highway and Transportation Officials 2011) and other sources.

Table 14: Equivalency Between LOS and Average Vehicle Delay

HCM LOS Threshold/ Boundary	Corresponding Average Vehicle Delay per HCM (seconds)	Description
A / B	10	Operations with very slight delay, with no approach phase fully utilized.
B / C	20	Operations with slight delay, with occasional full utilization of approach phase.
C / D	35	Operations with moderate delay. Individual cycle failures begin to appear.
D / E	55	Operations with heavier, but frequently tolerable delay. Many vehicles stop, and individual cycle failures are noticeable.
E / F	80	Operations with very high delays and congestion volumes vary widely depending on downstream queue conditions.
n/a	120	Operations with extremely high delays and congestion volumes vary widely depending on downstream queue conditions.

LOS can be a very useful and effective metric for designing infrastructure and understanding the consequences *to automobile traffic* of planning and design decisions. However, that is generally the extent of its utility. It does not help to inform us about a number of other factors that are important such as the availability of and access to other modes of travel and potential impacts to safety for all road users resulting from increased vehicular speeds and infrastructure design that prioritizes motor vehicle travel. The Veirs Mill Corridor Master Plan seeks to provide safe and efficient travel for all transportation modes and the LOS metric does not consider operations or conditions for other modes of transportation, including walking, bicycling and transit use.

Appendix D:

Demographics & Employment

Veirs Mill Demographics and Employment

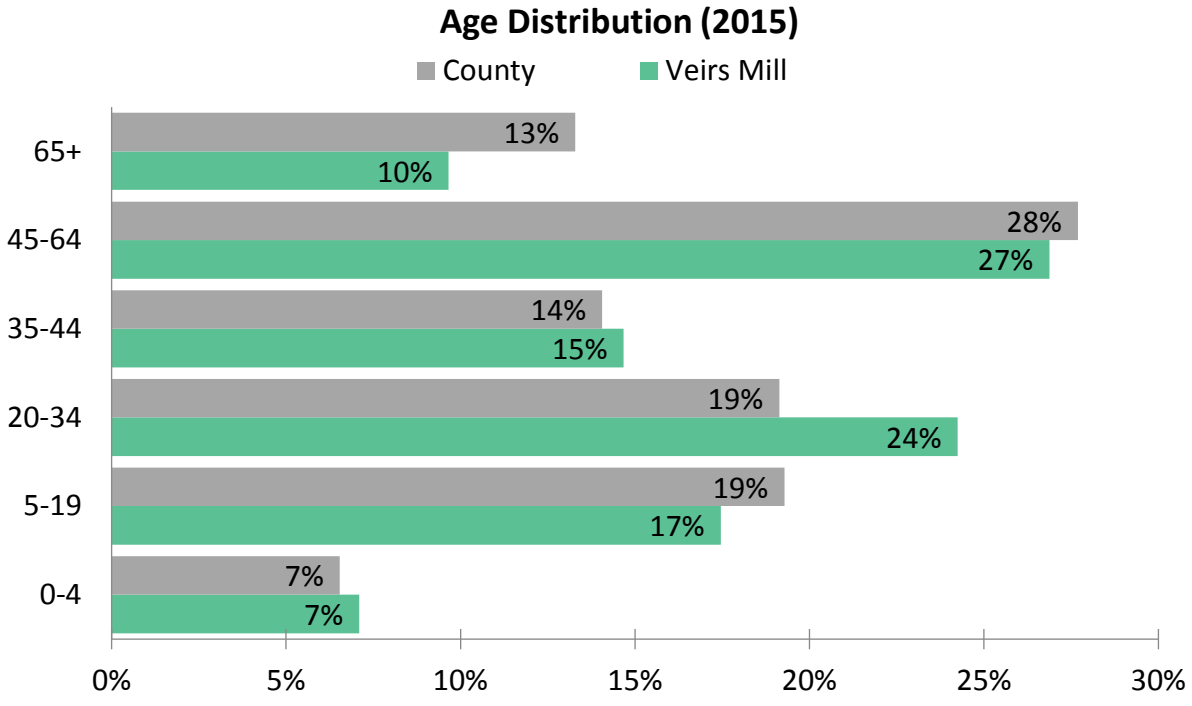
Prepared by: Pamela Zorich and Caroline McCarthy, Montgomery County Planning Department, Research and Special Projects

DEMOGRAPHICS

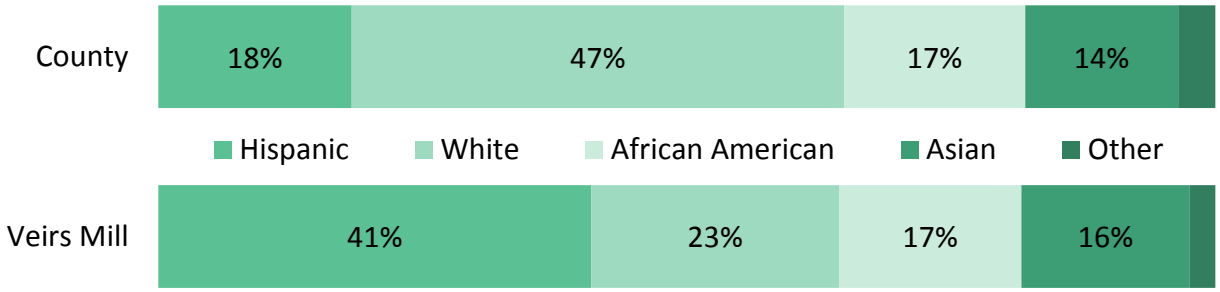
The Veirs Mill Corridor Master Plan area is a racially and ethnically diverse community. Nearly 75 percent of the residents are African American, Asian or Hispanic. Hispanic or Latino residents represent the greatest percentage (41 percent), followed by African American residents (17 percent) and Asian residents (16 percent). Over half of the local residents are foreign born compared to a third of the population countywide. Two out of three residents speak a language other than English at home, with Spanish as the predominant language (39 percent).

The average household income within the plan area is approximately $82,000, about three-fifths of the County average of $133,500. Approximately one-third of the households have incomes below $50,000, and nearly three-quarters have incomes below $100,000. In comparison, approximately one-quarter of County households have incomes below $50,000 and half have incomes below $100,000. The lower household incomes are likely due to a higher percentage of young adults and lower educational attainment when compared with the County. One-third of local residents age 25 and older have a bachelor's or advanced degree compared to 58 percent countywide.

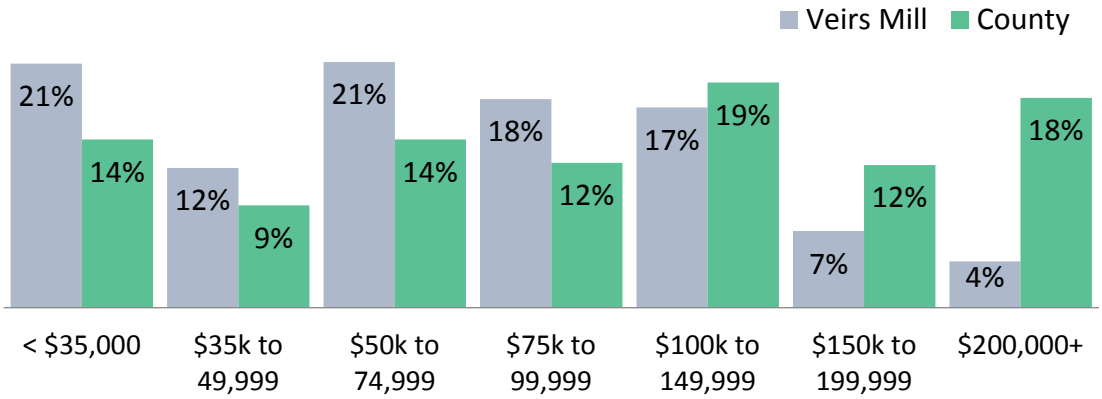
Nearly 25 percent of employed residents in the plan area utilize public transportation to commute to work, compared to 16 percent of County residents. While over 70 percent of residents drive to work, another 14 percent participate in carpools, compared to 10 percent of County residents.



Race and Hispanic Origin (2015)



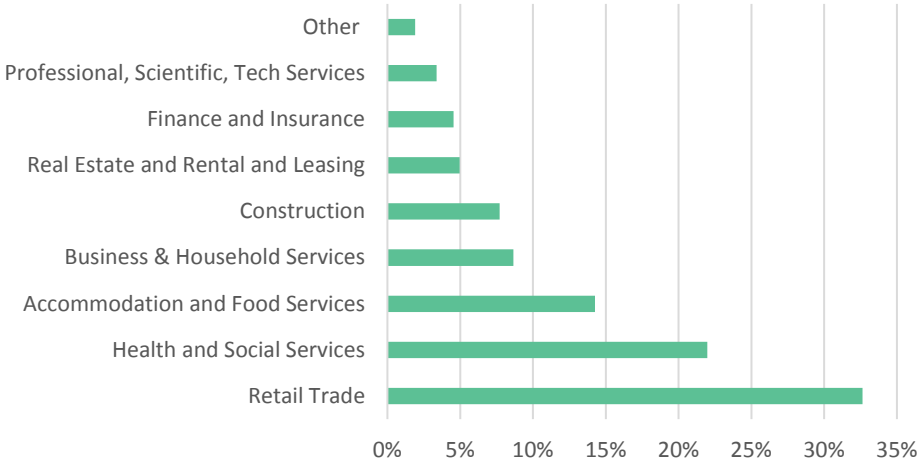
Household Income (2015)



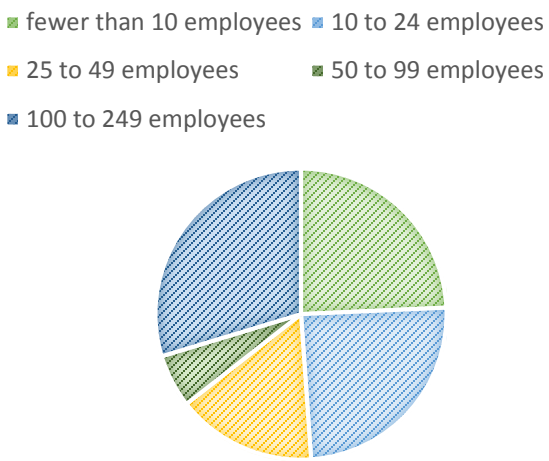
EMPLOYMENT

According to the Maryland Department of Labor, Licensing and Regulation, there are approximately 122 establishments, which provide approximately 1,000 jobs in the Veirs Mill Corridor Master Plan area, most of which are private sector. Nearly all of the establishments (94 percent) employ fewer than 25 employees, with 81 percent of the establishments employing fewer than 10 employees. The predominate industries within the plan area are retail; health and social services; and accommodation and food services. The predominate employers are Randolph Hills Nursing Home, Unique Thrift, Burger King, La Baguette de Paris and Korean Korner.

Jobs by Industry



WORKPLACE SIZE



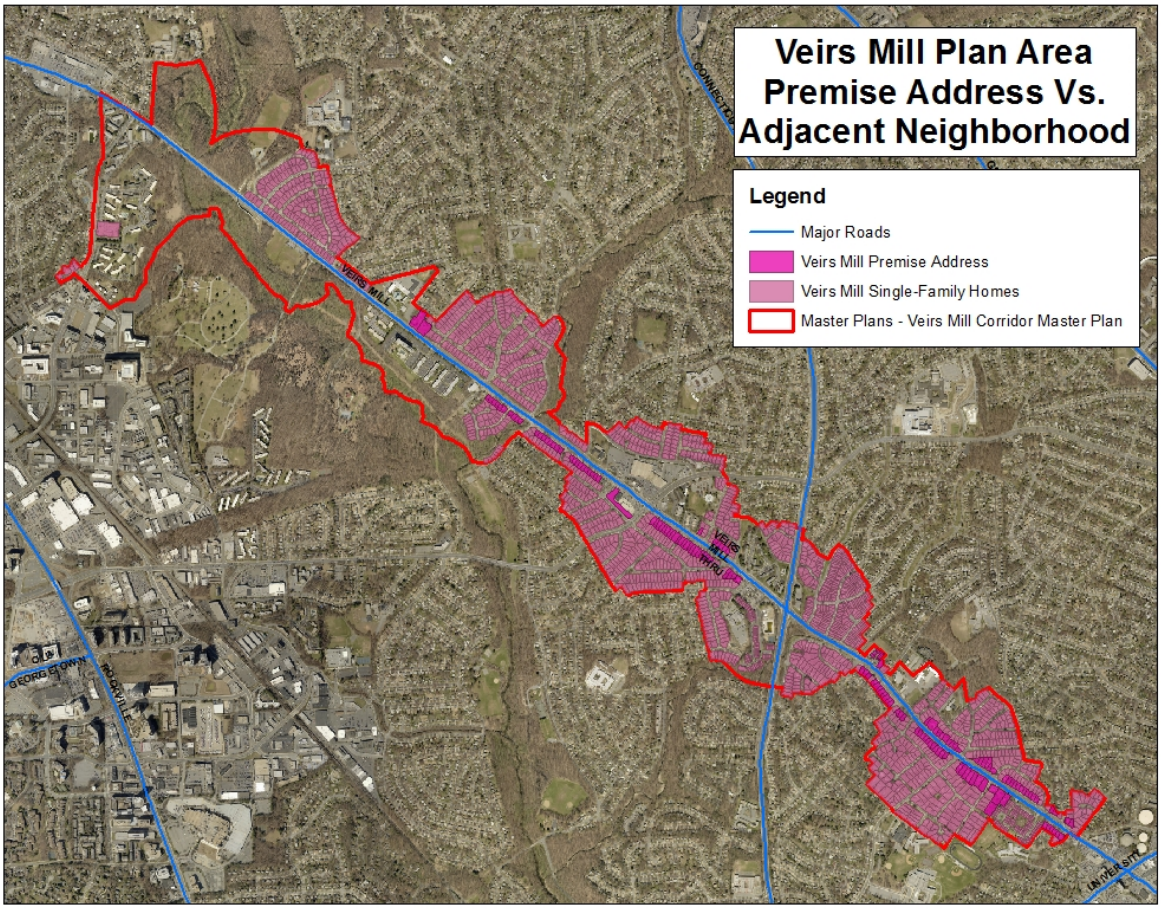
Appendix E:

Housing Analysis

Veirs Mill Housing Analysis

Prepared by: Lisa Govoni, Lisa.Govoni@montgomeryplanning.org, Montgomery County Planning Department, Research and Special Projects

Single-family Homes



Value of Homes on Veirs Mill Versus Adjacent Neighborhoods

In the Veirs Mill Corridor Master Plan area, single-family detached homes and attached homes with the premise address of "Veirs Mill Road" have a lower median land assessment, improvement assessment and median sales price, and take longer to sell by about 15 months than houses in adjacent neighborhoods.

For single-family attached and detached homes with a premise address of "Veirs Mill Road," the median land assessment is $156,400. This evaluation is $7,050 lower, or 5 percent lower, than homes without a "Veirs Mill Road" premise address. For the median improvement assessment, homes with a premise address of "Veirs Mill Road" have a median assessment of $120,500, a value difference of $16,500 and a percent change of 14 percent.

The median sales price for homes with a premise address of "Veirs Mill Road" is $222,250, a difference of $27,750 or 12 percent lower than homes located without a premise address of "Veirs Mill Road." Homes without a premise address of "Veirs Mill Road" also had a more recent sale date by almost 15 months.

Table 1 – Veirs Mill Vs. Adjacent Neighborhoods Value

	On Veirs Mill	Off Veirs Mill	Value Difference	Percent Change
Median Land Assessment	$156,400	$163,450	$7,050	5%
Median Improvement Assessment	$120,500	$137,000	$16,500	14%
Median Sales Price	$222,250	$250,000	$27,750	12%
Median Sales Date	11/24/2004	2/21/2006		

Source: SDAT

Single-Family Homes Rented

In the Veirs Mill Corridor Master Plan area, rented single-family attached or detached homes represent 17 percent of homes. This percentage is slightly higher than the countywide average of 13 percent of single-family attached or detached homes rented.

Table 2 – Veirs Mill Single Family Homes Rented

	Veirs Mill Plan Area	Montgomery County
Single-Family Homes Rented	17%	13%

Source: SDAT

Gross Floor Area

Gross floor area is the total amount of floor space in a building, including the external walls, and excluding the roof. In the Veirs Mill Corridor Master Plan area, the median gross square footage for a single-family dwelling is 1,128 square feet. The Montgomery County median is 1,767, a difference of 639 square feet, or 36 percent larger.

Table 3 – Gross Floor Area

	Veirs Mill Plan Area	Montgomery County
Median Gross Floor Area	1,128	1,767

Multifamily Homes

The Veirs Mill Corridor Master Plan has five multifamily rental developments, four of which are garden style (low-rise), one of which has both a high-rise and a garden-style facility on the premises. The facilities are on average 47 years old. All facilities in the plan area have vacancy rates under 5 percent.

Table 3 – Veirs Mill Current Conditions

NAME	ADDRESS	CITY	STRUCTURE TYPE	BUILDING AGE	VACANCY
HALPINE HAMLET	5501 Halpine Pl	Rockville	Garden	50	3.0%
HALPINE VIEW	13013 Crookston LA	Rockville	Garden	50	1.8%
PARKWAY WOODS	12933 Twinbrook Pkwy	Rockville	Garden	35	4.2%
ROCK CREEK TERRACE	12630 Veirs Mill Rd	Rockville	Garden/High -Rise	45	3.0%
ROCK CREEK WOODS	13206 Twinbrook Pkwy	Rockville	Garden	49	1.9%
VILLAGE SQUARE WHEATON	12011 Veirs Mill RD	Wheaton	Garden	53	3.7%

Source: 2016 DHCA Rental Housing Survey, 2017 CoStar

Veirs Mill's multifamily rental housing stock currently contains 1,613 units. More than half (53 percent) of the units in the plan area are 2-bedroom units. Thirty-one percent are 1-bedroom units, 16 percent are 3-bedroom units, 2 percent are efficiencies and 0.4 percent are 4-bedroom units. Due to the age of the structures, none of the units in the plan area are moderately priced dwelling units (MPDUs). Landlords of two facilities note that they accept federal or state subsidies for low-income tenants, but the Montgomery County Department of Housing and Community Affairs (DHCA) does not identify units by subsidy.

Table 4 – Veirs Mill Current Units

NAME	SUBSIDY PROGRAM*	EFFICIENCIES	1-BEDROOMS	2-BEDROOMS	3-BEDROOMS	4-BEDROOMS	TOTAL UNITS
HALPINE HAMLET	OTH		26	41			67
HALPINE VIEW		16	241	250	57		564
PARKWAY WOODS	PH			9	9	6	24
ROCK CREEK TERRACE	S8		138	256	132		526
ROCK CREEK WOODS	OTH OV	18	72	160	19		269
VILLAGE SQUARE WHEATON			30	102	31		163
TOTAL		**34 (2%)**	**507 (31%)**	**818 (53%)**	**248 (16%)**	**6(0.4%)**	**1613**

*The DHCA Rental Housing Survey does not identify the units by subsidy. Facilities are only asked what types of subsidies are accepted.

Source: 2016 DHCA Rental Housing Survey, CoStar

Of the five multifamily buildings within the plan area, all are market-rate affordable, meaning they are generally affordable to households earning at or below 80 percent AMI.[1] [2]

Table 5 – Veirs Mill Affordability Conditions

NAME	EFFICIENCY AVG RENT	AMI	1-BEDROOM AVG RENT	AMI	2-BEDROOM AVG RENT	AMI	3-BEDROOM AVG RENT	AMI	4-BEDROOM AVG RENT	AMI
HALPINE HAMLET			$1,095	52%	$1,250	55%				
HALPINE VIEW	$995	52%	$1,262	60%	$1,456.50	65%	$1,733.50	64%		
PARKWAY WOODS					$809	36%	$1,027	38%	$1,523	53%
ROCK CREEK TERRACE			$1,069	51%	$1,211	54%	$1,601	59%		
ROCK CREEK WOODS	$1,028.50	54%	1,279	61%	$1,500	67%	$ 1,729	63%		
VILLAGE SQUARE WHEATON			$1,437	69%	$1,646.50	73%	$ 1,942	71%		

Source: 2016 DHCA Rental Housing Survey, CoStar

[1] For a detailed breakdown on the Planning Department's affordability assumptions and affordable housing definitions, see the attached "Appendix-Affordable Rental Housing Methodology."

[2] Area median income (AMI) limits are set by the U.S. Department of Housing and Urban Development (HUD) across metropolitan regions to measure housing affordability. These AMI levels are often used to measure target income levels for federal, state and local housing programs and subsidies.

Affordable Housing Methodology

In order to determine affordability, households are first categorized by their income relative to the area median income (AMI). AMI is adjusted for household size. Low-to-moderate income households are those earning up to 65 percent of AMI. The income limits in the table below are based on income requirements for Montgomery County's moderately priced dwelling unit (MPDU) program and United States Department of Housing and Urban Development (HUD) standards.

Table 1 - 2016 Income Limits

HOUSEHOLD SIZE	65% AMI	80% AMI (MARKET RATE AFFORDABLE)	100% AMI (MEDIAN)	120% AMI
1	49,400	60,800	76,000	91,200
2	56,485	69,520	86,900	104,280
3	63,505	78,160	97,700	177,240
4	70,590	86,880	108,600	130,320
5	76,245	93,840	117,300	140,760

Source: Montgomery County DHCA, HUD

Rather than just counting the number of low-to-moderate income households, the number of rental units affordable to those households are counted to understand the inventory of low-cost housing. Households of different sizes will have different needs with respect to bedrooms. And households of the same size will even have different bedroom needs. For example, two unrelated adults would require two bedrooms, while a married couple typically would need one.

The following table provides the Planning Department's standard assumptions regarding the distribution of household sizes by number of bedrooms. (Note: HUD typically accepts no more than 2 persons per bedroom for HUD-funded projects, while other programs use a standard of 1.5 persons per bedroom. HUD programs do not allow more bedrooms than persons per unit.)

Table 2 – Household-Size Distribution by Number of Bedrooms

	NUMBER OF BEDROOMS				
HOUSEHOLD SIZE	**Efficiency**	**1**	**2**	**3**	**4**
1	100%	30%			
2		70%	10%		
3			60%	20%	
4			30%	50%	40%
5				30%	60%

Income limits by number of bedrooms can be estimated based on the two tables of household income limits and assumptions about the distribution of household sizes by the number of bedrooms. This calculation is a weighted average of household income limits for each bedroom size. For example, for 1-bedroom units occupied by households up to 65 percent of AMI, the maximum weighted income is .3 x $49,400 + .7 x $56,485 = $ 54,360.

Table 3 – Income Limits by Number of Bedrooms

# OF BEDROOMS	65% AMI	80% AMI	100% AMI	120% AMI
0	$48,685	$60,800	$76,000	$91,200
1	$54,360	$66,904	$83,630	$100,356
2	$58,578	$75,568	$90,120	$138,144
3	$70,870	$84,264	$109,030	$142,836
4	$73,983	$91,752	$113,820	$136,584

"Affordable" housing is defined as costing no more than 25 percent of household income, if utilities are not included, or 30 percent of household income if utilities are included. This definition is similar to the rent requirements for MPDUs set by the County Department of Housing and Community Affairs (DHCA). The maximum affordable rent by number of bedrooms is listed below.

Table 4 – Affordable Limits at 30 Percent of Income

# OF BEDROOMS	65% AMI	80% AMI	100% AMI	120% AMI	FMR
0	$1,235	$1,520	$1,900	$2,280	$1,307
1	$1,359	$1,673	$2,091	$2,509	$1,402
2	$1,464	$1,889	$2,253	$3,454	$1,623
3	$1,772	$2,107	$2,726	$3,571	$2,144
4	$1,850	$2,294	$2,846	$3,415	$2,726

Table 5 – Affordable Limits at 25 Percent of Income

# OF BEDROOMS	65% AMI	80% AMI	100% AMI	120% AMI
0	$1,029	$1,267	$1,583	$1,900
1	$1,132	$1,394	$1,742	$2,091
2	$1,220	$1,574	$1,878	$2,878
3	$1,476	$1,756	$2,271	$2,976
4	$1,541	$1,912	$2,371	$2,846

Affordable Housing Definitions:

Income-Restricted Affordable Housing: A moderately priced dwelling unit (MPDU) or a dwelling unit built under government regulation or binding agreement requiring the unit be affordable to households at or below the income eligibility for the MPDU program.

Income-Restricted Workforce Housing: Chapter 25B of the Montgomery County Code defines housing that is affordable to households at or below 120 percent of area median income (AMI). When a master plan refers to workforce housing as a part of its affordable housing goals or requirements, incomes are limited to 100 percent of AMI.

Market Rate Affordable Housing. Market rate affordable dwelling units are affordable to households earning no more than 80 percent of area median income, adjusted as MPDUs for household and unit size, and must not exceed the median rent for the planning area.

Rent-Restricted Affordable Housing: This term is not currently defined in the County Code or commonly used, but appears to be the best term to describe housing where rent increases will be limited and there is no income test for the tenant. The preservation of market rate affordable housing may require an agreement that both establishes the baseline rent (priced to be affordable at 80 percent of AMI) and rent restrictions (such as requiring that rents increase only according to the Voluntary Rent Guideline.)

Appendix F:
Archaeology

Appendix - Archaeology Summary

In 1838, Samuel Clark Veirs constructed a mill on Rock Creek along the south side of the one-lane Rockville Turnpike (today's Veirs Mill Road). By 1927, the mill was no longer operational, and a 1937 *State Roads Commission* plat indicated only a "stone foundation of Veirs Mill."

The former mill site was somewhere within the present-day Rock Creek Stream Valley Park. Historic maps place the mill east of the turnpike's intersection with a northerly road, no longer in existence, that traversed the current parkland. Investigation into the location of the mill structure was undertaken as part of the Veirs Mill Corridor Master Plan, including documentary research and field testing.

Review of background research did not provide a clear indication of the original location of the Veirs Mill or nearby structures. Historic files referenced include: 1865 Martenet and Bond; 1878 Hopkins; 1908, 1923 and 1944 United States Geological Survey quadrangles; and aerials from 1951, 1970, 1979, 1993, 1994, 2008, and 2012; as well as Maryland State Highway Administration (SHA) as-built plans from 1953 and 1970.

While the structure is known to have been located somewhere near the intersection of Veirs Mill Road and Aspen Hill Road, there is significant discrepancy about the exact location. The alignment and width of both Veirs Mill Road and Aspen Hill Road, as well as the watercourse of Rock Creek, have all been altered over the last century, making comparisons of historic and present-day locations approximate.

As noted in SHA's correspondence with the Maryland Historical Trust in 2002, "…It is not possible to determine with precision what, if any, changes have occurred in the actual alignments of each road though time." In addition, both natural and cultural forces have modified Rock Creek, including the construction of the mill race which appears to have obscured the depiction of the course of Rock Creek on some historic maps.

Due to these discrepancies, historic maps show conflicting locations of Veirs Mill in relation to the intersection of Veirs Mill Road and Aspen Hill Road. It is variously shown at the intersection of the two roads, or slightly northwest or slightly southeast of it. A 1934 *State Roads* plat shows one foundation labeled "stone foundation of Veirs Mill" approximately 200 feet northwest of the intersection with Aspen Hill Road, although the exact location is difficult to determine given the modifications to both roadways and the sparse information on the plat.

Review of aerials shows the parkland south of Veirs Mill Road remained largely forested, except for a clearing shown in 1951 just southeast of where Rock Creek passes under Veirs Mill Road and is a potential location for the mill. The 1994 aerial shows construction activity immediately adjacent to Veirs Mill Road along the south side. By 2012, a hiker-biker bridge over Veirs Mill Road was constructed in almost the same area

as the 1994 work. The Facility Plan documents for the bridge, and personal communications with Maryland-National Capital Parks and Planning Commission staff associated with the bridge project indicate that the mill location was believed to be known and was considered during the design of the bridge to avoid any impacts. Parks staff indicated the location was on Park land to the west of the road intersection with Aspen Hill Road, closer to where Rock Creek passes under Veirs Mill Road.

The Montgomery Parks archaeologist identified the location as being outside the area impacted by the preferred alternative for the bridge, specifically 100 feet west of Alternative 3 and southeast of where Rock Creek meets Veirs Mill Road.

Montgomery Parks staff conducted a field visit on May 9, 2017 to determine the potential for archaeological resources to be present on Park land outside of the road and bridge construction corridors. Six judgmentally placed Soil Test Pits (STP) were excavated – four were placed south of the bridge, between it and the U-shaped watercourse off Rock Creek, potentially a mill race.

STPs 1-4 showed the soils to be free of modern disturbances related to road or bridge construction and in areas that are currently wooded. Artifacts recovered from these STPs include: a brick fragment, two unidentified metal fragments, and a nail, possibly machine-cut. Significant charcoal fragments were encountered at 1.4 feet below the surface in STP1. Given the intact condition of soils in this area, there is potential for archaeological resources to be present south of the pedestrian bridge, outside the limits of disturbance for bridge construction.

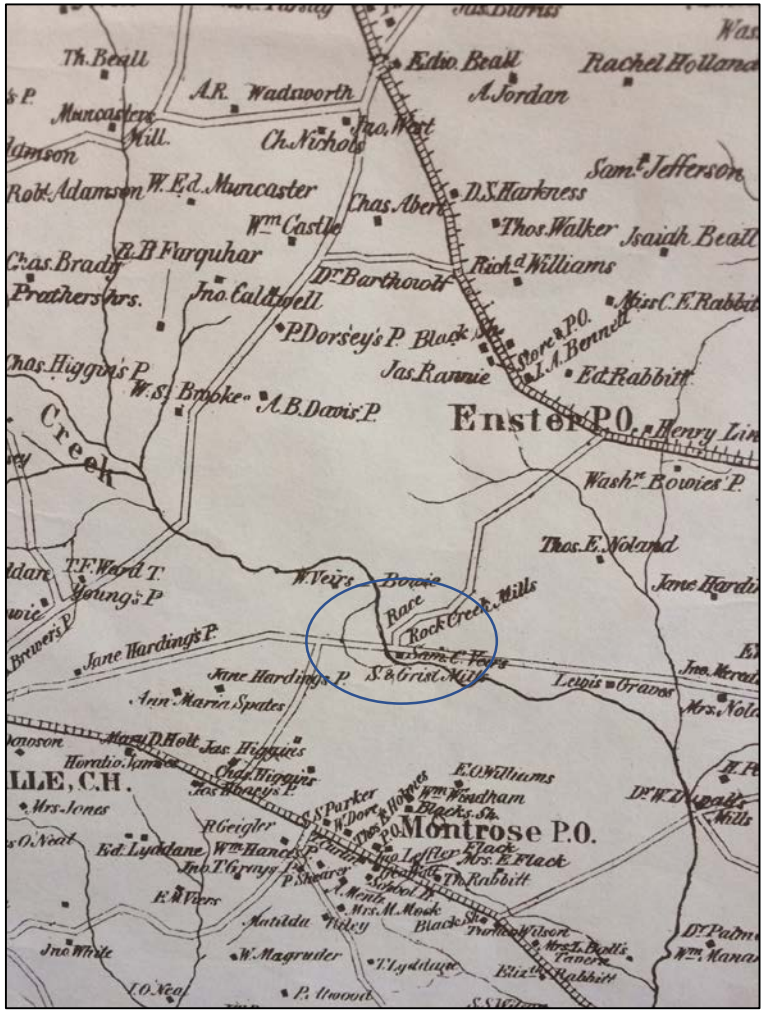
Two additional STPs (5 and 6) were excavated further northwest, on a rise of land closer to the Rock Creek crossing at Veirs Mill Road. The landscape in this area appears to have been modified and could be remnants of a mill race and building locations, as well as 20th century access road construction further west. Concrete rubble, asphalt, and recent trash – bottles, beer cans, plastic tarps – were present on the surface. Both STPs encountered destruction debris and neither were excavated to sterile subsoil due to the amount of rubble. The few artifacts recovered from these two STPs included brick, mortar, corroded nails, and miscellaneous metal fragments that appear to date from the 20th century.

As sterile soil was not encountered, it is possible that deposits from earlier time periods are located below this destruction layer, and one of these could be the location of the 19th century structure shown on historic maps. The mill location mentioned in the Facility Plan is near STPs 5 and 6, and there is potential for archaeological resources to be present in those areas.

Montgomery Parks staff conducted two other site visits on February 16 and 21, 2018 to assess the location of the stone foundation location shown on the State Roads map and verify the locations mentioned in the Facility Plan, both recently discovered.

Staff estimated that the foundation location shown on the plat lies within the area previously disturbed by road improvements and by the bridge construction. If the mill building was at this location, the road improvements and bridge construction would have erased its presence and it is unlikely any archaeological resources remain in this area.

Given the ambiguous results, it is possible the foundation of the Veirs Mill site, an associated building, or archaeological deposits associated with either structure are still present on Park land and outside of the Area of Potential Effects for previous projects. A systematic sub-surface survey is recommended if any ground-disturbing project occurs in these areas.



1865 Martenet and Bond Map of Montgomery County

1878 GM Hopkins Atlas of Fifteen Miles Around Washington, including the County of Montgomery, Maryland.

2004 aerial showing construction activity along south side of Veirs Mill Road (MD 586)
http://gis3.montgomerycountymd.gov/historical_images/

Areas tested by soil test pits and potential locations for mill structure
2015 aerial, http://gis3.montgomerycountymd.gov/historical_images/

Appendix G:
Schools

Buildout Enrollment Forecast in the Richard Montgomery (RM) Cluster

	ES Enrollment	MS Enrollment	HS Enrollment	Notes
2023-24 RM Cluster Projections	2,875	1,298	2,668	Final year projections of the 6-year Capital Improvements Program
Approved but Unbuilt within the Veirs Mill Corridor Master Plan Area	0	0	0	No projects in the pipeline
Veirs Mill Corridor Master Plan Area Additional Capacity*	106	42	60	1,942 multi-family high-rise units
TOTAL	**2,981**	**1,340**	**2,728**	

* Projected plan impact based on the 2016 student generation rates for the *Southwest Region* of Montgomery County.

Buildout Program Capacity Potential in the Richard Montgomery (RM) Cluster

	ES Capacity	MS Capacity	HS Capacity	Notes
RM Cluster in 2017	2,275	1,462	2,236	
RM Cluster ES #5 opening	740			Opening fall 2018
TOTAL	**3,015**	**1,462**	**2,236**	

NET DIFFERENCE	**34**	**122**	**-492**

Buildout Enrollment Forecast in the Downcounty Consortium (DCC)

	ES Enrollment	MS Enrollment	HS Enrollment	Notes
2023-24 DCC Projections	17,195	9,050	12,327	Final year projections of the 6-year Capital Improvements Program
Approved but Unbuilt within the Veirs Mill Corridor Master Plan Area	0	0	0	No projects in the pipeline
Veirs Mill Corridor Master Plan Area Additional Capacity*	180	74	102	175 townhouses 227 multi-family mid-rise units 844 multi-family high-rise units
TOTAL	**17,375**	**9,124**	**12,429**	

* Projected plan impact based on the 2016 student generation rates for the *East Region* of Montgomery County.

Buildout Program Capacity Potential in the Downcounty Consortium (DCC)

	ES Capacity	MS Capacity	HS Capacity	Notes
DCC in 2017	16,988	8,271	9,586	
Montgomery Knolls ES addition	144			Opening fall 2020
Pine Crest ES addition	184			Opening fall 2020
Piney Branch ES addition	115			Opening fall 2021
East Silver Spring ES addition	75			Opening fall 2022
Woodlin ES addition	159			Opening fall 2022
Takoma Park MS addition		367		Opening fall 2020
Col. E. Brooke Lee MS addition		478		Opening fall 2021
Parkland MS addition		255		Opening fall 2021
Silver Spring Intl. MS addition		193		Opening fall 2022
Wheaton HS addition			558	Opening fall 2018
John F. Kennedy HS addition			405	Opening fall 2022
Northwood HS addition			1,183	Not yet planned
TOTAL	**17,665**	**9,564**	**11,732**	

NET DIFFERENCE	**290**	**440**	**-697**

The tables below detail the latest enrollment and capacity projections for the 2023-24 school year:

School Level	Projected Enrollment	Projected Capacity	Available Space	Projected Utilization Rate
Downcounty Consortium Totals				
High Schools (5)	12,327	10,549	-1,778	116.9%
Middle Schools (9)	9,050	9,564	514	94.6%
Elementary Schools (29)	17,195	17,665	470	97.3%
Richard Montgomery Cluster Totals				
High Schools (1)	2,668	2,236	-432	119.3%
Middle Schools (1)	1,298	1,462	164	88.8%
Elementary Schools (5)	2,875	3,015	140	95.4%

School	Projected Enrollment	Projected Capacity	Available Space	Projected Utilization Rate
Downcounty Consortium				
Albert Einstein HS	2,260	1,612	-648	140.2%
Wheaton HS	2,138	2,279	141	93.8%
Loiederman MS	850	871	21	97.6%
Parkland MS	1,127	1,203	76	93.7%
Newport Mill MS	660	825	165	80.0%
Highland ES	575	535	-40	107.5%
Rock View ES	572	661	89	86.5%
Sargent Shriver ES	757	673	-84	112.5%
Viers Mill ES	559	743	184	75.2%
Wheaton Woods ES	502	741	239	67.7%
Richard Montgomery Cluster				
Richard Montgomery HS	2,668	2,236	-432	119.3%
Julius West MS	1,298	1,462	164	88.8%
Twinbrook ES	523	558	35	93.7%

Appendix H:

Carbon Analysis

Montgomery County Bill Number 32-07 establishes a goal to stop increasing greenhouse gas emissions by the year 2010, and to reduce emissions to 20 percent of 2005 levels by the year 2050. In order to estimate the amount of greenhouse gas emissions, a model is used that includes embodied energy emissions, building energy emissions, and transportation emissions. The model documentation defines embodied energy emissions as "emissions that are created through the extraction, processing, transportation, construction and disposal of building materials as well as emissions created through landscape disturbance (by both soil disturbances and changes in above ground biomass). Building energy emissions are created in the normal operation of a building, including lighting, heating, cooling and ventilation, operation of computers and appliances, etc. Transportation emissions are released by the operation of cars, trucks, buses, motorcycles, etc.

This model was run for the existing conditions and the projected buildout of the Veirs Mill Corridor Master Plan, with the following results.

Scenario	Emissions (MTCO2e*)
2010 Baseline	5,238,264
2040 Buildout, average of low and high scenarios	5,387,046

*Metric Tons Carbon Dioxide Equivalents (over the life of the development)

While the 2040 projected buildout of the Veirs Mill Corridor Master Plan shows a small increase in total emissions, there is a decrease in emissions on a per capita basis. The decrease in per capita emissions is due to the master plan recommendations which:

- Focus on shifting transportation use from automobiles to mass transit;
- Increase the number of multifamily residential units, which are more energy efficient than single-family homes; and
- Increase growth without substantially increasing the amount of pavement.

EXECUTIVE SUMMARY

A traffic study was performed for the intersection of MD 586 (Veirs Mill Road) at Turkey Branch Parkway (Matthew Henson Trail Crossing) in Aspen Hill, MD, evaluating the need for a full color traffic signal or other traffic safety measures. The study evaluated the traffic control criteria as specified by the Maryland Manual on Uniform Traffic Control Devices (MUTCD 2011). Although the warrants are not met for a full traffic signal at this location, given the unique needs of a major trail crossing and recently observed driver-pedestrian-bicycle confusion, it is recommended to redesign the intersection to provide a direct pedestrian/bicycle crossing, a full color traffic signal with upgraded detection, and incorporate Turkey Branch Parkway under traffic signal control. The following paragraphs summarize the preliminary findings and specific recommendations.

Primary Concern

As part of the Corridor Vision Zero Initiative, this location was identified as a candidate for upgraded traffic controls and pedestrian infrastructure.

Site Description

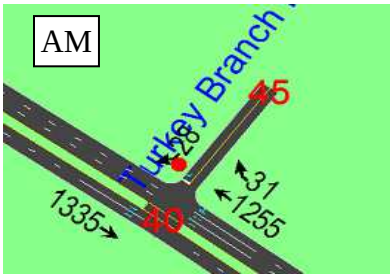
MD 586 at Turkey Branch Parkway is a five-lane, urban other principal arterial oriented in the northwest/southeast direction. There is a frontage road immediately southwest of MD 586 allowing southeast bound traffic flow only. Turkey Branch Parkway is a two-lane road that runs in the northeast/southwest direction. On-street parking is permitted on both sides of Turkey Branch Parkway. Turkey Branch Parkway has sidewalks on both sides. There are no sidewalks along MD 586.

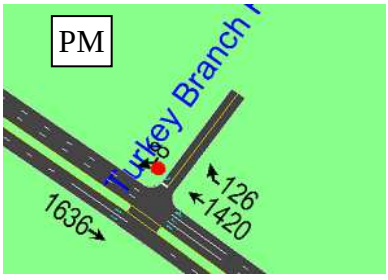
Land use in the vicinity of the intersection is residential, and Turkey Branch Creek is surrounded with thick vegetation at the southeast corner of the intersection. Turkey Branch Creek runs almost parallel to Turkey Branch Parkway on the southeast side. The Matthew Henson Trail, a multi-use trail for pedestrians and bicyclists, runs parallel to Turkey Branch Parkway immediately to the southeast. There is a marked crosswalk with a pedestrian-activated half signal across MD 586 linking the Matthew Henson Trail from the southeast side of Turkey Branch Parkway to the northwest side of Edgebrook Road. Edgebrook Road intersects the MD 586 frontage road southwest of the study intersection and does not actually intersect MD 586.

Summary and Findings

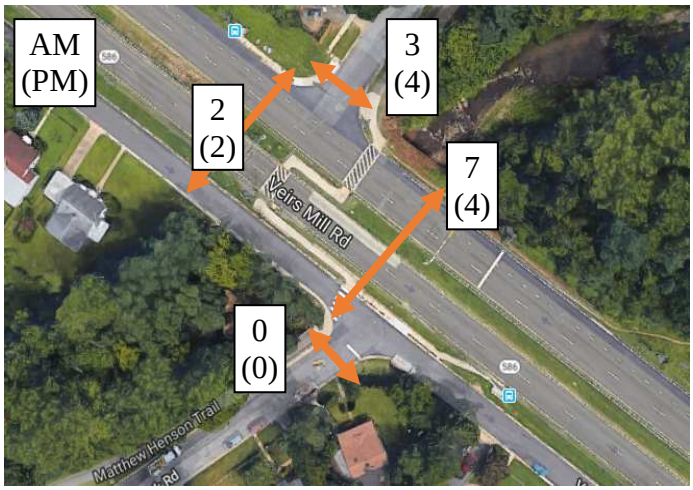
Traffic counts were performed on Tuesday, May 22, 2018. The AM and PM peak hours were 7:30-8:30 AM and 4:45-5:45 PM, respectively.

1) VEHICULAR TRAFFIC: Approximately 2,600 vehicles during the AM and 3,200 vehicles during the PM peak hours entered the intersection. Peak hour traffic volumes are shown in the following images. SHA's Highway Location Reference identifies MD 586 as having an AADT of approximately 42,671 vpd.





2) PEDESTRIAN TRAFFIC: During the eight hours counted, 52 pedestrians were recorded crossing MD 586 at the intersection. Eleven pedestrians crossed Turkey Branch Parkway, and thirteen pedestrians crossed Edgebrook Road south of the study intersection. The following image shows the crosswalk volumes corresponding to the vehicular peak hours.



3) BUSES: A bus stop is present on the far side of the intersection in the northwest direction serving WMATA Routes Q1, Q2, Q4, Q5, and Q6. Fall 2017 WMATA data shows 11 boardings and 12 alightings occur at this stop. For the southeast direction, there is a bus stop located at the far side of the intersection of MD 586 and Edgebrook Road serving WMATA Routes Q1, Q2, Q4, Q5, and Q6. 27 boardings and 6 alightings occur at this stop.

4) CRASH EXPERIENCE: Between January 1, 2015 and December 31, 2017, there were 45 crashes at the intersection (12 in 2015, 21 in 2016, and 12 in 2017). There were two fatalities. Four bicycles were involved in collisions. Out of these four collisions, three crashes involved westbound vehicles hitting the bicyclists at the crosswalk due to the lack of driver's full attention and an unknown reason. These bicycle crashes occurred at 1 PM, 7 PM, and at 8 PM on weekdays. The remaining bicycle crash involved an eastbound vehicle hitting the bicyclist in the crosswalk due to an unknown reason at 1 PM during the weekend. Two of the bicycle crashes were fatal. The other crash types involved 35 rear end, four sideswipe, one angle, and one fixed object crashes. The majority of rear end collisions occurred due to vehicles following too closely and lack of drivers' full attention. Half of the sideswipe collisions occurred due to the improper turn and the lack of drivers' full attention. An angle collision occurred due to the vehicle failing to yield the right of way. A fixed object collision occurred due to other or unknown reason. (Note: the supplied crash summary indicated that the 2017 data may be incomplete and unedited).

5) SPEED LIMIT: The posted speed limit is 45 mph on MD 586 (Veirs Mill Road) and 25 mph on Turkey Branch Parkway.

6) SIGHT DISTANCE: The study intersection is located near the bottom of a vertical curve on MD 586, which allows for sufficient sight distance for vehicles turning from Turkey Branch Parkway.

7) QUEUES, DELAYS, & GAPS: Minimal queues were observed with the longest queue on southwest Turkey Branch Parkway reaching two vehicles. The average delay on Turkey Branch Parkway was 13 seconds during the peak hours.

8) EXISTING TRAFFIC CONTROL: There are STOP signs on Turkey Branch Parkway. There are other right of way signs such as DO NOT ENTER and ONE WAY along MD 586 and the frontage road on the southwest side. The marked crosswalk on MD 586 is provided with parallel transverse markings and cross-hatching at different sections aided with a pedestrian-activated half signal. ADA ramps with detectable warning surfaces are also provided. There are trail crossing plaques and combined pedestrian and bicyclist signs. The existing signs and pavement markings are placed correctly per the MUTCD. There are no lane markings on Turkey Branch Road.

9) DESIGNATED SCHOOL CROSSING: The study location is not located within a school zone.

10) FIELD OBSERVATIONS: A traffic engineer observed the intersection, specifically focusing on driver and pedestrian behavior, traffic patterns, and overall operations. The following summarizes the observations:
    a. Few pedestrians were observed at this intersection despite the presence of the multi-use trail.
    b. Pedestrians were observed walking along MD 586 to access bus stops.
    c. No sidewalks are present on MD 586.
    d. No bicyclists were observed during the morning or evening peak hour observations.
    e. Street lighting is provided along MD 586; there is no street lighting on Turkey Branch Parkway at the study intersection.
    f. Buses were not observed to affect traffic operations significantly at the study intersection.
    g. Sight distance is greater than the minimum required.

11) WARRANT ANALYSIS SUMMARY: The traffic signal warrant analysis evaluation performed for the study intersection was based on the Maryland Manual on Uniform Traffic Control Devices (MUTCD), 2011 Edition. Vehicle and/or pedestrian volumes are not high enough to meet any of the warrants for the installation of a full traffic signal or a pedestrian-activated signal.

Table 1: Peak Hour Vehicle and Pedestrian Volumes

Peak Hour	Vehicle Volume on MD 586	Vehicle Volume on Turkey Branch Parkway*	Pedestrians Crossing MD 586	Warrant				Ped-activ. signal
				1A	1B	2	3	
7:30 AM	2,621	8	10	No	No	No	No	No
4:45 PM	3,182	2	6	No	No	No	No	No

** 70% deduction in minor street right-turn volume was applied*

12) CAPACITY ANALYSIS: Capacity analyses were performed for the study intersection to depict the existing condition of traffic operations. **Table 2** provides a summary of the results of the capacity analysis performed using Synchro 9 and Highway Capacity Manual (HCM) methodology. The delay, volume-to-capacity ratio, level of service, and 95th-percentile queue lengths in feet are shown for each approach and the overall intersection.

Table 2: Summary of Capacity Analysis

Scenario	Approach	Synchro 9 (HCM2000) Results							
		Delay (sec/veh)		v/c Ratio		Level of Service		95th-% Queues	
		AM	PM	AM	PM	AM	PM	AM	PM
Existing Conditions	**Overall**	0.1	0	0.40*	0.49*	A	A	-	-
	Southeast	0	0	0.43	0.52	A	A	0	0
	Northwest	0	0	0.32	0.36	A	A	0	0
	Southwest	12	13	0.06	0.02	B	B	4	1
Proposed Signal	**Overall**	1.5	2.6	0.44	0.54	A	A	-	-
	Southeast	0.8	3.2	0.45	0.55	A	A	20	351
	Northwest	0.3	1.4	0.30	0.36	A	A	9	111
	Southwest	85.9	87.9	0.02	0.01	F	F	0	0

**Intersection Capacity Utilization (ICU) for overall intersection only*

The results of the capacity analysis show that the intersection currently operates at an overall LOS A during the morning and during the afternoon. During both peak periods with a signal, the overall intersection and Veirs Mill Road operate at LOS A. Turkey Branch Parkway is expected to have higher delay with drivers waiting less than two minutes, but the volume to capacity ratio and side street volumes are extremely low.

Recommendations

Although the warrants are not met for a full color traffic signal at this location, given the unique needs of a major trail crossing and recently observed driver-pedestrian-bicycle confusion, it is recommended to redesign the intersection to provide a direct pedestrian/bicycle crossing, a full color traffic signal with upgraded detection, and incorporate Turkey Branch Parkway under traffic signal control.

APPENDIX

Signal Warrant Summary

The traffic signal warrant analysis evaluation performed for the study intersection was based on the nine warrants outlined in Section 4C of the Manual on Uniform Traffic Control Devices (MUTCD), 2009 Edition. The first three warrants focus on the vehicle volumes at the intersection (eight-hour volumes, four-hour volumes, and peak-hour volume) while the fourth warrant focuses on pedestrian volumes. Warrant 5 relates to school crossings. Warrant 7 examines the crash history of the intersection. The other warrants are not applicable to this location.

Warrant #1 (Eight Hour Volume), Warrant #2 (Four Hour Volume), and *Warrant #3 (Peak Hour Volume)* have minimum requirements for vehicles per hour on both streets. These minimum volumes are NOT MET for any of the 8 hours counted for Warrants #1, #2, or #3. *Warrant #4 (Pedestrian Volume)* requires a minimum traffic volume and minimum corresponding pedestrians per hour crossing the major street. The highest volume of pedestrians crossing the major street in one hour was 11 people, which does not meet the minimum thresholds of 93 and 75 pedestrians per hour. Warrant 4 is NOT MET. *Warrant #5 (School Crossing)* is intended for application where schoolchildren cross the major street at a designated school crossing. The intersection is not located within a school zone; therefore, Warrant 5 is not applicable. *Warrant #7 (Crash Experience)* requires five or more reported crashes, minimum volumes, and testing of alternatives before warranting a traffic signal. Based on the three most recent years of available crash data, only one crash (angle + left turn) correctable by a traffic signal has occurred (year 2016) at the intersection. Therefore, Warrant 7 is NOT MET.

Table A1 summarizes the signal warrant results. **Table A2** summarizes the traffic volumes used in the signal analysis. The results of the analysis indicate that none of the nine warrants are met for the study intersection. Hence, a traffic signal is not warranted at the study intersection.

Table A1: Summary of Signal Warrant Analysis

Warrant	Description	Warrant Met?
1	Eight Hour Vehicular Volume	No
2	Four Hour Vehicular Volume	No
3	Peak Hour*	No
4	Pedestrian Volume	No
5	School Crossing	N/A
6	Coordinated Signal System	N/A
7	Crash Experience	No
8	Roadway Network	N/A
9	Intersection Near a Grade Crossing	N/A

**The Peak Hour Warrant shall only be used in unusual cases with a high-volume special generator; volumes are not high enough to meet Warrant 3, nor is it applicable at this location.*

Table A2: Summary of Hourly Vehicular Volumes

Hour	Vehicle Volume on MD 586 (Both Approaches)	Vehicle Volume on Turkey Branch Parkway (Highest Approach)	Total Pedestrian Volume Crossing MD 586 (Total of Both Legs)	Meets Warrant?				
				1A	1B	2	3	4
6:15 AM	2,158	3	11	No	No	No	No	No
7:15 AM	2,609	8	9	No	No	No	No	No
8:15 AM	2,274	5	5	No	No	No	No	No
10:45 AM	1,714	2	9	No	No	No	No	No
11:45 AM	1,824	2	7	No	No	No	No	No
3:45 PM	2,917	2	4	No	No	No	No	No
4:45 PM	3,182	2	6	No	No	No	No	No
5:45 PM	2,869	2	1	No	No	No	No	No

Pedestrian-Activated Signal Analysis

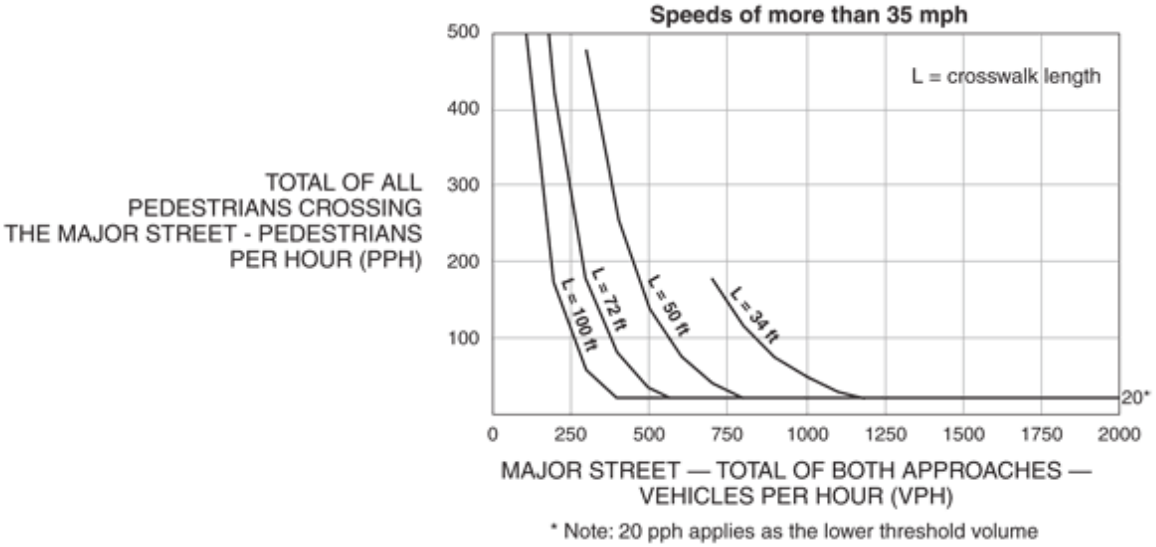
A pedestrian-activated signal was evaluated using guidance from Section 4F of the 2009 MUTCD. A pedestrian hybrid beacon (PHB), also known as a HAWK (**H**igh-intensity **A**ctivated Cross**W**al**K**), is used to warn and control traffic at an unsignalized location. The beacon would remain dark until actuated by a pedestrian pressing a walk button. The pedestrian-activated signal shown below is installed in Towson, Maryland.

MD 45 & Yarmouth Road

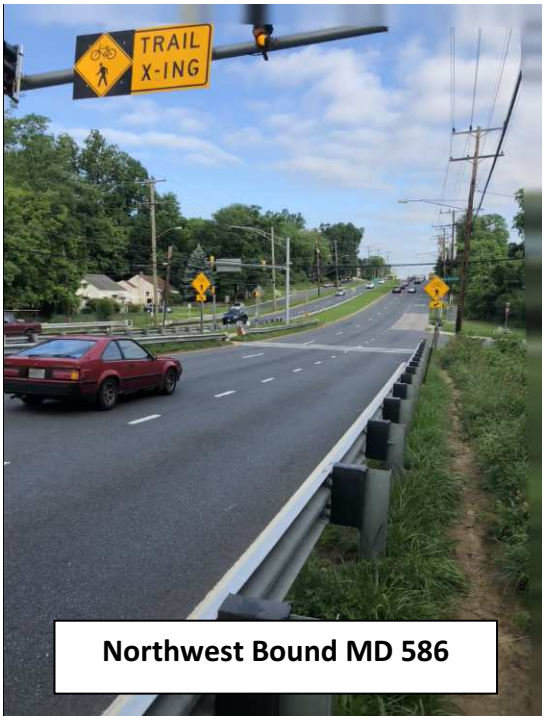
According to the MUTCD, a pedestrian hybrid beacon may be considered if the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding total of all pedestrians crossing the major street for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in Figure 4F-1 for the length of the crosswalk. See **Figure A1**.

The width of northwest MD 586 (Veirs Mill Road) is approximately 35 feet with a crossing distance of 115 feet following the trail crossing. The highest volume of pedestrians crossing MD 586 in an hour was eleven people. No points fall within the appropriate curve. The guidelines established by the MUTCD in Figure 4F-1 are not satisfied under existing conditions.

Figure A1: Pedestrian Hybrid Beacon Guidelines

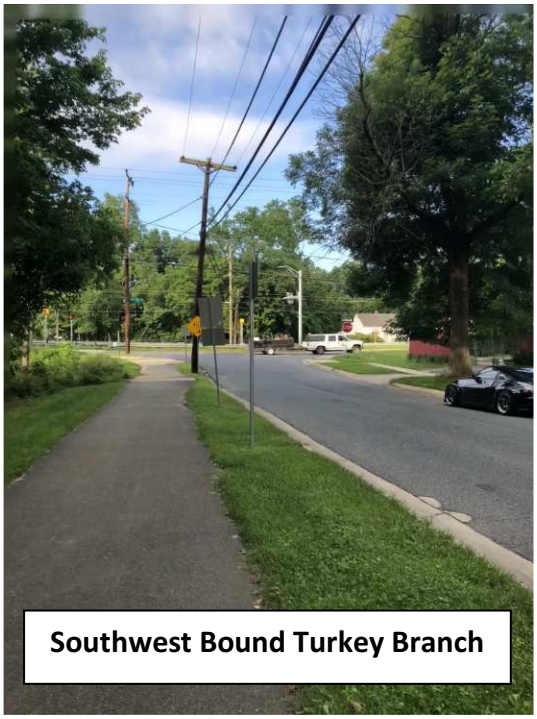


Intersection Photographs



Northwest Bound MD 586

Southeast Bound MD 586



Southwest Bound Turkey Branch

EXECUTIVE SUMMARY

A traffic study was performed at the intersection of MD 586 (Veirs Mill Road) at Valleywood Drive in Silver Spring, MD, evaluating the need for a full color traffic signal, pedestrian-activated signal, or other traffic safety measure. The study evaluated the traffic control criteria as specified by the Maryland Manual on Uniform Traffic Control Devices (MUTCD 2011). While this study concludes that neither a full traffic control signal nor a pedestrian-activated signal is warranted based on existing traffic volumes, it is recommended to relocate the bus stops and crosswalk from Valleywood Drive/Gail Street and Centerhill Street to Andrew Street in order to justify the installation of a pedestrian-activated traffic signal. The following paragraphs summarize the preliminary findings and specific recommendations.

Primary Concern

As part of the Corridor Vision Zero Initiative, this location was identified as a candidate for upgraded traffic controls and pedestrian infrastructure.

Site Description

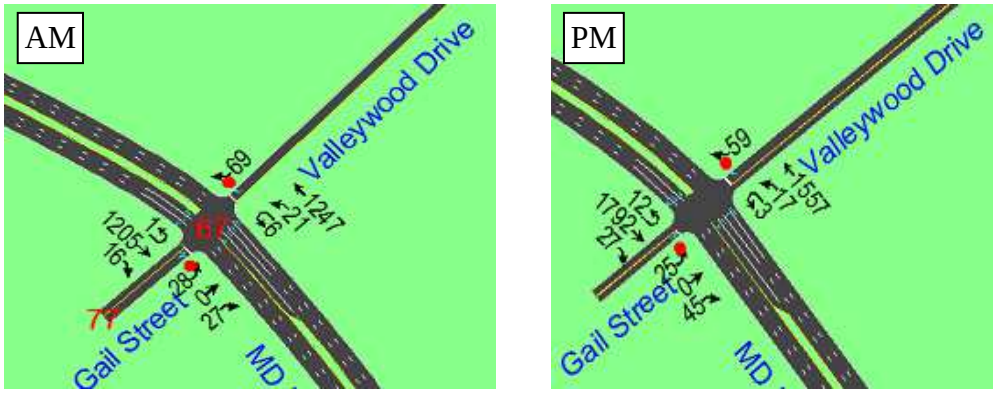
MD 586 at Valleywood Drive is a six-lane, urban other principal arterial oriented in the northwest/southeast direction. Valleywood Drive is a one-way, one-lane road that runs in the southwest direction. Gail Street is a two-way, two-lane road that intersects Veirs Mill Road immediately east of Valleywood Drive. Access is not possible between Valleywood Drive and Gail Street due to the median on Veirs Mill Road. Gail Road terminates at a T-intersection offset approximately 110 feet east of Valleywood Drive with a median opening to allow left turns to and from Gail Street. On-street parking on both sides of Valleywood Drive is permitted. Valleywood Drive has a sidewalk on the northwest side while Gail Street does not have sidewalks. MD 586 has sidewalks on both sides.

Land use in the vicinity of the intersection is residential. Small Creek runs almost parallel to Valleywood Drive at the southeast side. The nearest controlled crosswalk is approximately 640 feet southeast at the intersection of MD 586 and Claridge Road, which is signalized with pedestrian signals. Similarly, there is a signalized intersection with pedestrian signals and crosswalks at MD 586 and MD 185 (Connecticut Avenue), which is approximately 1350 feet northwest of the study intersection.

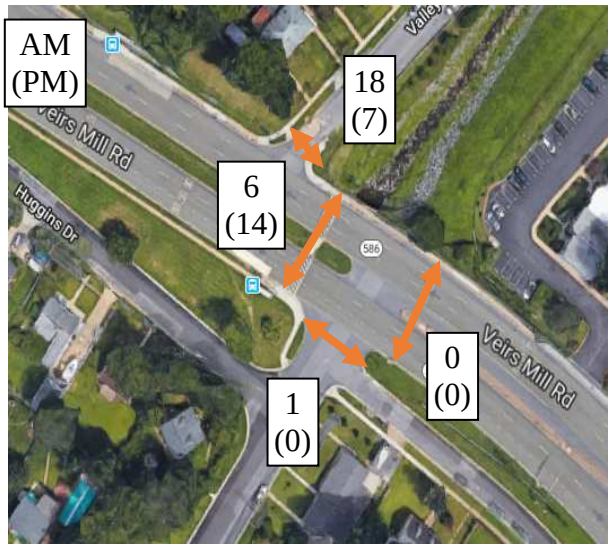
Summary and Findings

Traffic counts were performed on Tuesday, May 22, 2018. The AM and PM peak hours were 7:30-8:30 AM and 5:00-6:00 PM, respectively.

1) VEHICULAR TRAFFIC: Approximately 2,600 vehicles during the morning and just over 3,500 vehicles during the evening peak hours entered the intersection. Peak hour traffic volumes are shown in the following images. SHA's Highway Location Reference identifies MD 586 as having an AADT of approximately 38,421 vpd in the vicinity of this intersection.



2) PEDESTRIAN & BICYCLE TRAFFIC: During the eight hours counted, 64 pedestrians were recorded crossing MD 586 at the intersection. Eighty pedestrians crossed Valleywood Drive, and six pedestrians crossed Gail Street. The following image shows the crosswalk volumes corresponding to the vehicular peak hours.



3) BUSES: A bus stop is present on the far side of the intersection close to the intersection of MD 586 and Andrew Street in the northwest direction serving WMATA Routes Q1, Q2, Q4, Q5, Q6, C2, and C4. Fall 2017 WMATA data shows that an average of 84 boardings and 105 alightings occur at this stop. For the southeast direction, there is a bus stop located at the near side of the intersection of MD 586 and Gail Street serving WMATA Routes Q1, Q2, Q4, Q5, Q6, and C4, and 57 boardings and 18 alightings occur at this stop.

4) CRASH EXPERIENCE: Between January 1, 2015 and December 31, 2017, there were two crashes at the intersection of Valleywood Drive and Veirs Mill Road (1 in 2015 and 1 in 2017). There were no fatalities. The pedestrian crash was reported as a southbound vehicle hitting a pedestrian due to the driver's failure to yield right of way. It occurred at 7:00 AM on a weekday; the surface condition was wet. The angle crash occurred due to fast driving on a snowy surface. (Note: the supplied crash summary indicated that the 2017 data may be incomplete and unedited. Also, crash data provided did not include Gail Street).

5) SPEED LIMIT: The posted speed limit is 40 mph on MD 586 (Veirs Mill Road) and 25 mph on Valleywood Drive.

6) SIGHT DISTANCE: Sight distance is inadequate on Valleywood Drive. Looking left from the stop bar, the measured sight distance is 90 feet due to the bridge abutment over Small Creek, but the required sight distance is 275 feet.

7) QUEUES, DELAYS, & GAPS: No more than one vehicle was observed queuing on Valleywood Drive. The average delay on Valleywood Drive was 13 seconds during the peak hours. Delays on Gail Street based on HCM results were over eight minutes in the PM peak hour but excessive queuing was not observed with no more than three vehicles observed queuing during the afternoon/evening field observations. The delay on Gail Street is associated with the left turns onto Veirs Mill Road, and the low volume of this movement is consistent with the queuing conditions observed in the field.

8) EXISTING TRAFFIC CONTROL: Stop signs are provided as traffic control on both minor streets. There are other right-of-way signs such as DO NOT ENTER and ONE WAY at the intersection of Valleywood Drive. The high-visibility marked crosswalk across MD 586 has cross-hatching; pedestrian warning signs are present on both sides of the road in both directions. Additionally, "PED XING" pavement markings are present in both directions on MD 586. ADA ramps with detectable warning surfaces are also provided. The existing signs and pavement markings are placed correctly per the MUTCD. Pavement markings on Gail Street are either faded or not provided.

9) DESIGNATED SCHOOL CROSSING: The study location is not located within a school zone.

10) FIELD OBSERVATIONS: A traffic engineer observed the intersection, specifically focusing on driver and pedestrian behavior, traffic patterns, and overall operations. The following summarizes the observations:
    a. Pedestrians, including many middle and high school students, were observed constantly using the marked crosswalk between Gail Street and Valleywood Drive.
    b. There is a median refuge on MD 586 (Veirs Mill Road) for pedestrians using the crossing.
    c. Vehicles were observed to stop/slow if a pedestrian was in the process of crossing the street but did not stop for pedestrians waiting to cross.
    d. Excessive queuing was not observed on Valleywood Drive or Gail Street during the morning and evening peak hour observations.
    e. Due to the sight distance issues on Valleywood Road, drivers move slightly past the stop bar to obtain a better view of conflicting traffic on MD 586.
    f. Street lighting is provided on Veirs Mill Road and Valleywood Drive.
    g. The bus stops on MD 586 were not observed to significantly impact traffic operations at the intersection.
    h. No bicycles were observed at the study intersection during the field observations.

11) WARRANT ANALYSIS SUMMARY: The traffic signal warrant analysis evaluation performed for the study intersection was based on the Maryland Manual on Uniform Traffic Control Devices (MUTCD), 2011 Edition. One warrant analysis was conducted for just Valleywood Drive and another warrant analysis was conducted that included both Valleywood Drive and Gail Street given the proximity of the intersections. Vehicle and/or pedestrian volumes are not high enough to meet the warrants for the installation of a full traffic signal for one or both conditions. Additionally, installation of a pedestrian-activated signal was examined. With a crosswalk length of approximately 85 feet and a maximum

pedestrian crossing of 14 people, the minimum requirements to consider a pedestrian-activated signal were not met for either condition. **Table 1** shows a summary of the volumes at the intersection.

Table 1: Peak Hour Vehicle and Pedestrian Volumes

Peak Hour	Vehicle Volume on MD 586	Vehicle Volume on Valleywood Drive/ Gail Street*	Pedestrians Crossing MD 586	Warrant				Ped-Activ. Signal
				1A	1B	2	3	
7:30 AM	2,496	55	6	No	Yes	No	No	No
5:00 PM	3,408	70	14	No	Yes	Yes	No	No

**Higher approach volume (70% deduction in right turn volume in Valleywood Drive was applied)*

Table 2: Peak Hour Vehicle and Pedestrian Volumes (Valleywood Drive only)

Peak Hour	Vehicle Volume on MD 586	Vehicle Volume on Valleywood Drive*	Pedestrians Crossing MD 586	Warrant				Ped-Activ. Signal
				1A	1B	2	3	
7:30 AM	2,496	21	6	No	No	No	No	No
5:00 PM	3,408	18	14	No	No	No	No	No

**Higher approach volume (70% deduction in right turn volume in Valleywood Drive was applied)*

12) CAPACITY ANALYSIS: Capacity analyses were performed for the study intersection to depict the existing condition of traffic operations. **Tables 3 and 4** provide a summary of the results of the capacity analysis performed using Synchro 9 and the Highway Capacity Manual (HCM) methodology. The delay, volume-to-capacity ratio, level of service, and 95th-percentile queue lengths in feet (unless otherwise noted) are shown for each approach and the overall intersection.

Table 3: Summary of Capacity Analysis (Valleywood Drive and Gail Street)

Scenario	Approach	Synchro 9 (HCM2010) Results							
		Delay (sec/veh)		v/c Ratio		Level of Service		95th-% Queues	
		AM	PM	AM	PM	AM	PM	AM	PM
Existing Conditions	**Overall**	**2.6**	**12.4**	**-**	**-**	**A**	**C**	**-**	**-**
	Southeast	0	0	-	-	A	A		
	Northwest	0.4	0.5	0.10	0.16	A	A	0.3	0.5
	Northeast	89	554	0.62	1.81	F	F	2.9	7.9
	Southwest	18.6	23	0.22	0.24	C	C	0.8	0.9

Queue and V/c are for corresponding left turn movements except Valleywood Drive; queues in vehicles

Table 4: Summary of Capacity Analysis (Valleywood Drive only)

Scenario	Approach	Synchro 9 (HCM2010) Results							
		Delay (sec/veh)		v/c Ratio		Level of Service		95th-% Queues	
		AM	PM	AM	PM	AM	PM	AM	PM
Existing Conditions	**Overall**	**0.3**	**0.2**	**0.35***	**0.40***	**A**	**A**	**-**	**-**
	Southeast	0	0	0.26	0	A	A	0	0
	Northwest	0	0	0.27	0.06	A	A	0	0
	Southwest	12.5	13.9	0.14	0.14	B	B	12	12

**Intersection Capacity Utilization (ICU) for overall intersection only*

The results of the capacity analysis show that the intersection currently operates at an overall LOS A during the morning and overall LOS C during the afternoon peak periods for the combined intersection. The analysis shows that the northbound left-turn movement on Gail Street experiences exceptional delay, though the peak hour volumes for this movement are relatively low and field observations did not note long delays.

Recommendations

The warrants for a full traffic control signal are not met at the study intersection. The intersection did not meet the guidelines necessary to consider a pedestrian-activated signal based on current weekday vehicle and pedestrian volumes. Therefore, no changes to traffic control at the intersection are recommended at this time at the study location.

To better align pedestrian activity with upgraded traffic controls, it is recommended to relocate the bus stops and crosswalk from Valleywood Drive/Gail Street and Centerhill Street to Andrew Street and install a new pedestrian-activated signal at Andrew Street, as recommended by PRSA. It is expected that by consolidating the bus stops and pedestrian crossings to one location, the requirements to install the proposed pedestrian-activated signal warrant will likely be met.

The following recommendations should be considered:

- Relocate the existing southeast bus stops at Gail Street and at Centerhill Street to Andrew Street.
- Relocate the existing crosswalk to Andrew Street and install a pedestrian-activated signal with appropriate signing and marking.

APPENDIX

Signal Warrant Summary

The traffic signal warrant analysis evaluation performed for the study intersection was based on the nine warrants outlined in Section 4C of the Manual on Uniform Traffic Control Devices (MUTCD), 2009 Edition. The first three warrants focus on the vehicle volumes at the intersection (eight-hour volumes, four-hour volumes, and peak-hour volume) while the fourth warrant focuses on pedestrian volumes. Warrant 5 relates to school crossings. Warrant 7 examines the crash history of the intersection. The other warrants are not applicable to this location.

Warrant #1 (Eight Hour Volume), Warrant #2 (Four Hour Volume), and *Warrant #3 (Peak Hour Volume)* have minimum requirements for vehicles per hour on both streets. These minimum volumes with Gail Street included are NOT MET for most of the 10 hours counted for Warrants #1 and Warrant #2 for the 70 % criteria. The volume at periods from 7:15 AM to 8:15 AM, 4:45 PM to 5:45 PM, and 5:45 PM to 6:45 PM individually meet the Warrant 1B and Warrant 2 condition, but the total volume combinations (8 hours for Warrant 1 and 4 hours for Warrant 2) do not fulfill the warrant condition. It is also to be noted that since Valleywood Drive serves only right-turning vehicles, a 70% deduction of right turning volumes was considered. For Warrant 3, the traffic volumes during the 4:15 PM hour plot above the applicable curve in the 70% Factor Peak Hour graph (3,348 major street vehicles and 76 minor street vehicles) in the MUTCD. However, this warrant is intended for use in unusual cases, such as facilities that attract or discharge large numbers of vehicles over a short time; therefore, this warrant is not applicable at the study intersection.

Warrant #4 (Pedestrian Volume) requires a minimum traffic volume and minimum corresponding pedestrians per hour crossing the major street. The highest volume of pedestrians crossing the major street in one hour was 14 people, which did not meet the minimum thresholds of 75 and 93 pedestrians per hour. Warrant 4 is NOT MET. *Warrant #5 (School Crossing)* is intended for application where schoolchildren cross the major street at a designated school crossing. The intersection is not located within a school zone; therefore, Warrant 5 is not applicable. *Warrant #7 (Crash Experience)* requires five or more reported crashes, minimum volumes, and testing of alternatives before warranting a traffic signal. Based on minimum volumes, Warrant 7 is NOT MET for the combined intersection scenario, though it should be noted that crash data was only received for Valleywood Drive. For the consideration of Valleywood Drive only, based on the three most recent years of available crash data, only one crash (angle + left turn) correctable by a traffic signal has occurred (year 2015) at the intersection. Therefore, Warrant 7 is NOT MET.

Table A1 summarizes the signal warrant results. **Table A2** summarizes the traffic volumes used in the signal analysis. The results of the analysis indicate that a traffic signal is not warranted at the study intersection.

Table A1: Summary of Signal Warrant Analysis

Warrant	Description	Warrant Met for Valleywood Drive/Gail Street?	Warrant Met for Valleywood Drive Alone?
1	Eight Hour Vehicular Volume	No	No
2	Four Hour Vehicular Volume	No	No
3	Peak Hour	No*	No
4	Pedestrian Volume	No	No
5	School Crossing	N/A	N/A
6	Coordinated Signal System	N/A	N/A
7	Crash Experience	No	No
8	Roadway Network	N/A	N/A
9	Intersection Near a Grade Crossing	N/A	N/A

**The Peak Hour Warrant shall only be used in unusual cases with a high-volume special generator; volumes are high enough to meet Warrant 3, but it is not applicable at this location.*

Table A2: Summary of Hourly Vehicular Volumes

Hour	Vehicle Volume on MD 586 (Both Approaches)	Vehicle Volume on Valleywood Drive / Gail Street (Highest Approach)	Total Pedestrian Volume Crossing MD 586 (Total of Both Legs)	Meets Warrant?				
				1A	1B	2	3	4
6:15 AM	1,906	38	10	No	No	No	No	No
7:15 AM	2,362	63	11	No	Yes	Yes	No	No
8:15 AM	2,362	33	11	No	No	No	No	No
10:45 AM	2,016	16	3	No	No	No	No	No
11:45 AM	2,131	14	5	No	No	No	No	No
3:45 PM	3,137	45	6	No	No	No	No	No
4:45 PM	3,367	72	11	No	Yes	Yes	No	No
5:45 PM	3,101	74	7	No	Yes	Yes	No	No

Pedestrian-Activated Signal Analysis

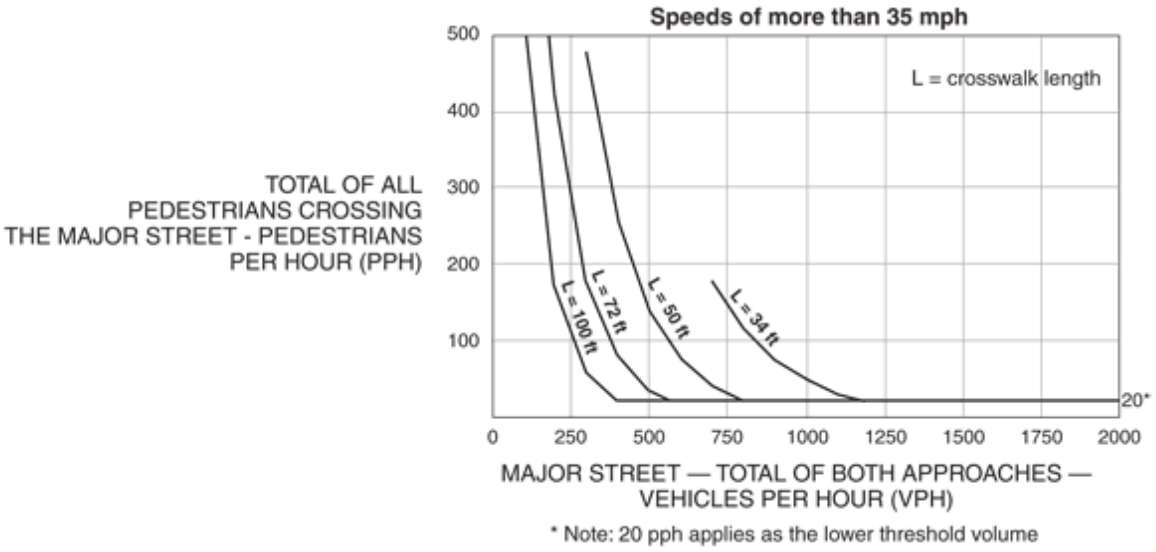
A pedestrian-activated signal was evaluated using guidance from Section 4F of the 2009 MUTCD. A pedestrian hybrid beacon (PHB), also known as a HAWK (**H**igh-intensity **A**ctivated Cross**W**al**K**), is used to warn and control traffic at an unsignalized location. The beacon would remain dark until actuated by a pedestrian pressing a walk button. The pedestrian-activated signal shown below is installed in Towson, Maryland.

MD 45 & Yarmouth Road

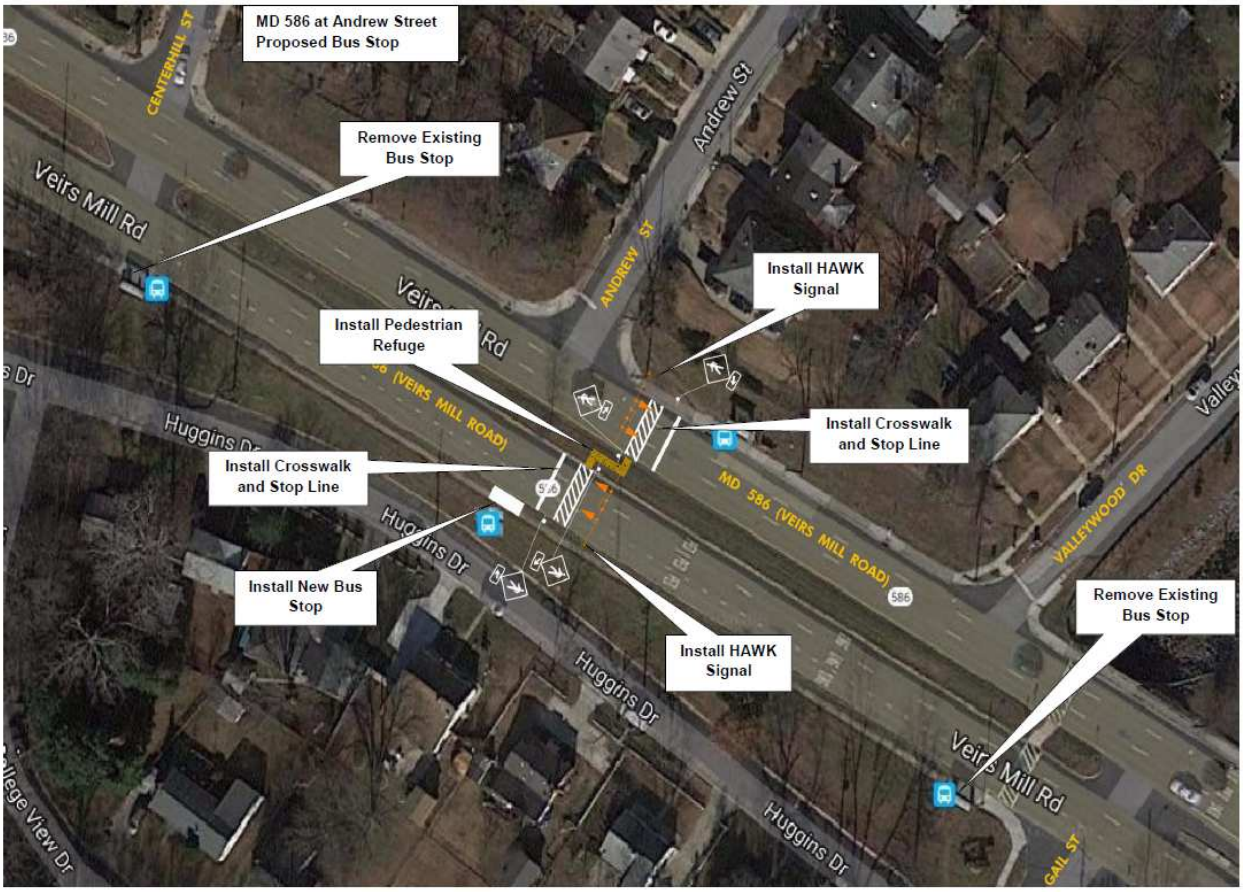
According to the MUTCD, a pedestrian hybrid beacon may be considered if the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding total of all pedestrians crossing the major street for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in Figure 4F-1 for the length of the crosswalk. See **Figure A1**.

The width of MD 586 (Veirs Mill Road) is approximately 85 feet. The highest volume of pedestrians crossing MD 586 in an hour was 14 people. No points fall within the appropriate curve. The guidelines established by the MUTCD in Figure 4F-1 are **not satisfied** under existing conditions.

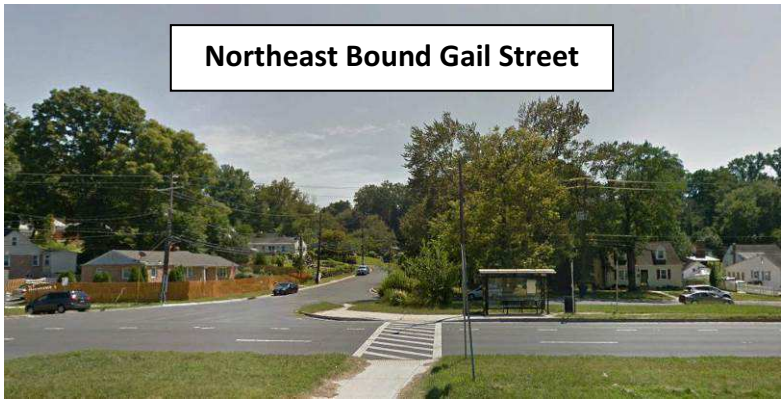
Figure A1: Pedestrian Hybrid Beacon Guidelines



Proposed Improvements



Intersection Photographs



EXECUTIVE SUMMARY

A traffic study was performed for the intersection of MD 586 (Veirs Mill Road) at Norris Drive in Silver Spring, MD, evaluating the need for a full color traffic signal, pedestrian-activated signal, or other traffic safety measure. The study evaluated the traffic control criteria as specified by the Maryland Manual on Uniform Traffic Control Devices (MUTCD 2011). While this study concludes that a traffic signal is not warranted, warrants are met for a pedestrian-activated signal; therefore, it is recommended to install a pedestrian-activated signal at this location. The following paragraphs summarize the preliminary findings and specific recommendations.

Primary Concern

As part of the Corridor Vision Zero Initiative, this location was identified as a candidate for upgraded traffic controls and pedestrian infrastructure.

Site Description

MD 586 at Norris Drive is a five-lane, urban other principal arterial oriented in the northwest/southeast direction. There is a frontage road immediately north of MD 586. Norris Drive is a two-lane road that runs in the northeast/southwest direction. This is a four-legged intersection where Monterrey Drive serves as the northeast leg. Monterrey Drive is also a two-lane road running in the northwest/southeast direction. On-street parking is permitted on both sides of the minor streets. Norris Drive has sidewalk on the northwest side only. Monterrey Drive has sidewalks on both sides. MD 586 has a sidewalk on the north side only.

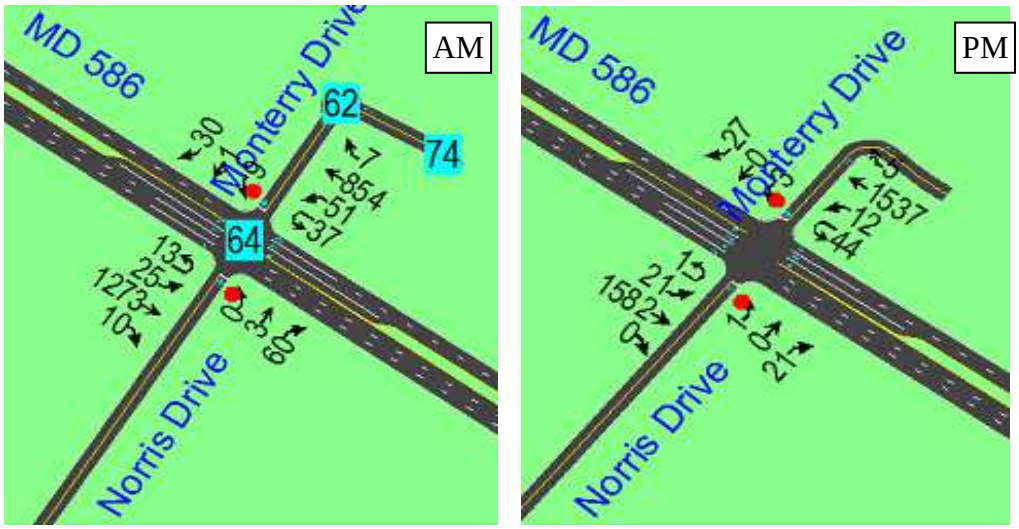
Land use in the vicinity of the intersection is residential. There is an Islamic Education Society office approximately 50 feet from the intersection in the northwest corner.

The nearest controlled crosswalk is approximately 650 feet northwest of the study intersection at MD 586 at Newport Mill Road, which is signalized with pedestrian signals. Similarly, there is a signalized intersection with pedestrian signals and crosswalks at MD 586 and University Boulevard, which is over 2500 feet southeast of the study intersection.

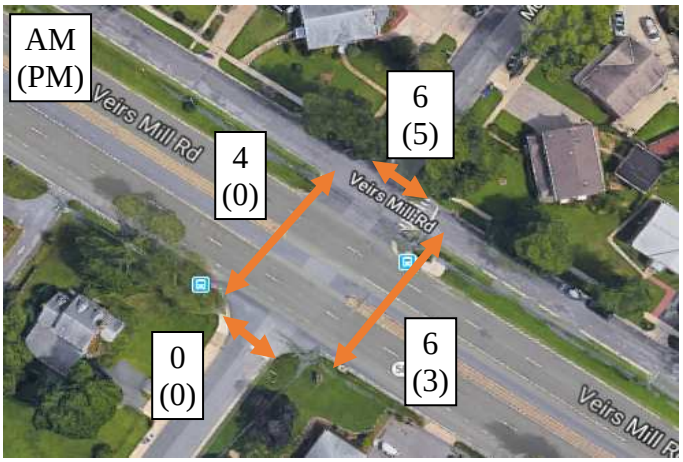
Summary and Findings

Traffic counts were performed on Tuesday, May 22, 2018. The AM and PM peak hours were 7:30-8:30 AM and 4:30-5:30 PM, respectively.

1) VEHICULAR TRAFFIC: Approximately 2,400 vehicles during the morning and just over 3,250 vehicles during the evening peak hours entered the intersection. Peak hour traffic volumes are shown in the following images. SHA's Highway Location Reference identifies MD 586 as having an AADT of approximately 38,421 vpd at the vicinity of this intersection.



2) PEDESTRIAN & BICYCLE TRAFFIC: During the 10 hours counted, 110 pedestrians were recorded crossing MD 586 at the intersection. 68 pedestrians crossed Monterrey Drive, and 22 pedestrians crossed Norris Drive. The following image shows the crosswalk volumes corresponding to the vehicular peak hours.



3) BUSES: Bus stops are present at the near side of the intersection in both the northwest and southeast directions. The bus stop serving the southeast direction serves WMATA Routes Q1, Q2, Q4, Q6, and C4. Fall 2017 WMATA data shows that an average of 49 boardings and 14 alightings occur at this stop. The bus stop servicing the northwest direction serves WMATA Routes Q1, Q2, Q4, Q6, C2, and C4, and 38 boardings and 30 alightings occur at this stop.

4) CRASH EXPERIENCE: Between January 1, 2015, and December 31, 2017, there were six crashes at the intersection (2 in 2015, 3 in 2016, and 1 in 2017). The one fatal crash was reported as an eastbound vehicle hitting a pedestrian with unknown reason. It occurred at 9 PM on a weekday. The surface condition was wet during that incident. The other crash types involved two rear end, two angle, and one "other" crashes. One rear end crash and one angle crash occurred due to the lack of drivers' full attention. The "other" type of crash occurred due to driving under the influence of alcohol. (Note: the supplied crash summary indicated that the 2017 data may be incomplete and unedited).

5) SPEED LIMIT: The posted speed limit is 45 mph on MD 586 (Veirs Mill Road) and 25 mph on Norris Drive and Monterrey Drive.

6) SIGHT DISTANCE: Stopping sight distance is adequate on MD 586. Intersection sight distance on Norris Drive is approximately 70 feet looking east because of a large tree stump in the southeast quadrant of the intersection and approximately 230 feet looking west. These distances are less than the required sight distance of 275 feet.

7) QUEUES, DELAYS, & GAPS: Minimal queues were observed with the longest queue on either side street approach not exceeding two vehicles. The average delay on the side streets was 18 to 75 seconds.

8) EXISTING TRAFFIC CONTROL: This two-way stop controlled intersection has stop signs on Norris Drive and on Monterrey Drive. There are stop signs on the frontage road as well. No marked crosswalks across MD 586, Norris Drive, or Monterrey Drive are provided. However, there is a crosswalk across the frontage road allowing pedestrians to access the bus stop. ADA ramps with detectable warning surfaces are provided on the northeast and southwest corners. The existing signs and pavement markings are placed correctly as per the MUTCD. However, the pavement markings on Norris Drive and Monterrey Drive are either faded or not provided.

9) DESIGNATED SCHOOL CROSSING: The study location is not located within a school zone. However, Newport Mill Middle School and Albert Einstein High School are both located at the end of Norris Drive (1/4 mile long) making the study intersection a primary crossing location for students.

10) FIELD OBSERVATIONS: A traffic engineer observed the intersection, specifically focusing on driver and pedestrian behavior, traffic patterns, and overall operations. The following summarizes the observations:
    a. Schoolchildren were observed constantly crossing MD 586 during the AM peak hour.
    b. Unsupervised children were observed having some difficulty crossing the street.
    c. Vehicles were observed to stop/slow if a pedestrian was in the process of crossing the street but did not stop for pedestrians waiting to cross.
    d. No bicyclists were observed.
    e. Buses were not observed to significantly impact traffic flow along MD 586.
    f. Intersection sight distance on Norris Drive is obstructed by large tree stump located in the southeast corner of the intersection.
    g. Street lighting is provided on MD 586 and Norris Drive.

11) WARRANT ANALYSIS SUMMARY: The traffic signal warrant analysis evaluation was based on the Maryland Manual on Uniform Traffic Control Devices (MUTCD), 2011 Edition. Vehicle and/or pedestrian volumes are not high enough warrant the installation of a full traffic control signal. Additionally, use of a pedestrian-activated signal was examined. With a crosswalk length of approximately 75 feet and a maximum pedestrian crossing of 38 people, the minimum requirements to consider a pedestrian-activated signal are met. **Table 1** shows a summary of the peak hour volumes and the two hours that met the warrant. See the **Appendix** for more detail.

Table 1: Vehicle and Pedestrian Volumes Summary

Peak Hour	Vehicle Volume on MD 586	Vehicle Volume on Norris Dr/ Monterrey Dr*	Pedestrians Crossing MD 586	Warrant					Ped-Activ. Signal
				1A	1B	2	3	4	
7:30 AM	3,202	30	10	No	No	No	No	No	No
10:45 AM	1,955	34	34	No	No	No	No	No	YES
1:45 PM	2,315	49	38	No	No	No	No	No	YES
4:30 PM	2,270	63	3	No	Yes	Yes	No	No	No

**Higher approach volume*

12) CAPACITY ANALYSIS: Capacity analyses were performed for the study intersection under existing conditions. **Table 2** provides a summary of the results of the capacity analysis performed using Synchro 9 and Highway Capacity Manual (HCM) methodology. The delay, volume-to-capacity ratio, level of service, and 95th-percentile queue lengths in feet are shown for each approach and the overall intersection.

Table 2: Summary of Capacity Analysis

Scenario	Approach	Synchro 9 (HCM2000) Results							
		Delay (sec/veh)		v/c Ratio		Level of Service		95th-% Queues	
		AM	PM	AM	PM	AM	PM	AM	PM
Existing Conditions	**Overall**	1.6	1.0	0.59*	0.57*	A	A	-	-
	Southeast	0.2	0.2	0.14	0.51	A	A	3	5
	Northwest	0.7	0.1	0.46	0.66	A	A	8	2
	Northeast	18.0	30.4	0.76	0.15	C	D	18	12
	Southwest	40.7	75.1	0.39	0.40	E	F	30	39

*Note: * Intersection Capacity Utilization (ICU) for overall intersection only*

In terms of overall intersection performance, it operates at LOS A during both peak hours and has an Intersection Capacity Utilization (ICU) below 60 percent. The southwest approach operates under poor LOS conditions of E and F during the AM and PM peak hours respectively.

Recommendations

The warrants for a full traffic control signal are not met at the study intersection. However, the criteria necessary to install a pedestrian-activated signal are met based on current weekday vehicle and pedestrian volumes. Additionally, many schoolchildren cross MD 586 at Norris Drive to reach Newport Mill Middle School and Albert Einstein High School from the neighborhoods east of MD 586. Therefore, a pedestrian-activated signal is recommended for this location. It is also recommended to construct sidewalk on both sides of MD 586, as necessary, to address gaps in sidewalk along Veirs Mill Road and provide pedestrian access to the proposed pedestrian-activated signal.

APPENDIX

Signal Warrant Summary

The traffic signal warrant analysis evaluation performed for the study intersection was based on the nine warrants outlined in Section 4C of the Manual on Uniform Traffic Control Devices (MUTCD), 2009 Edition. The first three warrants focus on the vehicle volumes at the intersection (eight-hour volumes, four-hour volumes, and peak-hour volume) while the fourth warrant focuses on pedestrian volumes. Warrant 5 relates to school crossings. Warrant 7 examines the crash history of the intersection. The other warrants are not applicable to this location.

Warrant #1 (Eight Hour Volume), Warrant #2 (Four Hour Volume), and *Warrant #3 (Peak Hour Volume)* have minimum requirements for vehicles per hour on both streets. These minimum volumes are NOT MET for most of the 10 hours counted for Warrant #1 and Warrant #2 for 70 % criteria. The volume at period of 7:15 AM to 8:15 AM individually meets the Warrant 1B and Warrant 2 condition, but the total volume combinations (8 hours for Warrant 1 and 4 hours for Warrant 2) do not fulfill the warrant condition. For Warrant 3, the traffic volumes during the 7:00 AM hour plot above the applicable curve in the 70% Factor Peak Hour graph (2,167 major street vehicles and 77 minor street vehicles) in the MUTCD. However, this warrant is intended for use in unusual cases, such as facilities that attract or discharge large numbers of vehicles over a short time; therefore, this warrant is not applicable at the study intersection.

Warrant #4 (Pedestrian Volume) requires a minimum traffic volume and minimum corresponding pedestrians per hour crossing the major street. The highest volume of pedestrians crossing the major street in one hour was 38 people, which did not meet the minimum thresholds of 93 and 75 pedestrians per hour. Warrant 4 is NOT MET. Warrant #5 *(School Crossing)* is intended for application where schoolchildren cross the major street at a designated school crossing. The intersection is not located within a school zone; therefore, Warrant 5 is not applicable. Warrant #7 (Crash Experience) requires five or more reported crashes, minimum volumes, and testing of alternatives before warranting a traffic signal. Based on the three most recent years of available crash data, only two crashes (angle +left turn) correctable by a traffic signal have occurred (year 2016) at the intersection. Therefore, Warrant 7 is NOT MET.

Table A1 summarizes the signal warrant results. **Table A2** summarizes the traffic volumes used in the signal warrant analysis. The results of the analysis indicate that a traffic signal is not warranted at the study intersection.

Table A1: Summary of Signal Warrant Analysis

Warrant	Description	Warrant Met?
1	Eight Hour Vehicular Volume	No
2	Four Hour Vehicular Volume	No
3	Peak Hour*	No*
4	Pedestrian Volume	No
5	School Crossing	N/A
6	Coordinated Signal System	N/A
7	Crash Experience	No
8	Roadway Network	N/A
9	Intersection Near a Grade Crossing	N/A

**The Peak Hour Warrant shall only be used in unusual cases with a high-volume special generator; volumes are high enough to meet Warrant 3, but it is not applicable at this location.*

Table A2: Summary of Hourly Vehicular and Pedestrian Volumes

Start of Hour	Vehicle Volume on MD 586 (Both Approaches)	Vehicle Volume on Norris Dr/ Monterrey Dr (Highest Approach)	Total Pedestrian Volume crossing MD 586 (total of both legs)	Meets Warrant?				
				1A	1B	2	3	4
6:15 AM	1,800	38	5	No	No	No	No	No
7:15 AM	2,185	72	9	No	Yes	Yes	No	No
8:15 AM	2,120	30	2	No	No	No	No	No
10:45 AM	1,955	34	34	No	No	No	No	No
11:45 AM	2,053	27	6	No	No	No	No	No
12:45 AM	2,019	36	6	No	No	No	No	No
1:45 PM	2,315	49	38	No	No	No	No	No
3:45 PM	2,875	35	9	No	No	No	No	No
4:45 PM	3,204	29	0	No	No	No	No	No
5:45 PM	2,870	28	1	No	No	No	No	No

Pedestrian-Activated Signal Analysis

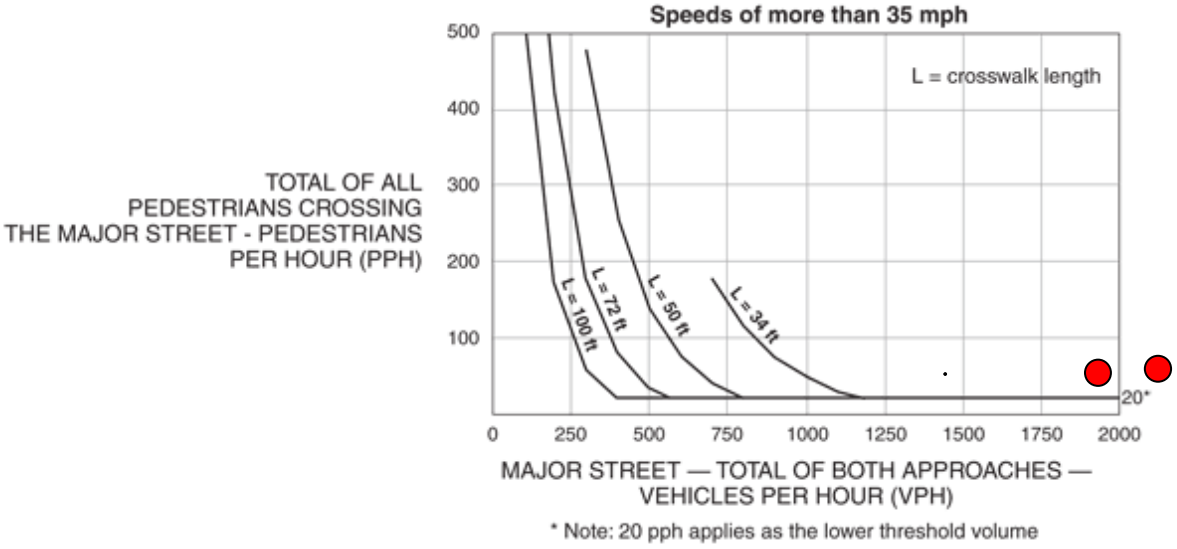
A pedestrian-activated signal was evaluated using guidance from Section 4F of the 2009 MUTCD. A pedestrian hybrid beacon (PHB), also known as a HAWK (**H**igh-intensity **A**ctivated Cross**W**al**K**), is used to warn and control traffic at an unsignalized location. The beacon would remain dark until actuated by a pedestrian pressing a walk button. The pedestrian-activated signal shown below is installed in Towson, Maryland.

MD 45 & Yarmouth Road

According to the MUTCD, a pedestrian hybrid beacon may be considered if the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding total of all pedestrians crossing the major street for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in Figure 4F-1 for the length of the crosswalk. See **Figure A1**.

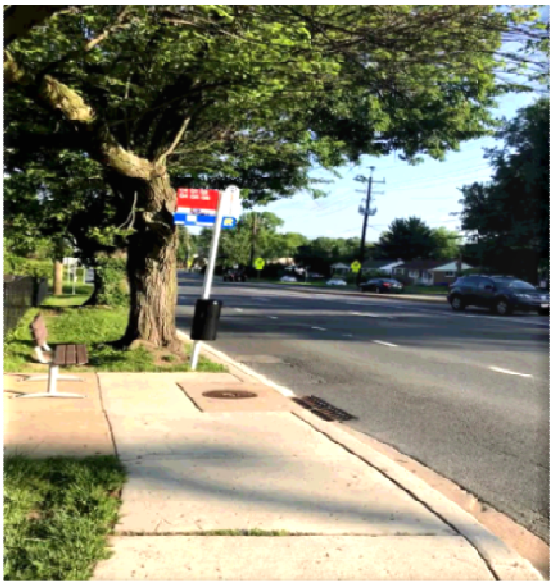
The width of MD 586 (Veirs Mill Road) is approximately 75 feet. The highest volume of pedestrians crossing MD 587 in an hour was 38 people (1:45 PM-2:45 PM) corresponding to major street total approach volume of 2,315 vehicles. Similarly, 34 people crossed the major street during the period from 10:45 AM to 11:45 AM against 1,955 vehicles. Therefore, two points fall above the appropriate curve. The guidelines established by the MUTCD in Figure 4F-1 are **satisfied** under existing conditions.

Figure A1: Pedestrian Hybrid Beacon Guidelines



Intersection Photographs

Northwest Bound MD 586



Southeast Bound MD 586

Northeast Bound Norris Drive

Southwest Bound Monterrey Drive

EXECUTIVE SUMMARY

A traffic study was performed for the intersection of MD 586 (Veirs Mill Road) at Arbutus Avenue in Rockville, MD, evaluating the need for a full color traffic signal, pedestrian-activated signal, or other traffic safety measures. The study evaluated the traffic control criteria as specified by the Maryland Manual on Uniform Traffic Control Devices (MUTCD 2011). While this study concludes that a traffic signal is not warranted, a pedestrian-activated traffic beacon could be considered. The following paragraphs summarize the preliminary findings and specific recommendations.

Primary Concern

As part of the Corridor Vision Zero Initiative, this location was identified as a candidate for upgraded traffic controls and pedestrian infrastructure.

Site Description

MD 586 at Arbutus Avenue is four-lane, urban other principal arterial oriented in the northwest/southeast direction. Arbutus Avenue is a two-lane road that forms a T-intersection to the northeast of MD 586. On-street parking is permitted on both sides of Arbutus Avenue. Arbutus Avenue has sidewalks on both sides. MD 586 has no sidewalks but has bike lanes on both sides in the shoulders.

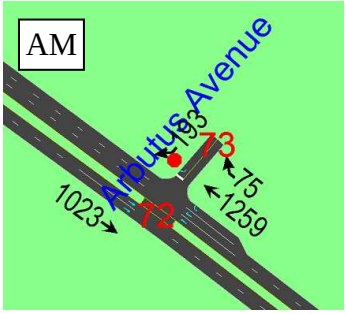
Land use in the vicinity of the intersection is residential. There is thick vegetation and grounds belonging to the Parkland Memorial Park on the southwest side of the intersection. Saint Jude Thaddeus Catholic Church and School are approximately 1,300 feet southeast of the study intersection.

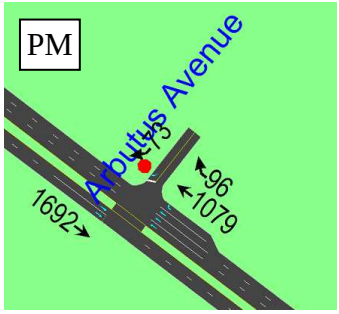
The nearest controlled crosswalk is approximately 1,500 feet northwest of the study intersection at the signalized intersection of MD 586 and Aspen Hill Road. Similarly, a signalized intersection with pedestrian signals and crosswalks is at MD 586 and Robindale Drive, which is approximately 2,100 feet southeast of the study intersection.

Summary and Findings

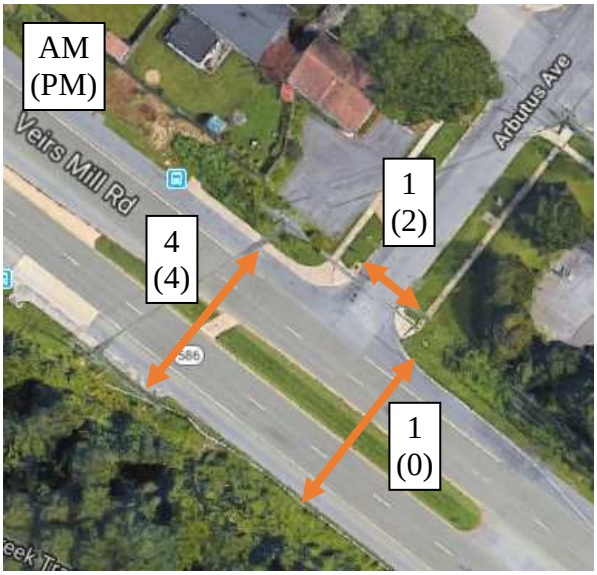
Traffic counts were performed on Tuesday, May 22, 2018. The AM and PM peak hours were 7:15-8:15 AM and 4:30-5:30 PM, respectively.

1) VEHICULAR TRAFFIC: Approximately 2,550 vehicles during the morning and about 2,950 vehicles during the evening peak hours entered the intersection. Peak hour traffic volumes are shown in the following images. SHA's Highway Location Reference identifies MD 586 as having an AADT of approximately 42,671 vpd in the vicinity of this intersection.





2) PEDESTRIAN TRAFFIC: During the eight hours counted, 19 pedestrians were recorded crossing MD 586 at the intersection. Five pedestrians crossed Arbutus Avenue. The following image shows the crosswalk volumes corresponding to the vehicular peak hours.



3) BUSES: A bus stop is present on the far side of the intersection in the northwest direction serving WMATA Routes Q1, Q2, Q4, Q5, and Q6. Fall 2017 WMATA data shows that an average of 22 boardings and 22 alightings occur at this stop. For the southeast direction, the nearest bus stop location is at the far side of the intersection of MD 586 and Parklawn Cemetery serving WMATA Routes Q1, Q2, Q4, Q5, and Q6. 31 boardings and 9 alightings occur at this stop.

4) CRASH EXPERIENCE: Between January 1, 2015, and December 31, 2017, there was one crash at the intersection (in 2016). There were no fatalities. There were no pedestrian/bicyclist crashes. The only recorded crash was an angle crash that occurred due to lack of the driver's full attention. (Note: the supplied crash summary indicated that the 2017 data may be incomplete and unedited).

5) SPEED LIMIT: The posted speed limit is 45 mph on MD 586 (Veirs Mill Road) and 25 mph on Arbutus Avenue.

6) SIGHT DISTANCE: Minimum intersection sight distance is adequate from Arbutus Avenue. The nearest obstructions are overhanging tree branches approximately 430 feet southeast of the study intersection. Trimming these branches would increase the sight distance to well beyond 500 feet.

7) QUEUES, DELAYS, & GAPS: Minimal queues were observed with the longest queue on southwest Arbutus Avenue reaching two vehicles. The average delay on Arbutus Avenue was 12 to 24 seconds.

8) EXISTING TRAFFIC CONTROL: This is a side-street, stop-controlled intersection with a stop sign on Arbutus Avenue. There is a ONE-WAY sign on MD 586 in the northwest direction. No marked crosswalks are provided. An opening for a pedestrian path in the median of MD 586 provides pedestrians access to each side of MD 586. ADA ramps with detectable warning surfaces are also provided. The existing signs and pavement markings are placed correctly per the MUTCD. However, no pavement markings are present on Arbutus Avenue.

9) DESIGNATED SCHOOL CROSSING: The study location is not located within a school zone.

10) FIELD OBSERVATIONS: A traffic engineer observed the intersection, specifically focusing on driver and pedestrian behavior, traffic patterns, and overall operations. The following summarizes the observations:
    a. Pedestrians were observed crossing MD 586 and Arbutus Avenue to access bus stops.
    b. No sidewalks are present on MD 586. Pedestrians were observed walking on the shoulders.
    c. No bicyclists were observed during the peak hour observations.
    d. Street lighting is provided on MD 586.
    e. Buses stop on the shoulders of MD 586 to minimize conflicts with vehicle traffic.
    f. Sight distance is adequate for pedestrians and vehicles exiting Arbutus Avenue.

11) WARRANT ANALYSIS SUMMARY: The traffic signal warrant analysis evaluation performed for the study intersection was based on the Maryland Manual on Uniform Traffic Control Devices (MUTCD), 2011 Edition. Vehicle and/or pedestrian volumes are not high enough to meet any of the warrants for the installation of a full traffic signal. Additionally, use of a pedestrian-activated signal was examined. With a crosswalk length of approximately 90 feet and a maximum pedestrian crossing of five people, the minimum requirements to consider a pedestrian-activated signal were not met. **Table 1** shows a summary of the volumes at the intersection.

Table 1: Peak Hour Vehicle and Pedestrian Volumes

Peak Hour	Vehicle Volume on MD 586	Vehicle Volume on Arbutus Avenue	Pedestrians Crossing MD 586	Warrant				Ped-activ. signal
				1A	1B	2	3	
7:15 AM	2,357	58	5	No	Yes	No	No	No
4:30 PM	2,867	22	4	No	No	No	No	No

12) CAPACITY ANALYSIS: Capacity analyses were performed for the study intersection to depict the existing condition of traffic operations. **Table 2** provides a summary of the results of the capacity analysis performed using Synchro 9 and Highway Capacity Manual (HCM) methodology. The delay, volume-to-capacity ratio, level of service, and 95th-percentile queue lengths in feet are shown for each approach and the overall intersection.

Table 2: Summary of Capacity Analysis

Scenario	Approach	Synchro 9 (HCM2000) Results							
		Delay (sec/veh)		v/c Ratio		Level of Service		95th-% Queues	
		AM	PM	AM	PM	AM	PM	AM	PM
Existing Conditions	**Overall**	**1.8**	**0.3**	**0.53 ***	**0.51***	**A**	**A**	**-**	**-**
	Southeast	0	0	0.33	0.54	A	A	0	0
	Northwest	0	0	0.40	0.23	A	A	0	0
	Northeast	-	-	-		-	-	-	-
	Southwest	24.1	12.2	0.53	0.14	C	B	76	12

** Intersection Capacity Utilization (ICU) for overall intersection only*

The results of the capacity analysis show that the intersection currently operates at an overall LOS A during the morning and during the afternoon.

Recommendations

The intersection did not meet the guidelines necessary to consider a full traffic signal or a pedestrian-activated signal based on current weekday vehicle and pedestrian volumes. However, the north side of intersection has a bus stop and there is an existing pedestrian path across the median to a park and another bus stop. Based on the posted speed limit, high vehicle and low pedestrian volumes, number of travel lanes, and distance to nearest controlled crossing, a pedestrian-activated beacon could be considered at this location and would be necessary since a marked crosswalk alone would not provide sufficient driver awareness of pedestrian activity.

APPENDIX

Signal Warrant Summary

The traffic signal warrant analysis evaluation performed for the study intersection was based on the nine warrants outlined in Section 4C of the Manual on Uniform Traffic Control Devices (MUTCD), 2009 Edition. The first three warrants focus on the vehicle volumes at the intersection (eight-hour volumes, four-hour volumes, and peak-hour volume) while the fourth warrant focuses on pedestrian volumes. Warrant 5 relates to school crossings. Warrant 7 examines the crash history of the intersection. The other warrants are not applicable to this location.

Warrant #1 (Eight Hour Volume), Warrant #2 (Four Hour Volume), and Warrant #3 (Peak Hour Volume) have minimum requirements for vehicles per hour on both streets. These minimum volumes are NOT MET for most of the 8 hours counted for Warrants #1, #2, or #3. The volume at 7:15 AM met the Warrant 1B condition, but the total volume combinations do not fulfill the warrant condition. Since Arbutus Avenue serves only right turning vehicles, a 70% deduction of right turn volumes was considered. Warrant #4 (Pedestrian Volume) requires a minimum traffic volume and minimum corresponding pedestrians per hour crossing the major street. The highest volume of pedestrians crossing the major street in one hour was five people, which did not meet the minimum thresholds of 75 and 93 pedestrians per hour. Warrant 4 is NOT MET. Warrant #5 (School Crossing) is intended for application where schoolchildren cross the major street at a designated school crossing. The intersection is not located within a school zone; therefore, Warrant 5 is not applicable. Warrant #7 (Crash Experience) requires five or more reported crashes, minimum volumes, and testing of alternatives before warranting a traffic signal. Based on the three most recent years of available crash data, only one correctable crash (angle +left turn) by a traffic signal has occurred (2016) at the intersection. Therefore, Warrant 7 is NOT MET.

Table A1 summarizes the signal warrant results. **Table A2** summarizes the traffic volumes used in the signal analysis. The results of the analysis indicate that none of the nine warrants are met for the study intersection. Hence, a traffic signal is not warranted at the study intersection.

Table A1: Summary of Signal Warrant Analysis

Warrant	Description	Warrant Met?
1	Eight Hour Vehicular Volume	No
2	Four Hour Vehicular Volume	No
3	Peak Hour*	No
4	Pedestrian Volume	No
5	School Crossing	N/A
6	Coordinated Signal System	N/A
7	Crash Experience	No
8	Roadway Network	N/A
9	Intersection Near a Grade Crossing	N/A

**The Peak Hour Warrant shall only be used in unusual cases with a high-volume special generator; volumes are not high enough to meet Warrant 3, nor is it applicable at this location.*

Table A2: Summary of Hourly Vehicular Volumes

Start of Hour	Vehicle Volume on MD 586 (Both Approaches)	Vehicle Volume on Valleywood Drive /Gail Street (Highest Approach)	Total Pedestrian Volume crossing MD 586 (Total of Both Legs)	Meets Warrant?				
				1A	1B	2	3	4
6:15 AM	1,743	44	4	No	No	No	No	No
7:15 AM	2,357	58	5	No	**Yes**	No	No	No
8:15 AM	2,088	40	1	No	No	No	No	No
10:45 AM	1,484	18	0	No	No	No	No	No
11:45 AM	1,623	13	0	No	No	No	No	No
3:45 PM	2,604	22	4	No	No	No	No	No
4:45 PM	2,866	21	4	No	No	No	No	No
5:45 PM	2,441	23	1	No	No	No	No	No

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The width of MD 586 (Veirs Mill Road) is approximately 90 feet. The highest volume of pedestrians crossing MD 586 in an hour was five people. No points fall within the appropriate curve. The guidelines established by the MUTCD in Figure 4F-1 are not satisfied under existing conditions.

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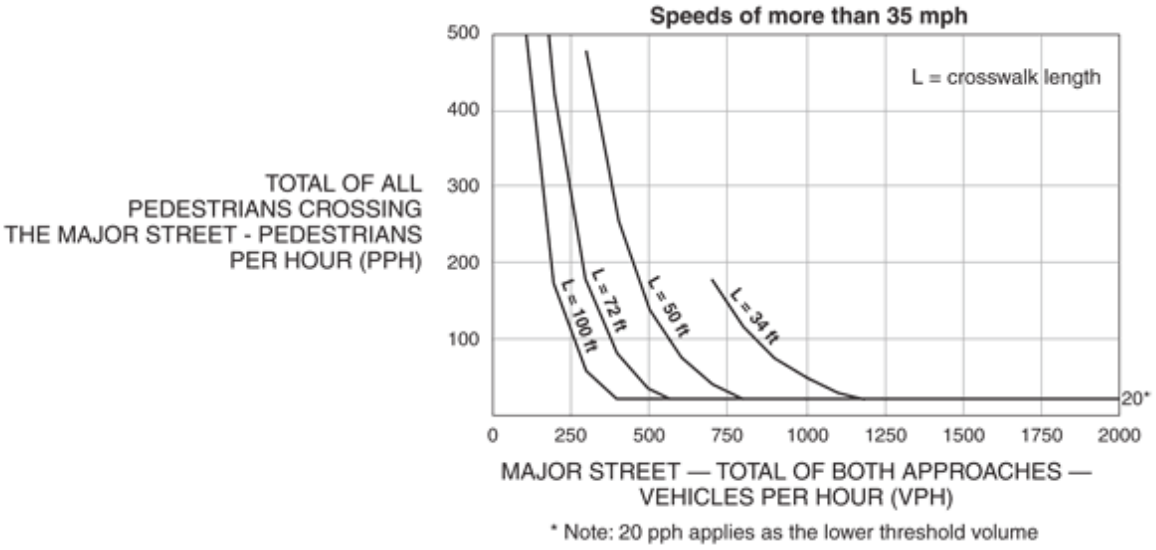

Intersection Photographs

Southeast Bound Veirs Mill Road

Northwest Bound Veirs Mill Road

Southwest Bound Arbutus Avenue