FREDERICK COUNTY

COMPLETE AND GREEN STREETS PLAN

JUNE 2022

A Letter from the County Executive

Dear Citizens,

The Complete and Green Streets Plan guides the development of a complete transportation network that is safe and accessible for all users, allows for all modes of travel, and accommodates users of all ages and abilities. Our streets are vital to our quality of life in Frederick County. As the County continues to grow and develop, our local street network also will need to grow and develop to meet the changing needs and expectations of our community.

Livable Frederick calls for the creation of a Complete and Green Streets Policy and Plan. The Complete and Green Streets policy was established in 2020 and serves as the basis for this plan. The plan provides a decision-making framework that can be used by planners, designers, and engineers to incorporate different roadway design components for a more inclusive and sustainable transportation network.

We look forward to implementation of this Plan and the realization of our goal of safe Complete and Green Streets for everyone.

Sincerely,

Jan. H. Gardner

Frederick County Executive

Acknowledgements

The development of this Plan was undertaken by Frederick County in response to the desire to establish county-wide guidance for the application of complete and green street components based on location and context. The purpose of this document is to provide a decision-making framework that can be used by planners and designers to incorporate different components for a more inclusive, equitable, and sustainable transportation network.

This Plan was prepared by the consultant firm, JMT, in collaboration with a Design Review Committee comprised of various divisions within Frederick County, ensuring that all aspects and implications of each proposed component was reviewed prior to recommendation within these guidelines. The members of the Design Review Committee are listed below.

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Introduction

Frederick County, Maryland is home to over 271,000 residents, with just under 73,000 of those residents living in the city of Frederick. (source: U.S. Census Bureau, Population Data for 2020) Much of Frederick County is considered rural with lower population density, however, the population density typically increases closer to and within the City of Frederick. The County is also home to a number of smaller towns, municipalities, and communities, many of which are anticipated to grow in the future. The residents and workers of Frederick County use the existing multi-modal transportation network to travel for employment, recreation, physical activity, errands, socialization, shopping, and much more. As areas within the County continue to grow, the transportation network must evolve to accommodate the changing needs of the community.

Downtown Frederick *source: FrederickCountyMD.gov*

Frederick County has developed a Complete and Green Streets Plan to provide design guidance to government agencies, consultants, private developers, and community groups on the planning, design, and operation of roadways and the overall transportation network to accommodate all users of all modes of transportation. This Plan stemmed from the policies established in the adopted 2020 Frederick County Complete and Green Street Policy and was a goal set forth in the Livable Frederick Master Plan (LFMP). This Plan is meant to supplement existing manuals and standards and should be referenced early in the planning and design process for transportation projects.

All draft material developed for this Complete and Green Streets Plan has been presented to and reviewed by the public and project stakeholders at a public meeting and a series of meetings with the Design Review Committee (DRC). This plan heavily incorporates the feedback received from the community to ensure that the multi-modal transportation network is appropriately developed for Frederick County.

PROJECT GOALS

Streets are vital to the quality of life for residents and visitors to Frederick County. As the County continues to grow and develop, the local street network will also need to grow and develop to accommodate the changing needs and expectations of the community. The purpose of this Complete and Green Streets Plan is to provide guidance for the planning and development of the transportation network within Frederick County to effectively accommodate users of all modes of travel and users of all ages and abilities. The County should work to develop a complete transportation network that is safe, equitable, and accessible for all users. This plan provides guidelines for the development and implementation of future transportation projects to ensure that these needs are met.

The Complete and Green Streets Plan includes guidance for the environmental components within the planning and development of the transportation network in Frederick County. The Green Street guidelines in this Plan will enhance the environmental sustainability and user experience of the transportation network through the implementation of future new and retrofit projects.

HOW TO USE THIS PLAN

The guidelines and recommendations provided in the Complete and Green Streets Plan should be referenced and used in the following circumstances:

During the planning stage of future roadway projects or land development projects

During the design stages of future roadway projects or land development projects

When there is an opportunity to reconsider the existing roadway features during a retrofit or resurfacing project

For each of these situations, this Complete and Green Street Plan should be referenced in the early stages of the process to identify the context of the project and the appropriate design features and elements that should be included. The Plan should also be continually consulted throughout the project lifecycle because design is iterative, and additional details may become known about the context of a project in the later stages of the community planning and development processes. To provide focused guidance for both multi-modal transportation projects and projects that incorporate green infrastructure and focus on environmental sustainability, **this Plan has been separated into two parts: a Complete Streets Manual and a Green Streets Manual.**

Users of the **Complete Streets Manual** should analyze the project in question and consider the established guidelines by taking the following steps:

1. **Use the Context Sensitive Design Process (page 9) to determine which context zone and street type applies most closely to the project in question.**
2. **Review the design element checklist and selection matrices (pages 19 to 23) to understand which design elements and treatments are recommended to be included in the project based on the appropriate context zone and street type.**
3. **Review the Roadway Facilities section to learn how the user experience of multi-modal facilities can be enhanced by roadway geometry, intersection geometry, traffic calming, and environmental features.**
4. **Review the Pedestrian, Bicycle, and Shared-Use Facilities sections to learn more about what features can be implemented in the design of these facilities. Analyze the sample projects in these sections for additional guidance on how to use this manual.**

Users of the **Green Streets Manual** should analyze the project in question and consider the established design considerations by taking the following steps:

1. **Review the checklist (page 59) of potential green street design considerations to be used during project development and identify potential issues within the project area.**
2. **Review the Best Management Practices (BMPs) Selection Matrices (pages 60 to 62) to understand which green infrastructure elements are most conducive in different roadway Context Zones. Refer to the Complete Streets Manual to determine the roadway Context Zone that applies to the project.**
3. **Review examples of Best Management Practices (BMPs) to determine which green infrastructure elements may be appropriate for the project and understand the benefits and challenges of each element.**
4. **Review the Plant Selection section to identify the appropriate plant species for the selected green infrastructure element.**
5. **Review the Maintaining Green Streets section to learn how to maximize the survivability and cost effectiveness of the system.**

Each project will have unique existing conditions and constraints that could limit the ability to follow the recommendations within this manual. This Plan provides guidelines for developing a multi-modal and environmentally conscious network and is intended to be considered in conjunction with engineering judgement and best practices. Frederick County will have the ultimate authority to determine the context zone and roadway type of a project on a case-by-case basis.

The Complete and Green Street Plan is intended to supplement existing manuals and standards that have been adopted for Frederick County and the State of Maryland, along with nationwide design guidance. These documents include the following:

- Maryland Manual on Uniform Traffic Control Devices (MdMUTCD),
- Guidance from the American Association of State Transportation Officials (AASHTO)
- Guidance from the National Association of City Transportation Officials (NACTO)
- Maryland Department of the Environment (MDE)
- Guidance from the Americans with Disabilities Act (ADA)
- Frederick County Streets and Roads Manual
- 2020 Frederick County Complete and Green Streets Policy
- Livable Frederick Master Plan
- 2021 Frederick County Towards Zero Deaths Plan
- Other policies and documents identified by the state and Frederick County.

More information about these documents can be found in the Complete Streets Additional References section on page 52 and the Green Streets Additional References section on page 92.

This Plan establishes guidelines for the roadway and green infrastructure design of County-owned roads and privately owned roadways located within Frederick County. The Complete and Green Streets Plan will help shape the County's multi-modal goals and vision for the state-owned roads within Frederick County and can be used as a planning reference document during discussions between the County and the Maryland Department of Transportation State Highway Administration (MDOT SHA).

Complete Streets Manual

Complete Streets

Complete Streets is a term used to designate the need for roads and streets to function not only as a transportation route for vehicles. Rather, streets should serve as a mechanism to connect people to places while accommodating all individuals and modes of transportation. The concept of Complete Streets encompasses many approaches to planning, designing, and operating roadways and rights-of-way with all users in mind to make the transportation network accessible, inclusive, safer, and more efficient.

Downtown Frederick *source: VisitFrederick.org*

A Complete Street is defined and described as one that safely and adequately accommodates motorized and non-motorized users, including pedestrians, bicyclists, motorists, freight vehicles, emergency vehicles, and transit riders of all ages and abilities, in a manner appropriate to the function and context of the facility. On a Complete Street, it is safe and easy to walk or bicycle to school, cross the streets, and access shops and restaurants.

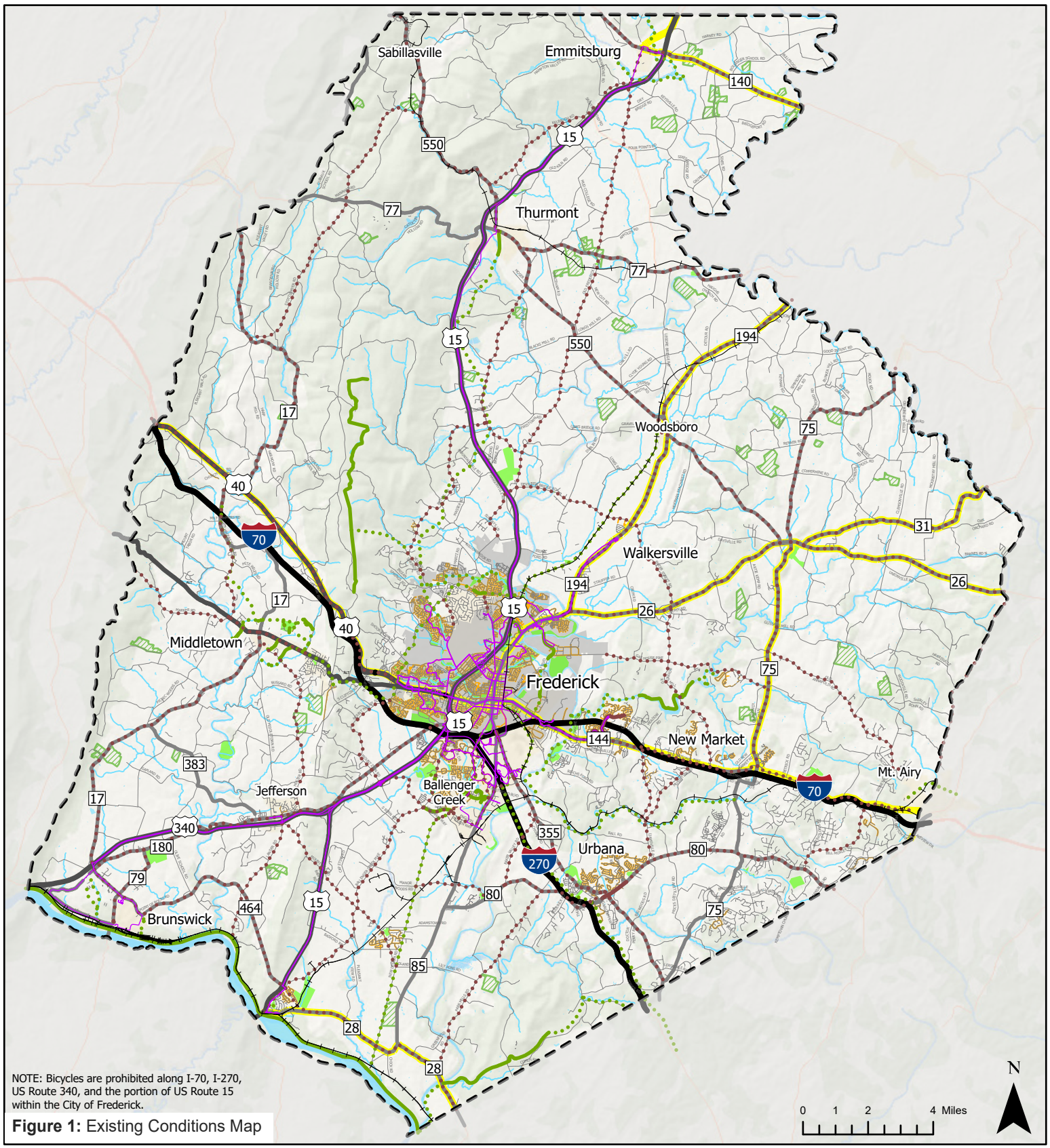
According to the National Complete Streets Coalition: **"A Complete Streets approach integrates people and place in the planning, design, construction, operation, and maintenance of our transportation networks. This helps to ensure streets are safe for all people of all ages and abilities, balance the needs of different modes, and support local land use economies, cultures, and natural environments."**

The approach to designing and implementing Complete Streets will vary throughout the County depending on the context of the roadway corridor, which is determined by the surrounding roadway features and land uses. A Complete Street in a more rural location, near Fairhaven for example, will look different than a Complete Street in the more commercial and urban City of Frederick. Some streets within the same town or neighborhood may offer different bicycle and pedestrian facilities based on these contextual distinctions. Complete Streets function as a system, ensuring that the transportation network as a whole provides safe and efficient access for all roadway users, and provides designated spaces for each mode when needed.

Existing Multi-Modal Network

Frederick County is a largely rural county with pockets of denser population near larger towns and cities. The goal of the existing multi-modal network is to provide pedestrian, bicycle, and transit routes in these areas of larger population density, while also supporting the connectivity for all modes of transportation to the surrounding, less dense areas. The existing multi-modal transportation network within Frederick County is shown in **Figure 1.** This map includes available GIS data for roads, railways, and transit routes, along with existing pedestrian and bicycle facilities.

EXISTING CONDITIONS MAP



NOTE: Bicycles are prohibited along I-70, I-270, US Route 340, and the portion of US Route 15 within the City of Frederick.

Figure 1: Existing Conditions Map

LEGEND

- County Boundary
- County Roadway
- State Roadway
- US Route
- Interstate
- Railroads
- Streams
- Existing Sidewalk
- Existing Bus Routes
- Proposed Off-Road Trails
- Existing Off-Road Trails
- Proposed On-Street Bicycle Facility
- Existing On-Street Bicycle Facility
- Maryland State Highway Signed Bicycle Route
- City of Frederick
- Waterways
- Parks
- Agricultural Land Preservation

Source: Frederick County and Maryland Open Data Portal.

EXISTING PEDESTRIAN FACILITIES

The pedestrian facilities within Frederick County are heavily concentrated within the City of Frederick, Urbana, and Ballenger Creek to accommodate the larger population density of these cities and towns. The sidewalk networks in these denser areas branch extensively throughout the roadways network and tend to provide clear connections from the residential areas to the commercial and downtown areas. The existing sidewalks in the City of Frederick, Urbana, and Ballenger Creek are in relatively good condition. Outside of these denser areas, sidewalk networks appear sporadically to accommodate some smaller clusters of residences and retail areas as necessary. Sidewalks are not typically provided along existing roads in the rural parts of the County, but there are a few disconnected segments of paved and natural trails available for pedestrian use. There are several proposed paved and natural trails throughout the rural parts of Frederick County that will help provide more opportunities for recreational pedestrian activity as they are implemented.

C&O Canal National Historic Park
source: VisitFrederick.org

EXISTING BICYCLE FACILITIES

There are several state roadways in the County that are signed as Maryland State Highway Signed Bicycle Routes, including MD 26, MD 75, MD 31, MD 194, as well as US Route 40. These routes typically identify the wide shoulders along these roadways as the intended bicycle facility and create a large-scale network throughout the County. On-road bicycle facilities are not common on County-owned roadways, and existing segments are discontinuous and not connected into a network. The Frederick County Bikeways and Trails Plan proposes a large network of on-street bicycle facilities around Frederick County to provide enhanced bicycle connections. There are a few segments of paved and natural trails available. The termini of these existing trails typically do not connect to other facilities to create a loop system or countywide trail network. The proposed paved and natural trails throughout Frederick County will help provide more connectivity between the existing trails and the signed bicycle routes to better accommodate bicyclist patterns.

Bicycles are specifically prohibited along I-70, I-270, US Route 340, and a portion of US Route 15 within the City of Frederick.

EXISTING TRANSIT FACILITIES

The existing bus system in Frederick County provides connections throughout the City of Frederick and extends out to Brunswick, Walkersville, Ballenger Creek, Hood College, Frederick Community College, Mount St. Mary's College, Fort Detrick, and the Potomac River. The bus services focus primarily on serving more populated cities and towns within the County and major trip generators including colleges and the Army installation. Outside of the City of Frederick and Ballenger Creek, the bus routes generally run along US Routes and interstates and do not extend into many residential neighborhoods.

Rail travel also provides additional transit options for the residents and commuters of Frederick County. The Maryland Transit Administration (MTA) operates a MARC train line, the Brunswick Line, which runs from Union Station in Washington, D.C. to the City of Frederick, Brunswick, Point of Rocks, and Monocacy stations.

ADDITIONAL EXISTING FACILITIES

The Frederick Municipal Airport (FDK) is located on the east side of the City of Frederick. This is a public facility that is designated as a reliever airport for Baltimore/Washington International Airport (BWI) and is considered the second busiest airport in Maryland with more than 90,000 aircraft operations annually. This airport is used by pilots and passengers for business, personal, and recreational flying activities.

Frederick Municipal Airport
source: VisitFrederick.org

NETWORK RECOMMENDATIONS

The existing multi-modal network in Frederick County has opportunities to provide additional connectivity for all users and modes of transportation throughout the County. Enhancing or implementing additional bicycle facilities along County-owned roadways would provide improved access from residential areas to the downtown and commercial areas. Improved connectivity for bicyclists would allow users to safely make longer trips more directly, benefiting the quality of life for the residents and commuters of Frederick County.

The trail networks that are currently proposed within the Frederick County Bikeways and Trails Plan will help provide recreational opportunities for pedestrians and bicyclists, especially within the more rural parts of the County. However, the County should consider the proposed termini of these routes to better connect to existing or other proposed trail facilities to create a loop system and connected network. For example, some of the proposed trails end near roadways that are designated as Maryland State Highway Signed Bicycle Routes. These proposed trails could be extended to connect with these signed routes to provide a more complete bicycle network and accommodate additional trips for trail users within Frederick County.

Walkersville Southern Railroad
source: BikeFrederick.org/mct

The existing bus routes should be analyzed to determine where new connections may be necessary to facilitate the use of the proposed trail systems. For example, when the proposed sections of the Hagerstown and Frederick Trolley Rails to Trails project are implemented, a bus connection to Middletown along I-70 to the end of the proposed trail in that area would help enable residents to access the facility. The bus route along MD 194 could also be extended to reach the end of the proposed Frederick and Pennsylvania Line Railroad Trail in the Woodsboro area.

Context Sensitive Design Process

A context sensitive design approach acknowledges that a community is best served by a roadway network that is designed to provide the transportation facilities that are appropriate for the characteristics and needs of the community and its surrounding setting. Frederick County can use this approach to efficiently enhance the transportation network by evaluating the given context and transportation needs of a project to determine what multi-modal elements are most appropriate to include. For example, a roadway in the heart of the City of Frederick may have greater multi-modal needs than a roadway in the rural area of Wolfsville. Analyzing the context of the roadway and the street type within that context will guide the implementation of multi-modal facilities to create an effective and purposeful transportation network for all users. The recommended steps of the Context Sensitive Design Process are as follows:

- ☑ **1a. Identify the project location and evaluate existing conditions.**
- ☑ **1b. Determine the Context Zone of the project location.**
- ☑ **1c. Determine the Roadway Type being considered.**
- ☑ **2. Identify multi-modal design elements to be included in the project, following steps 2-4 outlined in the How to Use this Plan section on page 2.**

Each project will have unique existing conditions and constraints that could limit the ability to follow the recommendations within this manual. This Plan provides guidelines for developing a multi-modal and environmentally conscious network and is intended to be considered in conjunction with engineering judgement and best practices. Frederick County will have the ultimate authority to determine the context zone and roadway type of a project on a case-by-case basis.

CONTEXT ZONES

The Maryland Department of Transportation State Highway Administration (MDOT SHA) Context Driven Guide (CDG) is a planning and design resource that offers guidelines centered on establishing safe and effective multi-modal transportation systems. These guidelines present a growing opportunity to deliver safer and more efficient transportation alternatives to Maryland residents by designing roadways based on the built environments and user characteristics that define their context. The CDG balances two priorities: access and mobility. Historically, the primary design function of roadways has been auto-mobility, regardless of land-use context. This approach put all non-motorized modes at an inherent disadvantage by not considering the needs of the diverse set of users. This disadvantage can create significant safety issues and compromise accessibility for pedestrians, bicyclists, and transit riders. To proactively address this historical imbalance, the CDG recommends that engineers and planners consider the four following critical factors in the planning, design, construction, and operation of transportation infrastructure: safety, land use, environmental culture, and community livability.

MDOT SHA Context Driven Guide
source: Roads.Maryland.gov

Because these factors vary significantly throughout the State of Maryland, the guidelines established six unique context zones that provide the first step toward a functional, safe, and equitable transportation network throughout the State. The CDG identifies five of these six context zones within Frederick County: **rural, suburban, suburban activity center, traditional town center, and urban center.** Urban Core is the only context zone that is not found within Frederick County. The map of context zones within Frederick County, as established by the CDG, are shown in **Figure 3** on page 12. For graphical purposes, suburban activity center and traditional town center areas are shown with the same color symbology per the MDOT SHA data in **Figure 3**. For additional information regarding these context zones, please see the Complete Street Additional References section on page 52.

RURAL CONTEXT ZONE

The CDG describes the rural context zone as having the lowest population density of the six context zones. These rural areas are primarily a mix of agricultural uses and green space, with some scattered development in residential clusters. Trip distances are typically longer, as origins and destinations are fewer and farther between. Mobility is considered the primary transportation need within the rural context areas. This context zone represents 78% of Frederick County's land area, but only a fraction of the overall population.

SUBURBAN CONTEXT ZONE

The suburban context represents approximately 20% of the land area in the County. These areas typically contain primarily single-family residential developments, office parks, commercial strip retail areas, and neighborhood-level civic and cultural facilities. These developments generally focus on off-street parking and discourage non-automobile trips. Roadway configurations offer increased mobility but have fewer destinations that are accessible by foot or bike.

SUBURBAN ACTIVITY CENTER CONTEXT ZONE

According to the CDG, suburban activity centers are located outside of the major urban centers and typically found along or at the intersection of major arterials. They feature a medium diversity of uses, including residential, office, and retail facilities. Development is at a much lower density than that in urban areas, and typically consists of detached low-rise structures. Off-street parking is typically located between the structures and the roadway. These areas often serve a variety of modes and trip types, requiring a balanced approach between access and mobility. The suburban activity center and the traditional town center zone, combined, represent roughly 2% of the land area in Frederick County.

TRADITIONAL TOWN CENTER CONTEXT ZONE

The traditional town center context zone, while smaller and less dense than the urban context, is still characterized by a high diversity of use types, including residential, office, retail, civic, and cultural facilities. Structures are typically mid- to low-rise buildings and are oriented toward the street with no setbacks. Parking is often provided on-street along the main thoroughfare, with additional parking at the rear of the building accessible by alleys or other minor streets. These areas often serve the dual purpose of accommodating both short trips in the areas surrounding the commercial corridor as well as longer pass-through trips. While the need for mobility through these areas exists, it is somewhat exceeded by the need for internal circulation within the context. The suburban activity center and the traditional town center zone, combined, represent roughly 2% of the land area in Frederick County.

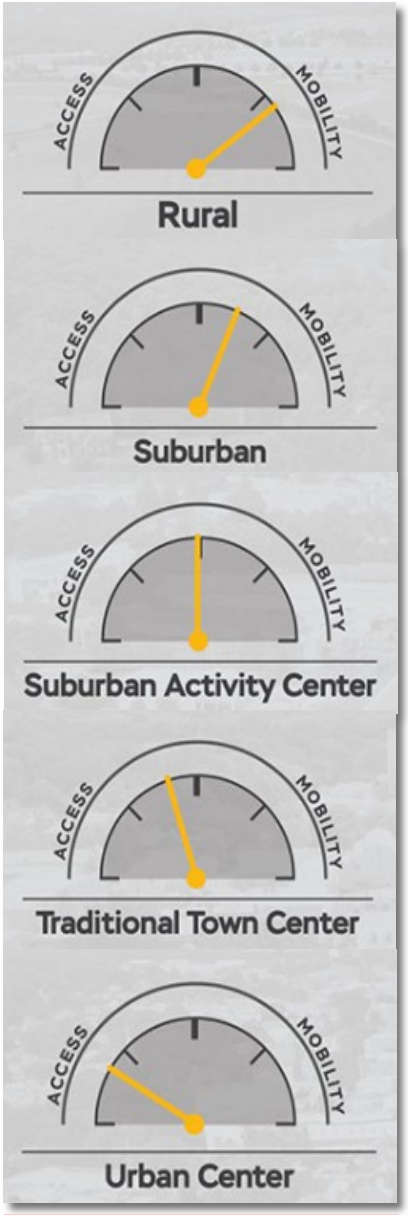


Figure 2: Context Zones Access and Mobility Balance
source: Roads.Maryland.gov

URBAN CENTER

According to the CDG, the urban center context is characterized by a high diversity of uses – including multi-family residential, office, retail, entertainment, civic, and cultural facilities – while having a moderately high density of development. Urban centers are typically characterized by mid-rise structures, minimal setbacks, a variety of street wall frontages, and off-street parking. Urban Centers may be either large commercial business districts in historic towns or newer, transit-oriented developments centered around a metro station. Because of its development density and diversity of uses, this land-use pattern generates a moderate to high volume of non-motorized trips. While the need for mobility through these areas does exist, it is exceeded by the need for internal circulation within this context. This zone represents less than 0.2% of the land area in Frederick. Within the boundary of the County, the only instance of an urban center is

entirely within the limits of the City of Frederick. Therefore, the Frederick County government will not likely have any proposed projects within an urban center context zone.

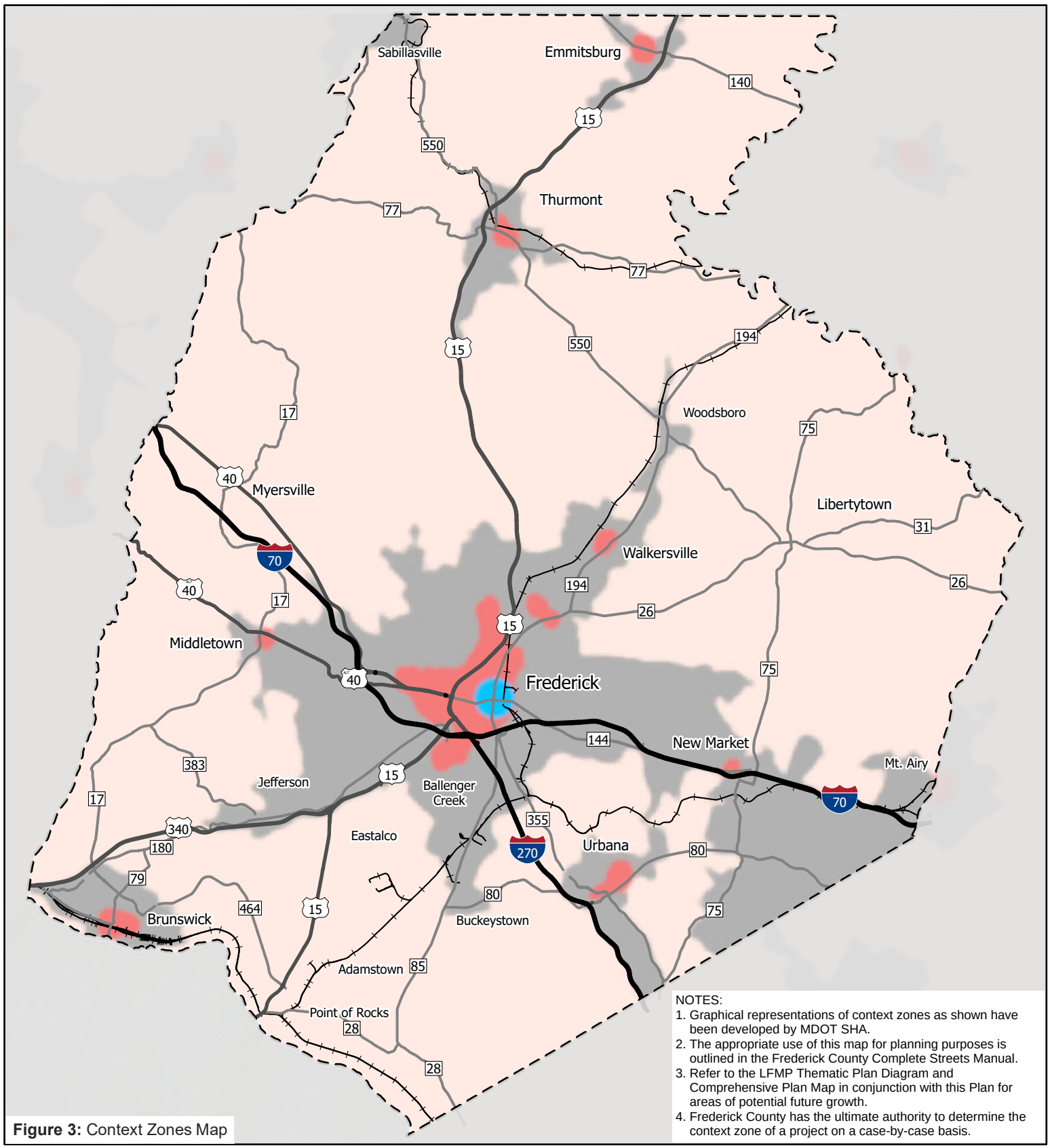
GROWTH AREAS

To guide future land use decisions, Community Growth Areas were identified on the Thematic Plan Diagram in the Livable Frederick Master Plan (LFMP) and the Comprehensive Plan Map for Frederick County. These are areas within the County where new growth and development are anticipated to occur in municipalities and unincorporated areas. These Growth Areas were defined by analyzing the character, location, scale, spread, and distribution of communities and municipalities within the County. Notably, as planning has progressed in the County, Growth Areas that reflect specific types of development character have been created, including transit corridors and suburban retrofit strategies.

It is important when identifying the context zone of a transportation project, to also recognize the proximity of the project location to these potential Growth Areas. As an area experiences growth and development, the respective context zone of the area may change over time to one with more development density that would require additional multi-modal accessibility. A project located within a Growth Area may warrant additional or different transit or bicycle and pedestrian accommodations than its current context zone would recommend. Planning for the future needs of the communities and municipalities within potential Growth Areas can minimize the expenses associated with future roadway retrofits to incorporate multi-modal facilities at a later time.

Additional details regarding the types of Growth Areas identified within Frederick County are included in the LFMP and on the Comprehensive Plan. These documents should be referenced in conjunction with this Plan when identifying the context zone of a project.

CONTEXT ZONES MAP



NOTES:
1. Graphical representations of context zones as shown have been developed by MDOT SHA.
2. The appropriate use of this map for planning purposes is outlined in the Frederick County Complete Streets Manual.
3. Refer to the LFMP Thematic Plan Diagram and Comprehensive Plan Map in conjunction with this Plan for areas of potential future growth.
4. Frederick County has the ultimate authority to determine the context zone of a project on a case-by-case basis.

Figure 3: Context Zones Map

LEGEND

- County Boundary
- Railroad
- State Roadway
- US Route
- Interstate

Context Zones

- Urban Center (Zone B)
- Suburban Activity Center / Traditional Town Center (Zone C)
- Suburban (Zone D)
- Rural (Zone E)

N

0 1 2 4 Miles

Source: Frederick County and Maryland Open Data Portal.

ROADWAY TYPES

The Livable Frederick Master Plan for Frederick County developed a transportation functional classification system based on several factors such as traffic volume and speed, trip length of those driving on the road, and the degree of access control. These classifications include Freeway/Expressway, Major and Minor Arterial, Collector Roads and Local Roads. This manual uses the established transportation functional classification system as a basis and identifies additional roadway types that provide more specific classifications.

Each project will have unique existing conditions and constraints that could limit the ability to follow the recommendations within this manual. This Plan provides guidelines for developing a multi-modal and environmentally conscious network and is intended to be considered in conjunction with engineering judgement and best practices. Frederick County will have the ultimate authority to determine the context zone and roadway type of a project on a case-by-case basis.

Each of the context zones within Frederick County encompass a combination of these roadway types that together provide the appropriate balance of mobility and access to serve the surrounding area and land uses. This manual, therefore, separated these roadway types into two functional groups: **Mobility Roadways** and **Access Roadways.** The primary function of a mobility roadway is to move travelers between locations efficiently and safely. These roads have limited connecting access points and typically higher traffic volumes and speeds. An access roadway focuses on providing increased access to desired destinations for a range of users, through connecting entrances and driveways and reduced traffic flow. While no roadway type is solely mobility driven or access driven, the classification of roadway types into either a Mobility Roadway or an Access Roadway intends to show a roadway's primary function. **Table 1** provides a breakdown of the eight types of mobility and access roadways.

Table 1: Roadway Types: Mobility and Access

Roadway Types	
Mobility	**Access**
Freeway / Expressway (F/E)	Commercial Street (CS)
Arterial Road (AR)	Connector (CN)
Collector (CL)	Neighborhood Street (NS)
Boulevard / Parkway (B/P)	Alley (A)

The transportation network within Frederick County utilizes different combinations of these roadway types to accommodate the unique balance of mobility and access needs of each of the five context zones. These combinations of roadways for each context zone are reflective of the traffic volumes and user needs of the respective context zone. While all roadway types can be found in all context zones, **Table 2** identifies the roadway types that typically represent the majority of roadways in each of the five context zones. This table also shows how the balance between mobility and access within a transportation network shifts as the context of an area changes.

Table 2: Roadway Types: Context Zones

Roadway Types								
Context Zone	**Mobility**				**Access**			
	F/E	AR	CL	B/P	CS	CN	NS	A
Rural	•	•	•			•	•	
Suburban		•	•	•		•	•	
Suburban Activity Center		•	•	•	•	•	•	•
Traditional Town Center			•	•	•	•	•	•
Urban Center					•	•	•	•

FREEWAY / EXPRESSWAY (F/E)

According to the Livable Frederick Master Plan (LFMP) for Frederick County, a Freeway / Expressway is a divided highway that carries a high volume of traffic at high design speeds for interstate and inter-county travel. It connects the major centers of activity and provides uninterrupted flow from origin to destination. Access on a Freeway / Expressway is fully controlled by grade separated interchanges. These roads are intended primarily for vehicular mobility, with buses sometimes using these roads as well. Medians and roadway lighting are always recommended, but roundabouts, on-street parking, speeds humps/cushions, and dedicated transit facilities or features are not recommended on Freeways / Expressways. Pedestrian and bicycle accommodations are not recommended along this roadway type due to the high travel speeds and lack of access points to destinations. Freeways / Expressways in Frederick County include I-70, I-270, and US 340. The recommended roadway, pedestrian, bicycle, and transit design features for Freeways / Expressways are the same for all context zones, so context-specific guidance for design features of this roadway type is not included in this manual.

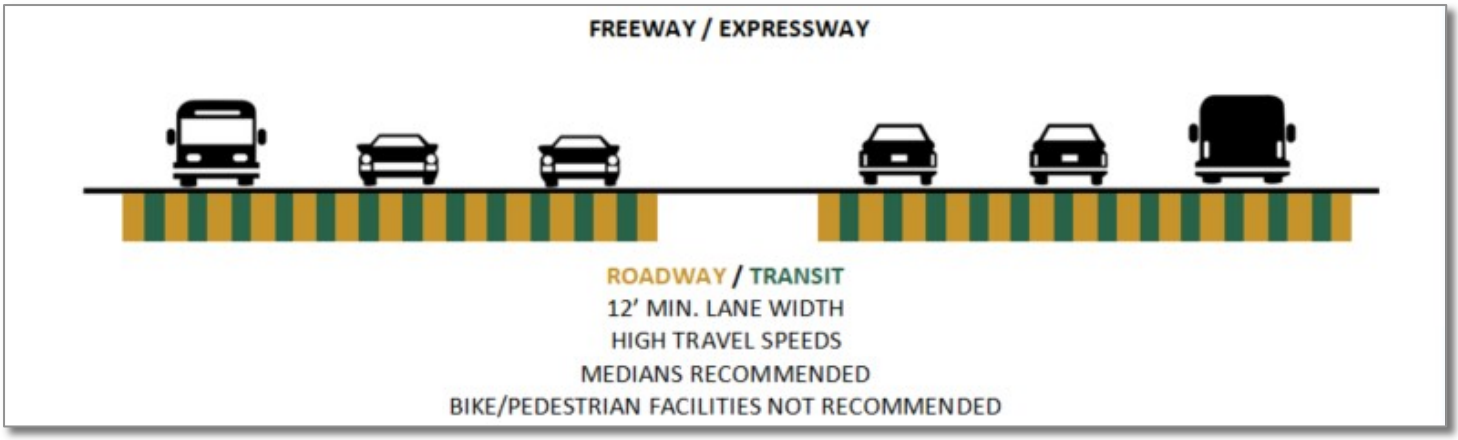


Figure 4: Freeway / Expressway Typical Section

ARTERIAL ROAD (AR)

An Arterial Road carries a moderate to high volume of traffic for travel within the County, or for travel to and from adjacent counties. These roads typically provide access to the interstate system and collector roads. Access to and from these roadways is typically allowed from intersecting public streets, but not directly with adjoining parcels. Signalized intersections may be present but are not common along Arterial Roads, especially in a rural and suburban context zone. Mobility for vehicles and buses is the primary focus, and pedestrian and bicycle facilities are not typically recommended for major arterials within a rural context due to safety concerns and access limitations. When located in a suburban or suburban activity center context zone, pedestrian and bicycle accommodations may be included in the form of an off-road shared-use facility with a horizontal buffer from the roadway.

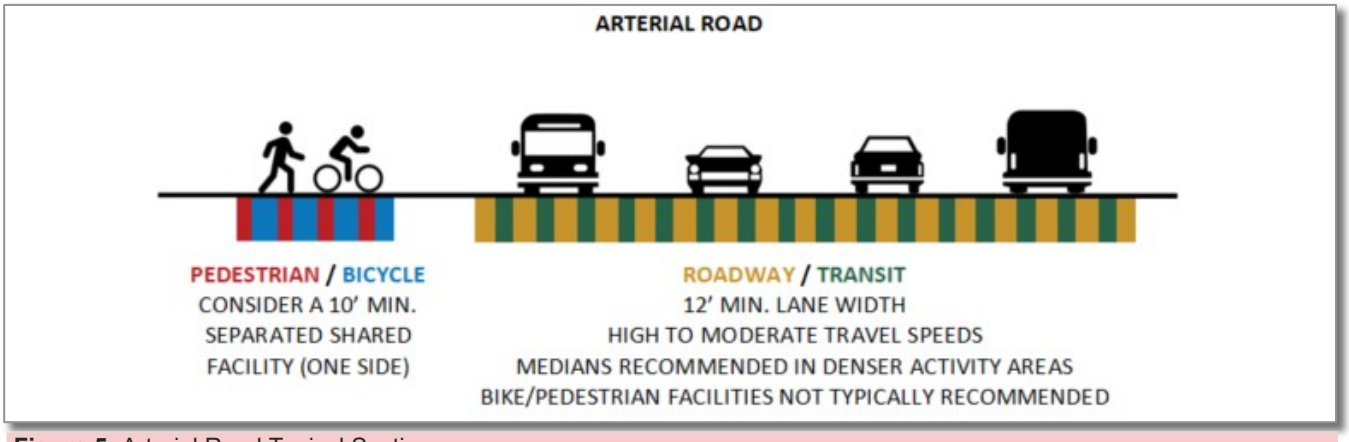


Figure 5: Arterial Road Typical Section

COLLECTOR (CL)

A Collector combines and distributes moderate traffic from neighborhoods to the arterial roadway system. These roads may allow some direct access to adjacent properties such as community shopping areas, schools, parks, and residential developments. Signalized intersections are not typical on Collector roads, as most access points connect to Collector roads at stop-controlled intersections. Mobility for vehicles and buses are the primary focus of these roadways, however, pedestrian and bicycle facilities may be implemented along Collector roadways between destination points that are reasonably close to one another. Pedestrian facilities should typically only be included on Collectors within a suburban activity center or traditional town center context zone. Destinations in a rural or suburban context may be too far apart to justify a pedestrian connection in most locations.

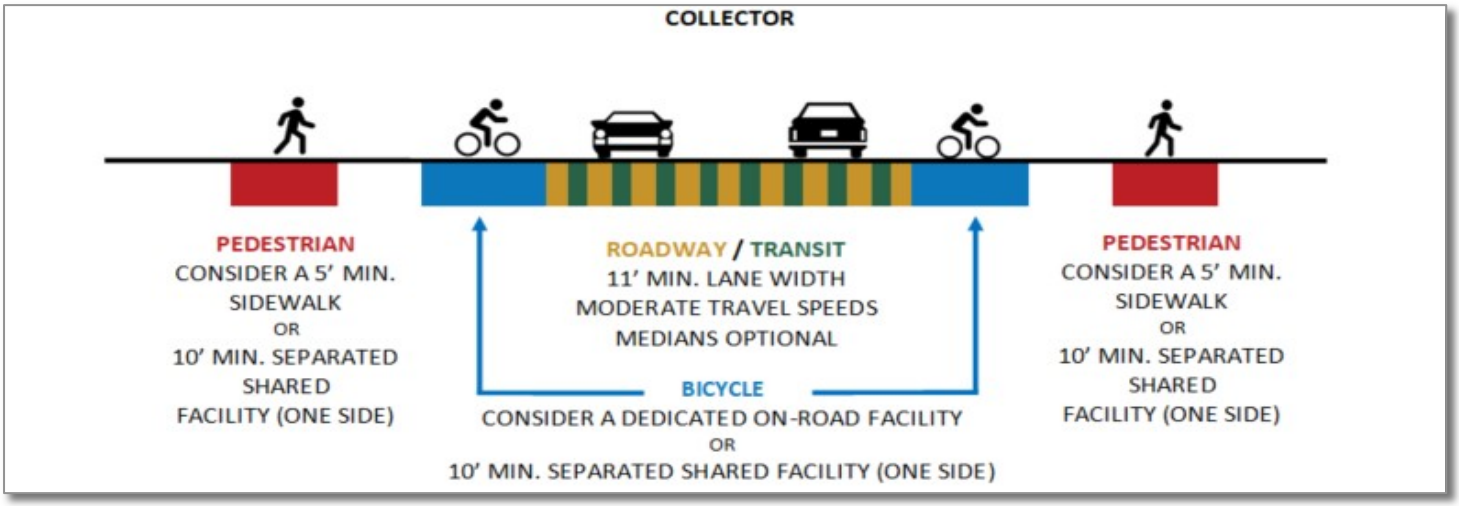


Figure 6: Collector Typical Section

BOULEVARD / PARKWAY (B/P)

A Boulevard / Parkway connects a moderate to high volume of traffic between prominent places, buildings, parks, or plazas and emphasize throughput of traffic. These roadways may or may not have urban characteristics, and typically have a shared center left turn lane or median between multiple travel lanes. Signalized intersections are common along Boulevard / Parkways. These roadways are typically found in suburban, suburban activity centers, and traditional town center context zones. Bicycle accommodations are usually provided in the form of a shared-use path or on-road bicycle facility. In a suburban context, pedestrian facilities can be included between close destination points and prominent places along Boulevards / Parkways. Within suburban activity centers or traditional town centers, sidewalks or shared-use paths are more common along these roadways.

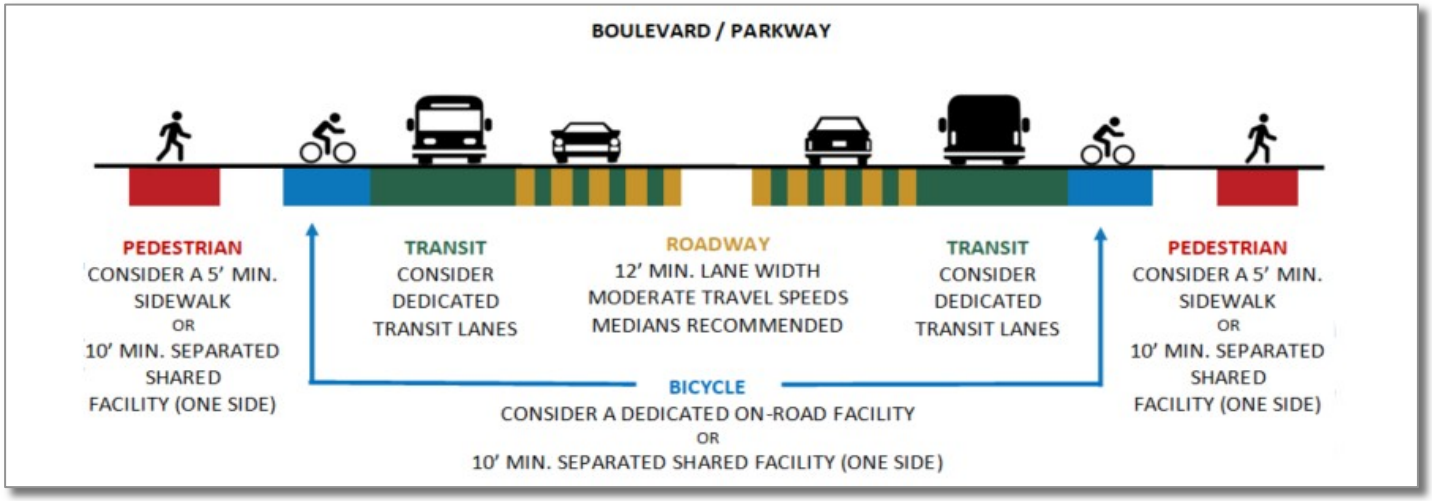


Figure 7: Boulevard / Parkway Typical Section

COMMERCIAL STREET (CS)

A Commercial Street connects moderate to low volumes of traffic while providing lower speeds, pedestrian-friendly, and signalized intersections. Direct vehicular access to building frontages or amenities from these roadways is typically not permitted. Transit stops and on-street parking are more prevalent to better accommodate access to the commercial destinations. Bicycle facilities along Commercial Streets in suburban activity center, traditional town center, and urban center context zones are typically on-road bicycle lanes or separated cycle tracks, and pedestrians are provided with a sidewalk.

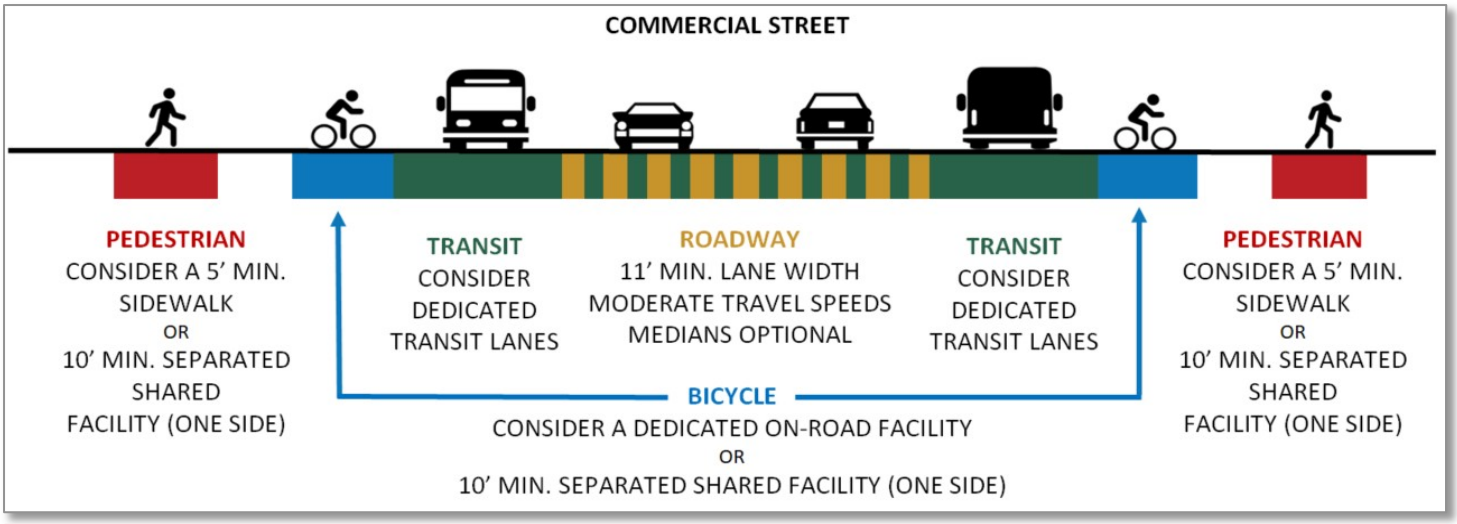


Figure 8: Commercial Street Typical Section

CONNECTOR (CN)

A Connector accommodates moderate to low levels of traffic and constitutes a large majority of links within the transportation network. These streets typically provide connections from neighborhoods to Collectors, Boulevards / Parkways, or Commercial Streets. The streets typically have stop-controlled intersections, with signals at some larger intersections. Connectors can be found in all five context zones to provide connections between residential areas or key destination points to larger roadways. Pedestrian facilities are not common along these roadways in rural context zones due to spacing of homes and destinations. On-street bicycle facilities and sidewalks or shared-use paths become increasingly necessary along these streets as the context becomes more suburban and urban. Transit vehicles share the roadway with cars along Connectors, and on-street parking and transit stops become more prevalent as the context becomes more urbanized.

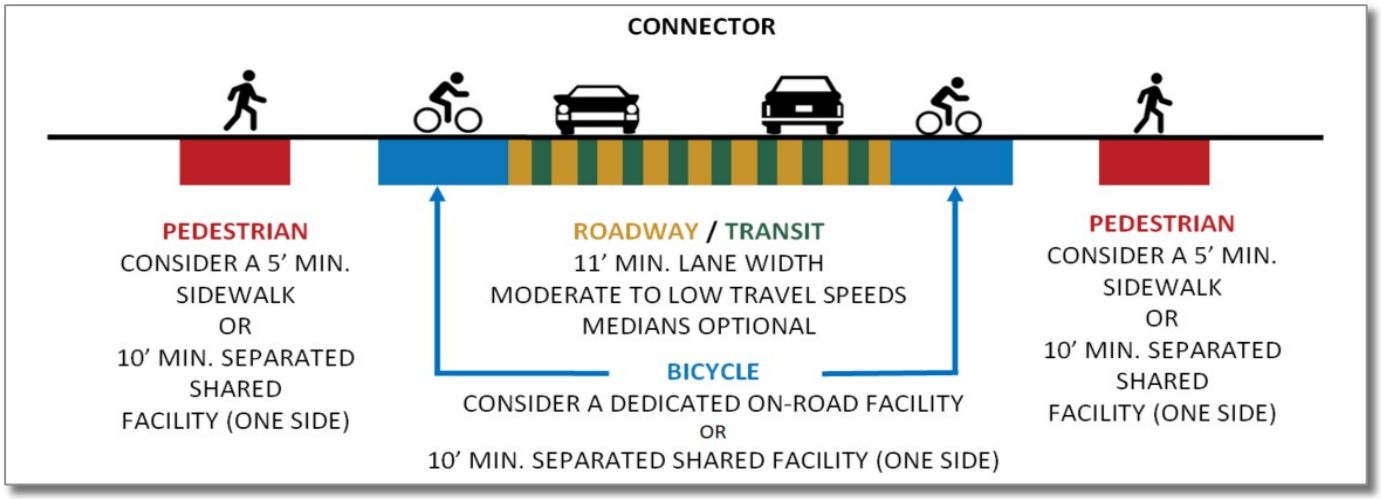


Figure 9: Connector Typical Section

NEIGHBORHOOD STREET (NS)

A Neighborhood Street accommodates low levels of traffic and constitutes another large majority of links within the transportation network. These streets typically provide connections through neighborhoods out to Connectors. These streets generally have on-street parking and stop-controlled intersections. Neighborhood Streets can be found in all five context zones to provide connections throughout residential areas. Sidewalks and on-street bicycle facilities, such as shared streets or a dedicated bicycle lane, become increasingly necessary along these streets as the context becomes more suburban and urban.

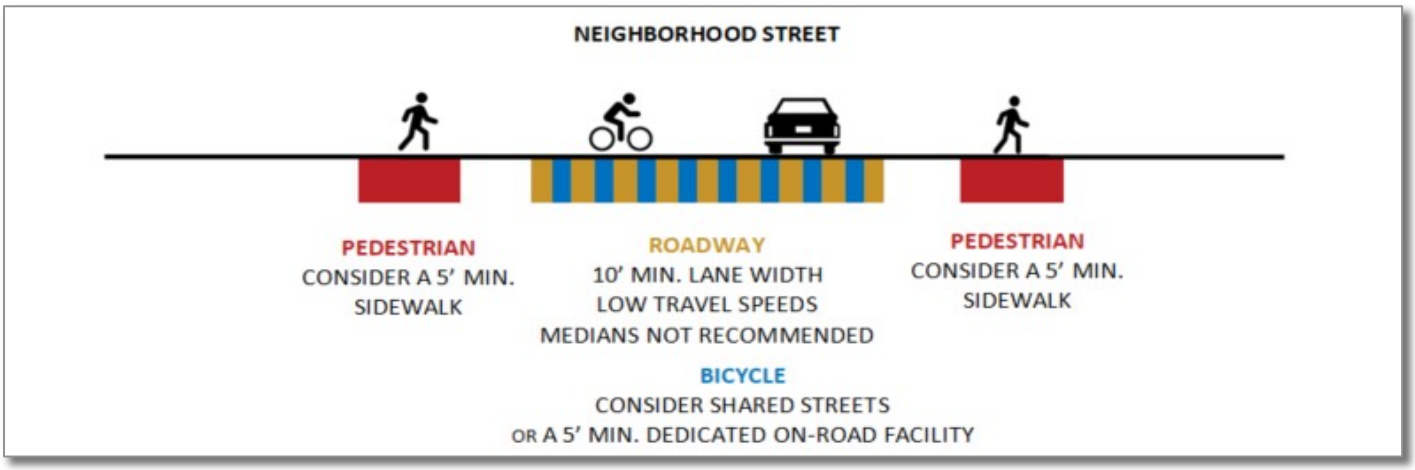


Figure 10: Neighborhood Street Typical Section

ALLEY (A)

An Alley provides coordinated vehicular access for very low traffic volumes across adjoining parcels. These roadways can be used to connect Connector, Neighborhood Streets, or parking lots that are typically within commercial areas. Medians, on-street parking, roadway lighting, roundabouts, speeds humps/cushions, and dedicated transit facilities or features are not recommended along Alleys. Pedestrian and bicycle facilities are not typically necessary along these roadways, as their focus is to provide improved, secondary access for vehicles within areas where multi-modal access is the primary focus on other adjacent roadway types. However, alleys can be used by pedestrians and people riding bicycles, with the understanding that they are sharing the same space as vehicles.

The roadway, pedestrian, bicycle, and transit design feature recommendations for Alleys remain the same for all context zones, so context-specific guidance for design features of this roadway type is not included in this manual.

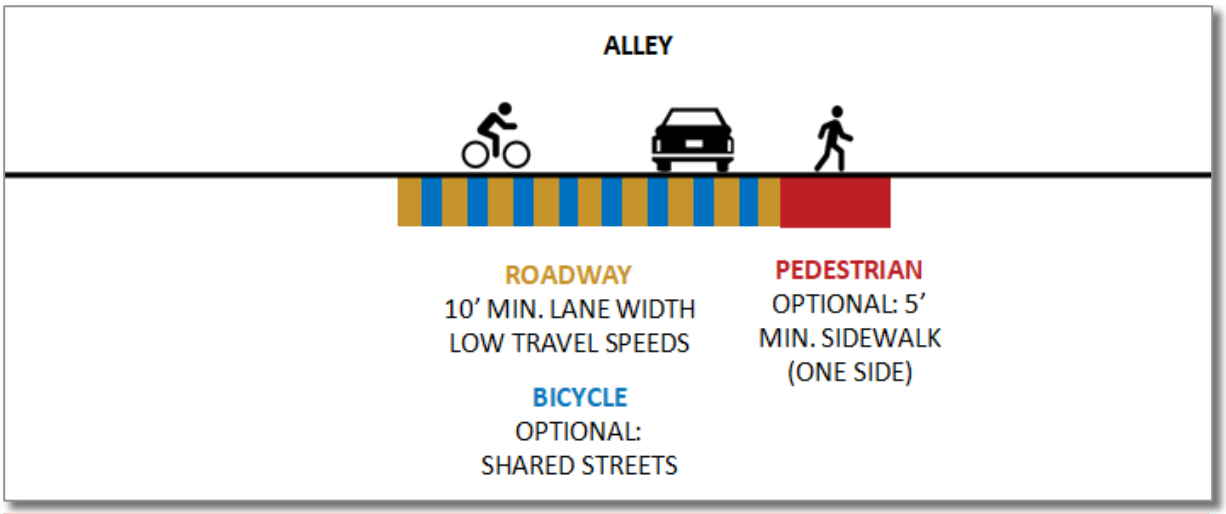


Figure 11: Alley Typical Section

DESIGN ELEMENT CHECKLIST

There are numerous design elements to consider for inclusion in transportation projects. Each roadway type within each context zone has a unique set of recommended design elements and treatments that can be applied to create a safe, equitable, and accessible transportation network for users of all applicable transportation modes.

This section provides guidance on specific street design elements, categorized by mode, that are desired or appropriate within each context zone and roadway type. Street design elements, categorized by mode as **Roadway, Pedestrian, Bicycle, and Transit**, are shown in separate tables for the five context zones in Frederick County. These guidelines are intended as a reference to inform project development for individual streets, however final design decisions will be dependent on the specific project.

Each project will have unique existing conditions and constraints that could limit the ability to follow the recommendations within this manual. This Plan provides guidelines for developing a multi-modal and environmentally conscious network and is intended to be considered in conjunction with engineering judgement and best practices. Frederick County will have the ultimate authority to determine the context zone and roadway type of a project on a case-by-case basis.

The table below lists the roadway type abbreviations that are used in the following design element selection matrices and throughout this manual.

Table 3: Roadway Type Abbreviations

Roadway Type	Abbreviation
Freeway/Expressway	**F/E**
Arterial Road	**AR**
Collector	**CL**
Boulevard / Parkway	**B/P**
Commercial Street	**CS**
Connector	**CN**
Neighborhood Street	**NS**
Alley	**A**

Freeways / Expressways (F/E) and Alleys (A) are roadway types that have the same recommended design features regardless of the context zone and are therefore not included in the design element selection matrices below. For additional information on the Complete Street recommendations for Freeways / Expressways (F/E) and Alleys (A), please refer to the previous section.

The design element selection matrices below each provide recommendations for all roadway types, except Freeways / Expressways (F/E) and Alleys (A). An asterisk **(*)** in the matrices denotes the roadway types that are not typically found within a particular context zone. These asterisks correspond to **Table 2** on page 13, which identifies the roadway types that generally make up the majority of roads in each context zone.

Table 4: Design Element Selection Matrix: Rural Context Zone

DESIGN ELEMENT SELECTION MATRIX							
	CONTEXT ZONE	Rural					
	Roadway Type	AR	CL	B/P*	CS*	CN	NS
Roadway	Min. Lane Width	12'	11'	12'	11'	11'	10'
	Roundabouts	✓	✓	✓	✓	✓	X
	Medians	O	O	✓	O	O	O
	On-Street Parking	X	X	X	O	O	O
	Speed Humps / Cushions	X	X	X	X	O	O
	Lighting	X	X	O	O	O	O
Pedestrian	ADA-Compliant Sidewalks (5' min, 6' desired)	X	X	O	✓	✓	O
	Continental Crosswalks	X	X	✓	✓	✓	O
	ADA-Compliant Curb Ramps	X	X	O	✓	✓	O
	Raised Crosswalks	X	X	X	O	O	O
	Raised Intersections	X	X	X	O	X	O
	Pedestrian-Scale Lighting	X	X	O	O	X	O
	Curb Extensions / Bulb Outs	X	X	X	✓	O	O
	Shared Use Path	X	X	O	✓	O	O
	Off-Road Trails	X	O	O	O	O	O
	Pedestrian Wayfinding	X	X	X	X	X	X
	Shade Trees	X	X	O	O	O	O
	HAWK Signal / RRFB	Optional at all High Conflict Crosswalks					
Bicycle	Shared Streets (unmarked)	X	X	X	X	X	O
	Sharrows	X	X	X	X	X	✓
	Wide Bikeable Shoulders	O	O	X	X	X	X
	Striped On-Road Bike Lanes (5' min, 6' desired)	X	O	O	✓	O	X
	Buffered Bike Lanes	X	O	O	✓	O	X
	Separated Bike Lanes	X	O	O	O	O	X
	Protected Intersections	X	X	X	X	X	X
	Bicycle Signals, Bike Boxes, Turn-Queue Boxes	X	X	X	X	X	X
	Shared Use Path	X	X	O	✓	O	O
	Off-Road Trails	✓	O	O	O	O	O
	Bicycle Parking	X	X	X	O	X	X
	Bicycle Wayfinding	X	O	O	X	O	X
Transit	Transit Shelters	O	O	O	O	O	X
	Seating at Transit Stops	O	O	O	O	O	X
	Recycling / Trash Receptacles at Transit Stops	O	O	O	O	O	X
	Dedicated Transit Lanes / Corridors	X	X	X	X	X	X
	Transit Connectivity for Pedestrians / Bicycles	✓	✓	✓	✓	✓	✓
	Transit Wayfinding	✓	✓	✓	✓	✓	X

LEGEND: ✓ = Recommended O = Optional X = Not Recommended or Not Applicable

* = Denotes Roadway Types Not Often Found in Context Zone

NOTE: Frederick County will have the ultimate authority to determine the context zone and roadway type of a project on a case-by-case basis.

Table 5: Design Element Selection Matrix: Suburban Context Zone

DESIGN ELEMENT SELECTION MATRIX							
	CONTEXT ZONE	Suburban					
	Roadway Type	AR	CL	B/P	CS*	CN	NS
Roadway	Min. Lane Width	12'	11'	12'	11'	11'	10'
	Roundabouts	O	✓	✓	✓	✓	O
	Medians	O	O	✓	✓	O	O
	On-Street Parking	X	X	O	O	O	✓
	Speed Humps / Cushions	X	X	X	X	O	O
	Lighting	X	X	O	✓	O	O
Pedestrian	ADA-Compliant Sidewalks (5' min, 6' desired)	X	X	O	✓	✓	✓
	Continental Crosswalks	X	X	✓	✓	✓	✓
	ADA-Compliant Curb Ramps	X	X	O	✓	✓	✓
	Raised Crosswalks	X	X	X	O	O	O
	Raised Intersections	X	X	X	O	X	O
	Pedestrian-Scale Lighting	X	X	O	O	O	O
	Curb Extensions / Bulb Outs	X	X	O	✓	O	O
	Shared Use Path	O	O	✓	✓	✓	O
	Off-Road Trails	O	O	O	O	O	O
	Pedestrian Wayfinding	X	X	✓	✓	✓	O
	Shade Trees	X	X	✓	✓	✓	O
	HAWK Signal / RRFB	Optional at all High Conflict Crosswalks					
Bicycle	Shared Streets (unmarked)	X	X	X	X	X	O
	Sharrows	X	X	X	X	O	✓
	Wide Bikeable Shoulders	O	O	O	X	X	X
	Striped On-Road Bike Lanes (5' min, 6' desired)	O	✓	✓	✓	✓	X
	Buffered Bike Lanes	O	✓	✓	✓	✓	X
	Separated Bike Lanes	X	O	O	O	O	X
	Protected Intersections	X	X	X	O	X	X
	Bicycle Signals, Bike Boxes, Turn-Queue Boxes	X	X	O	O	O	X
	Shared Use Path	O	O	✓	✓	✓	O
	Off-Road Trails	✓	✓	O	O	O	O
	Bicycle Parking	X	X	O	O	O	X
	Bicycle Wayfinding	X	O	✓	X	✓	O
Transit	Transit Shelters	O	O	✓	O	✓	X
	Seating at Transit Stops	O	✓	✓	O	✓	X
	Recycling / Trash Receptacles at Transit Stops	O	✓	✓	O	✓	X
	Dedicated Transit Lanes / Corridors	X	X	O	X	X	X
	Transit Connectivity for Pedestrians / Bicycles	✓	✓	✓	✓	✓	✓
	Transit Wayfinding	✓	✓	✓	✓	✓	X

LEGEND: ✓ = Recommended O = Optional X = Not Recommended or Not Applicable

* = Denotes Roadway Types Not Often Found in Context Zone

NOTE: Frederick County will have the ultimate authority to determine the context zone and roadway type of a project on a case-by-case basis.

Table 6: Design Element Selection Matrix: Suburban Activity Center Context Zone

DESIGN ELEMENT SELECTION MATRIX							
	CONTEXT ZONE	Suburban Activity Center					
	Roadway Type	AR	CL	B/P	CS	CN	NS
Roadway	Min. Lane Width	12'	11'	12'	11'	11'	10'
	Roundabouts	O	O	✓	✓	✓	O
	Medians	✓	✓	✓	✓	O	O
	On-Street Parking	X	O	✓	✓	✓	✓
	Speed Humps / Cushions	X	X	X	X	O	O
	Lighting	O	✓	✓	✓	✓	✓
Pedestrian	ADA-Compliant Sidewalks (5' min, 6' desired)	O	O	✓	✓	✓	✓
	Continental Crosswalks	O	O	✓	✓	✓	✓
	ADA-Compliant Curb Ramps	O	O	✓	✓	✓	✓
	Raised Crosswalks	X	X	O	O	O	O
	Raised Intersections	X	X	X	O	O	X
	Pedestrian-Scale Lighting	O	✓	✓	✓	✓	O
	Curb Extensions / Bulb Outs	X	O	✓	✓	✓	O
	Shared Use Path	O	O	✓	✓	✓	O
	Off-Road Trails	O	O	O	O	O	O
	Pedestrian Wayfinding	O	O	✓	✓	✓	✓
	Shade Trees	X	O	✓	✓	✓	✓
	HAWK Signal / RRFB	Optional at all High Conflict Crosswalks					
Bicycle	Shared Streets (unmarked)	X	X	X	X	X	O
	Sharrows	X	X	X	O	O	✓
	Wide Bikeable Shoulders	O	O	O	X	X	X
	Striped On-Road Bike Lanes (5' min, 6' desired)	O	✓	✓	✓	✓	O
	Buffered Bike Lanes	O	✓	✓	✓	✓	O
	Separated Bike Lanes	X	O	O	O	O	X
	Protected Intersections	O	O	O	✓	X	X
	Bicycle Signals, Bike Boxes, Turn-Queue Boxes	O	O	O	✓	O	X
	Shared Use Path	O	O	✓	✓	✓	O
	Off-Road Trails	O	O	O	O	O	O
	Bicycle Parking	O	O	✓	✓	✓	O
	Bicycle Wayfinding	O	✓	✓	✓	✓	O
Transit	Transit Shelters	✓	✓	✓	✓	✓	X
	Seating at Transit Stops	✓	✓	✓	✓	✓	X
	Recycling / Trash Receptacles at Transit Stops	✓	✓	✓	✓	✓	X
	Dedicated Transit Lanes / Corridors	X	X	O	O	X	X
	Transit Connectivity for Pedestrians / Bicycles	✓	✓	✓	✓	✓	✓
	Transit Wayfinding	✓	✓	✓	✓	✓	O

LEGEND: ✓ = Recommended O = Optional X = Not Recommended or Not Applicable

* = Denotes Roadway Types Not Often Found in Context Zone

NOTE: Frederick County will have the ultimate authority to determine the context zone and roadway type of a project on a case-by-case basis.

Table 7: Design Element Selection Matrix: Traditional Town Center Context Zone

DESIGN ELEMENT SELECTION MATRIX							
	CONTEXT ZONE	Traditional Town Center					
	Roadway Type	AR*	CL	B/P	CS	CN	NS
Roadway	Min. Lane Width	12'	11'	12'	11'	10'	10'
	Roundabouts	O	O	✓	✓	✓	O
	Medians	✓	✓	✓	✓	O	O
	On-Street Parking	X	O	✓	✓	✓	✓
	Speed Humps / Cushions	X	X	X	X	O	O
	Lighting	O	✓	✓	✓	✓	✓
Pedestrian	ADA-Compliant Sidewalks (5' min, 6' desired)	O	O	✓	✓	✓	✓
	Continental Crosswalks	O	O	✓	✓	✓	✓
	ADA-Compliant Curb Ramps	O	O	✓	✓	✓	✓
	Raised Crosswalks	X	X	O	O	O	O
	Raised Intersections	X	X	X	O	O	X
	Pedestrian-Scale Lighting	O	✓	✓	✓	✓	O
	Curb Extensions / Bulb Outs	X	O	✓	✓	✓	O
	Shared Use Path	O	✓	✓	✓	✓	O
	Off-Road Trails	O	O	O	O	O	O
	Pedestrian Wayfinding	O	O	✓	✓	✓	✓
	Shade Trees	X	O	✓	✓	✓	✓
	HAWK Signal / RRFB	Optional at all High Conflict Crosswalks					
Bicycle	Shared Streets (unmarked)	X	X	X	X	X	O
	Sharrows	X	X	X	O	O	✓
	Wide Bikeable Shoulders	O	O	X	X	X	X
	Striped On-Road Bike Lanes (5' min, 6' desired)	O	✓	✓	✓	✓	O
	Buffered Bike Lanes	O	✓	✓	✓	✓	O
	Separated Bike Lanes	X	O	O	O	O	X
	Protected Intersections	O	O	O	✓	O	X
	Bicycle Signals, Bike Boxes, Turn-Queue Boxes	O	O	O	✓	O	X
	Shared Use Path	O	✓	✓	✓	✓	O
	Off-Road Trails	O	O	O	O	O	O
	Bicycle Parking	O	O	✓	✓	✓	O
	Bicycle Wayfinding	O	✓	✓	✓	✓	O
Transit	Transit Shelters	✓	✓	✓	✓	✓	X
	Seating at Transit Stops	✓	✓	✓	✓	✓	X
	Recycling / Trash Receptacles at Transit Stops	✓	✓	✓	✓	✓	X
	Dedicated Transit Lanes / Corridors	X	X	O	O	X	X
	Transit Connectivity for Pedestrians / Bicycles	✓	✓	✓	✓	✓	✓
	Transit Wayfinding	✓	✓	✓	✓	✓	O

LEGEND: ✓ = Recommended O = Optional X = Not Recommended or Not Applicable

* = Denotes Roadway Types Not Often Found in Context Zone

NOTE: Frederick County will have the ultimate authority to determine the context zone and roadway type of a project on a case-by-case basis.

Table 8: Design Element Selection Matrix: Urban Center Context Zone

	DESIGN ELEMENT SELECTION MATRIX						
	CONTEXT ZONE	**Urban Center**					
	Roadway Type	AR*	CL*	B/P*	CS	CN	NS
Roadway	Min. Lane Width	11'	11'	11'	11'	10'	10'
	Roundabouts	O	O	✓	✓	✓	X
	Medians	✓	✓	✓	✓	O	X
	On-Street Parking	X	O	✓	✓	✓	✓
	Speed Humps / Cushions	X	X	X	X	O	O
	Lighting	✓	✓	✓	✓	✓	✓
Pedestrian	ADA-Compliant Sidewalks (5' min, 6' desired)	O	✓	✓	✓	✓	✓
	Continental Crosswalks	O	✓	✓	✓	✓	✓
	ADA-Compliant Curb Ramps	O	✓	✓	✓	✓	✓
	Raised Crosswalks	X	X	O	O	O	O
	Raised Intersections	X	X	X	O	O	O
	Pedestrian-Scale Lighting	O	✓	✓	✓	✓	✓
	Curb Extensions / Bulb Outs	X	O	✓	✓	✓	✓
	Shared Use Path	O	✓	✓	✓	✓	X
	Off-Road Trails	O	O	O	X	X	X
	Pedestrian Wayfinding	✓	✓	✓	✓	✓	O
	Shade Trees	✓	✓	✓	✓	✓	✓
	HAWK Signal / RRFB	Optional at all High Conflict Crosswalks					
Bicycle	Shared Streets (unmarked)	X	X	X	X	X	O
	Sharrows	X	X	X	O	O	✓
	Wide Bikeable Shoulders	O	O	X	X	X	X
	Striped On-Road Bike Lanes (5' min, 6' desired)	O	✓	✓	✓	✓	✓
	Buffered Bike Lanes	✓	✓	✓	✓	✓	✓
	Separated Bike Lanes	O	O	O	O	O	X
	Protected Intersections	O	O	O	O	O	O
	Bicycle Signals, Bike Boxes, Turn-Queue Boxes	O	O	O	✓	✓	X
	Shared Use Path	O	✓	✓	✓	✓	X
	Off-Road Trails	O	O	O	X	X	X
	Bicycle Parking	O	O	✓	✓	✓	✓
	Bicycle Wayfinding	✓	✓	✓	✓	✓	O
Transit	Transit Shelters	✓	✓	✓	✓	✓	✓
	Seating at Transit Stops	✓	✓	✓	✓	✓	✓
	Recycling / Trash Receptacles at Transit Stops	✓	✓	✓	✓	✓	✓
	Dedicated Transit Lanes / Corridors	O	O	O	O	O	O
	Transit Connectivity for Pedestrians / Bicycles	✓	✓	✓	✓	✓	O
	Transit Wayfinding	✓	✓	✓	✓	✓	O

LEGEND: ✓ = Recommended O = Optional X = Not Recommended or Not Applicable

* = Denotes Roadway Types Not Often Found in Context Zone

NOTE: Frederick County will have the ultimate authority to determine the context zone and roadway type of a project on a case-by-case basis.

Roadway Facilities

The following section provides additional guidance for roadway facility design elements that enhance roads and streets and can be considered during the development and planning for transportation projects. These recommendations should be considered as supplementary to design guidance found in the County Streets and Roads Design Manual. Specific design values and guidance for these roadway facility design elements can also be found in design manuals and guidelines published by MDOT SHA, NACTO and FHWA, which are listed under the Complete Streets Additional References on Page 52.

ROADWAY GEOMETRY

The geometry of a roadway provides opportunities for the implementation of Complete Streets features. The space provided from curb to curb or edge of pavement to edge of pavement can be manipulated to enhance the user experience for all modes of transportation.

TRAVEL LANE WIDTH

The width of a vehicular travel lane should be wide enough to safely accommodate the posted speed limits but should avoid providing unnecessary additional width for vehicles. If a travel lane is wider than necessary, the roadway may accidentally promote increased speeds. Recommended minimum travel lane widths are included in the typical sections for each roadway type within the Context Sensitive Design Process section of this manual.

PAVED SHOULDERS

Providing paved shoulders adjacent to the vehicular travel lanes can provide improved bicycle accommodations on higher speed roadways, create space for temporary storage of disabled vehicles, and preserve the service life of the pavement edges on the roadway. Shoulder widths should be wide enough to accommodate bicycles and disabled vehicles where needed, but shoulder widths wider than the adjacent travel lanes should be avoided. Shoulders that are excessively wide can encourage higher vehicular travel speed s along the roadway.

When a roadway has excessively wide shoulders that may be creating a speed issue, solutions that can be considered include utilizing some of the existing shoulder width to provide a dedicated on-road bicycle facility or on-street parking or implementing a road diet. These potential solutions are discussed in more detail in the corresponding sections below.

Additional considerations for paved shoulders, including minimum shoulder widths and preferred vehicular travel speeds for wide bikeable shoulders, are discussed in the Bicycle Facilities section on page 38.

ON-STREET PARKING

On-street parking is a beneficial amenity along stretches of roads with a high density of key destinations and lower to moderate travel speeds. Commercial Streets should always consider on-street parking where feasible to accommodate the increase in pedestrian and bicycle activity. Connectors and Neighborhood Streets should typically provide on-street parking as well, as long as the context of the roadway warrants parking. A Neighborhood Street with widely spread apart houses and individual driveways for each home may not necessitate on-street parking. Existing wide paved shoulders can be converted into on-street parking when needed, as long as bicycles are also accommodated through a different facility.

On-Street Parking on West Patrick Street
source: Google Street View

MEDIANS

Medians should be considered in curbed sections of roadways that have multiple travel lanes and moderate to high travel speeds. According to the Federal Highway Administration (FHWA), projects in areas with elevated pedestrian activity, traffic volumes of over 9,000 vehicles per day, and travel speeds of 35 MPH or greater, should consider the incorporation of a median between travel directions. Medians should be at least six feet wide.

Median on Fingerboard Road
source: Google Street View

DEDICATED TRANSIT LANES

A lane that is dedicated solely for transit vehicles can improve traffic flow in areas with increased frequency of bus stops and high transit ridership. Dedicated transit lanes can be considered along roadways in urban areas and some suburban areas where busses tend to cause congestion in the travel lanes. The effects of closing off one lane to vehicles should be weighed against the impact of congestion caused by transit operations, therefore, these bus-only lanes typically work best along roadways with three travel lanes in one direction or on roadways with large amounts of available right-of-way. A dedicated transit lane is typically installed using a different pavement color, usually red, to differentiate these lanes from the vehicular travel lanes.

CONNECTED AND AUTONOMOUS VEHICLE CONSIDERATIONS

As the technology surrounding connected and autonomous vehicles continues to develop over the next several years, agencies should look for ways to incorporate features and elements into the project planning and design that could prevent the need for retrofit or reconstruction in the future. For example, providing larger conduits to accommodate future communication lines within roadways as they are constructed or updated now could prevent the need for additional retrofit projects in the future. As infrastructure for autonomous connections are added to roadways, agencies should ensure that the pedestrian access route remains unimpeded and clear of obstructions.

As this technology is continuously changing and developing, agencies should consider implementing autonomous vehicle friendly features into projects within reason of where the technology stands at the time of the project. For more information regarding autonomous vehicle considerations, refer to the 2020 Connected and Autonomous Vehicles (CAVs) Planning Considerations for the National Capital Region Transportation Planning Board.

INTERSECTION GEOMETRY

Intersections introduce conflict points between vehicles, pedestrians, and people riding bicycles. Specific geometric elements can be considered to minimize the negative effects of these conflict points and provide a safe and comfortable user experience for all modes. The below intersection geometry considerations should be evaluated during the planning and design stages of transportation projects within Frederick County. Additional intersection design elements that are not related to the intersection geometry, such as crosswalks and curb ramps, are included in the mode-specific sections.

Pedestrian Refuge Island on West Patrick Street
source: Google Street View

CURB EXTENSIONS / BULB OUTS

Refer to Curb Extensions / Bulb Outs section under Traffic Calming on Page 28.

PEDESTRIAN REFUGE ISLANDS

Pedestrian refuge islands are medians that extend across a crosswalk and separate the travel lane directions. These islands provide a break in the crossing length for pedestrians and allow them to cross a leg of an intersection more safely. They can also be used as a traffic calming device by creating the illusion of narrower travel lanes. Pedestrian refuge islands should be considered on higher speed or high-volume roadways with crosswalks across multiple travel lanes in one or both directions. The NACTO Urban Street Design Guide notes that pedestrian refuge islands should be a minimum of six feet wide, with a preferred with of eight to ten feet.

ROUNDABOUTS

A roundabout or traffic circle is an alternative intersection layout that allows for vehicles to yield and enter the intersection, moving to their right around a circular center median. Roundabouts reduce crash frequency and intensity and improve traffic flow through intersections. Roundabouts can typically be considered within all context zones and along all roadway types except Freeways / Expressways and Alleys. On roadways with lower speeds and traffic volumes, mini-roundabouts can be considered for implementation. Mini-roundabouts are characterized by small diameters and tranversable center islands. The geometry of roundabouts can make the layout of pedestrian crosswalks and bicycle facilities more complex for all users to navigate than traditional intersections. Off-road bicycle facilities are generally easier to implement through a roundabout than an on-road facility, but both can be considered. Additional care should be taken in the design of these facilities to ensure safety for all users.

Roundabout at Sugarloaf Parkway and Worthington Boulevard (MD 355)
source: Google Street View

CURB RADIUS

The curb radius of intersecting roadways is determined based on the roadway type design vehicles. The needs of a turning vehicle must be balanced with the safety and needs of pedestrians and bicyclists. Larger curb radii generally result in higher speed turning movements by vehicles. Tighter curb radii are preferred to reduce crossing distances for pedestrians and slow down turning vehicles through the crosswalks. However, a curb radius that is too small for the design vehicle can introduce a pedestrian safety issue, because the vehicle may be forced to drive over the curb and onto the sidewalk to complete the turn. Curb radii should be small enough to prevent increased vehicular speeds, but not too small that the design vehicles are not able to successfully make the turn. When designing curb radii at intersections, the need for emergency vehicles to navigate and access the intersection should always be considered.

PROTECTED INTERSECTIONS

Protected intersections provide a safer way for pedestrians and bicyclists to navigate an intersection. In these intersections, the sidewalks and bicycle facility are set back from the adjacent motor vehicle traffic. Unlike at conventional intersections, bicyclists are separated from the travel lanes and are not forced to merge into mixed traffic. Instead, they are given a dedicated path through the intersection for both through and turning movements. The bicyclists also have the right of way over turning motor vehicles. The space between the motor vehicle lane and the bikeway makes bicyclists more visible to turning drivers than in a conventional intersection. In this layout, vehicles have more space to wait for a bicyclist to clear the crosswalk before turning.

Corner islands extend the protected bikeway further into the intersection and tighten the corner radius of the turn to reduce vehicle speeds. These islands create bicycle queue areas outside of the crosswalk where bicyclists can wait until the path is clear of vehicles. Protected intersections also provide shorter crossing distances for pedestrians navigating the intersection.

Protected intersections should be considered at major intersections in areas with significant levels of bicycle activity.

Protected Intersection
source: SF.Streetsblog.org

TRAFFIC CALMING

When a roadway frequently experiences vehicles exceeding the posted speed limit, the following traffic calming measures and treatments can be considered to slow vehicular speeds. Traffic calming should also be evaluated on roadways with high volumes of pedestrian and bicycle activity.

ROAD DIETS

The width of a roadway should be wide enough to safely accommodate the posted speed limits and necessary multi-modal facilities but avoid providing additional unnecessary width in vehicular travel lanes or shoulders. If travel lanes or shoulders are wider than necessary, the roadway may accidentally promote increased speeds. A road diet is a traffic calming technique where unnecessary existing pavement width in travel lanes or shoulders is either removed or converted into a dedicated bicycle facility. Removing or converting excess space on the roadway encourages drivers to slow down due to the absence of recovery space or perceived reduction in traffic flow. Road diets can be considered for use on roadways where drivers tend to exceed the speed limit which results in an increase in crashes.

CURB EXTENSIONS / BULB OUTS

The National Association of City Transportation Officials (NACTO) explains curb extensions or bulb outs as a narrowing of the roadway at pedestrian crossings to create safer and shorter crossings for pedestrians while increasing the available space for street furniture, benches, plantings, and street trees. These are typically implemented on suburban activity center, traditional town center, and urban center roadways with on-street parking.

Narrowing the vehicular travel lanes causes drivers to slow down through these actual or perceived pinch points. Strategically implementing curb extensions or bulb outs can slow vehicles in areas and intersections of high pedestrian and bicycle activity. These are typically implemented on suburban activity center, traditional town center, and urban center roadways with on-street parking.

Curb Extensions on Rosemont Avenue
source: Google Street View

Speed Hump
source: NACTO

SPEED HUMPS / CUSHIONS

Speed humps are traffic calming measures that aim to slow traffic speeds on roadways with lower traffic volume and posted speed limits. Speeds humps are raised locations across the vehicular travel lanes that range in height, length, and width depending on the target speed. NACTO explains that speed humps are generally three to four inches in height, 12 to 14 feet in width, with a ramp length of three to six feet. Specific design guidance for speed humps can be found in the NACTO Urban Street Design Guide. These traffic calming measures are effective at reducing speeds to 15 to 20 MPH but should typically only be implemented on Connectors or Neighborhood Streets where posted speed limits are lower. Placing a speed hump on a higher speed roadway can cause additional safety issues. Agencies should also be mindful not to install a speed hump in a location that blocks a driveway or access area.

On roadways where bicycles share the travel lanes with vehicles, speed cushions should be considered rather than speed humps. Speed cushions are designed similar to speed humps but have cut throughs to allow bicycles to safely pass through the raised pavement, while still slowing vehicles.

Signage along the roadway and pavement markings on the speed humps / cushions should be installed to warn drivers of the upcoming traffic calming measures. Guidance for the appropriate signage and pavement markings can be found in the FHWA Manual of Uniform Traffic Control Devices (MUTCD).

Speed Cushions
source: NACTO

RAISED CROSSWALKS / INTERSECTIONS

A raised crosswalk or raised intersection is a traffic calming measure that acts to slow drivers through intersections or pedestrian crossings, while also increasing the visibility of pedestrians and bicyclists in these areas. A raised crosswalk provides an elevated crossing location above the travel lanes that provides additional safety for the crosswalk users and slows vehicles before passing through the crosswalk.

A raised intersection elevates the entire intersection several inches above the roadway grade to slow drivers. The intersection then becomes a uniform raised platform that increases the visibility of the crosswalks and provides traffic calming as the vehicle passes through the entire intersection.

Raised crosswalks or intersections should primarily be used in suburban activity centers, traditional town centers, and urban centers along Commercial Streets with lower speeds or Connectors.

Raised Crosswalk on Stone Barn Drive
source: Google Street View

REDUCED SPEED LIMITS

In addition to other physical traffic calming measures, lowering the posted speed limit can be considered as a traffic calming measure when a roadway frequently experiences drivers exceeding the posted speed limit, in areas with high volumes of pedestrian and bicycle activity, and on roadways that experience a significant number of vehicular, pedestrian, or bicycle crash events. Reduced speed limits are not a standalone solution for traffic calming and should be accompanied by other physical traffic calming measures on the roadway, as well as increased enforcement to ensure compliance.

ROUNDABOUTS

Refer to Roundabouts section under Intersection Geometry section on page 26.

LIGHTING

The nighttime experiences lower levels of traffic volumes, but higher rates of serious injury and fatality crashes. 40 percent of all injury crashes and more than half of fatal crashes occur in locations where no roadway or pedestrian lighting is available. Roadway lighting is recommended along roadways that have a significant number of destinations and pedestrian and bicyclist activity to increase visibility and safety for all users. Agencies should also give consideration to allow more light to spill onto private property where there is a larger safety concern near intersections and bicycle and pedestrian corridors.

Pedestrian-scale lighting can be implemented along sidewalks or shared-use paths to improve the safety and user experience of the facilities. Lighting should be considered in areas of high pedestrian and bicycle facility utilization. Lighting can be added to crosswalk locations to increase the visibility of pedestrians and bicyclists, especially in rural locations. User-dependent lighting that illuminates on a motion activated basis can be considered to reduce light pollution where necessary.

Coordination with the County and nearby homeowners' associations or lighting districts will be necessary to determine maintenance of roadway and pedestrian-scale lighting. Please reference the "Take a Proactive Approach to Street Lighting" section of the 2021 Frederick County Towards Zero Deaths Plan for more information.

ENVIRONMENTAL FEATURES

The surrounding environment of a roadway is a major defining feature for the character and overall feel. Existing and proposed environmental features should be evaluated during the planning and design stages of transportation-related projects. These features include considerations for street trees, stormwater management, and other Green Street infrastructure as per the guidance developed in the **Green Streets Manual** within this Plan. Impacts to existing environmental features should be minimized and mitigated according to local and state requirements.

Pedestrian Facilities

The following section provides additional guidance for pedestrian facility design elements that enhance roads and streets and can be considered during the development and planning for transportation projects. These recommendations should be considered as supplementary to design guidance found in the County Streets and Roads Design Manual. Specific design values and guidance for these pedestrian facility design elements can also be found in design manuals and guidelines published by MDOT SHA, NACTO and FHWA, which are listed under the Complete Streets Additional References on page 52.

ADA COMPLIANT SIDEWALKS

Sidewalks provide a safe location for pedestrians to walk alongside of roadways and efficiently reach walkable destinations. Sidewalk planning should aim to provide direct routes between town centers, populated areas, and key destinations. New and retrofitted sidewalks must meet ADA design criteria established by the United States Department of Justice and summarized by the MDOT SHA Accessibility Policy and Guidelines for Pedestrian Facilities along State Highways. A sidewalk width of six feet is preferred, with a minimum acceptable width of five feet. Sidewalks must include ADA compliant curb ramps at crossing locations and should not have any physical barriers or obstacles in the pedestrian path. Sidewalks should include a horizontal buffer between the edge of roadway pavement and the edge of sidewalk with a minimum width of five feet where possible.

CONTINENTAL CROSSWALKS

Continental crosswalks are highly visible roadway markings to denote a pedestrian crossing location using thick stripes perpendicular to the direction of crossing. All transportation projects on all roadway types should implement continental crosswalks at all pedestrian and bicycle crossing locations. Additional guidance on continental crosswalk design can be found in the FHWA MUTCD and the NACTO Urban Street Design Guide.

Continental Crosswalk
source: NACTO

ADA COMPLIANT CURB RAMPS

ADA compliant curb ramps should be implemented at all crossing locations on new sidewalks and shared-use paths to facilitate safe roadway crossings for users with disabilities. Any curb ramps along retrofitted roadways or sidewalks and shared-use paths should also be updated to comply with ADA design criteria established by the United States Department of Justice and summarized by the MDOT SHA Accessibility Policy and Guidelines for Pedestrian Facilities along State Highways.

RAISED CROSSWALKS / INTERSECTIONS

Refer to Raised Crosswalks / Intersections under Traffic Calming in the Roadway Facilities section on page 29.

CURB EXTENSIONS / BULB OUTS

Refer to Curb Extensions / Bulb Outs under Traffic Calming in the Roadway Facilities section on page 28.

SHARED-USE PATHS

Refer to Shared-Use Paths in the Shared-Use Facilities section on page 47.

OFF-ROAD TRAILS

Refer to Off-Road Trails in the Shared-Use Facilities section on page 47.

WAYFINDING

Wayfinding is a series of signage that helps guide pedestrians and bicyclists through an area and enhances their understanding and user experience. Wayfinding should be considered in denser population areas where pedestrian and bicyclist activity is higher. These signs should provide directional arrows that direct users towards key destinations that are unlikely to change over a short period of time, such as off-road bicycle trails, shopping centers, museums, and hospitals. Wayfinding signage should be placed near locations where pedestrian and bicycle activity are frequently experienced, like transit stops, major intersections, and train stations. Signage should be placed near sidewalk and bicycle facilities but should not impede pedestrian or bicyclist movements or block drivers' sight lines.

Wayfinding Example
source: Burlington Business Association

Different municipalities can create a unified system of wayfinding signage by maintaining a consistent color scheme or theme to the signage throughout the area. A unified wayfinding system also increases user recognition of the signage as they navigate through the city or town.

HIGH-INTENSITY ACTIVATED CROSSWALK (HAWK) SIGNALS

A High-Intensity Activated CrossWalK (HAWK) Signal consists of a signal-head with two red lenses over a single yellow lens on a signal arm over a crosswalk location. These HAWK signals were developed to enhance pedestrian crossings on major streets. Some cities have installed modified HAWK devices that incorporate bicycle movements as well. These signals show no light indication unless activated by a pedestrian or bicyclist. Once activated, the device begins flashing yellow, then changes to a steady yellow light to warn vehicles that they must slow down, then the signal displays a solid red indication when drivers must stop and remain stopped. Once enough time has passed for the pedestrian or bicyclist to cross the intersection and the pedestrian signal head changes to "DON'T WALK", the device flashes red to inform drivers that they must stop and proceed only when the crosswalk is clear.

Crosswalk with HAWK Signal
source: NACTO

HAWK signals should be considered where bicycle routes or off-road pedestrian and bicycle facilities intersect major streets that do not have existing signalized crossings. They can also be considered at mid-block crossings of major roadways with high levels of pedestrian and bicycle activity. An education outreach program to inform the public of the operation of HAWK signals should be conducted in areas where these beacons have not been previously implemented.

RECTANGULAR RAPID FLASHING BEACON (RRFB)

Rectangular Rapid Flashing Beacons (RRFB) are enhancements to marked crosswalks that increase the drivers' awareness of pedestrians and bicyclists. These beacons include two rectangular yellow indication lights that flash with high frequency when activated by a pedestrian or bicyclist. These lights are installed on both sides of the crosswalk and in the pedestrian refuge island. They are located on the sign post beneath the pedestrian, trail, or school crossing sign and above the arrow sign that points at the crosswalk location. The flashing lights and pedestrian crossing warning signs help alert drivers when the crosswalk is occupied.

RRFBs should be considered where bicycle routes or off-road pedestrian and bicycle facilities intersect major streets that do not have existing signalized crossings. RRFBs can also be considered at mid-block crossings of major roadways with high levels of pedestrian and bicycle activity. They should also be considered at school crosswalks and trail crosswalks. An education outreach program to inform the public of the operation of RRFBs should be conducted in areas where these beacons have not been previously implemented.

Crosswalk with RRFB
source: NACTO

PEDESTRIAN REFUGE ISLANDS

Refer to Pedestrian Refuge Islands under Intersection Geometry in Roadway Facilities section on page 26.

SAMPLE PROJECT: PEDESTRIAN FACILITY

This section showcases a sample project for a proposed pedestrian facility along **Urbana Pike from MD 355 to Fingerboard Road** to provide an example of how to use this Complete Streets Manual. This sample project was recognized by Frederick County as a location in need of a completed pedestrian facility.

STEP 1A: PROJECT LOCATION

The first step of the Context Sensitive Design Process is identifying the project location and evaluating the existing conditions. Urbana Pike from Urbana Church Road to MD 355 is a two-lane roadway with intermittent on-street parking and commercial driveway entrances. The speed limit on the roadway is 25 MPH. There are shared lane markings along the roadway indicating that bicycles and vehicles share the travel lanes. The sidewalk along this section of Urbana Pike is disjointed and does not create a complete pedestrian network, however, most of the existing stretches of sidewalk are in good condition and appear to be ADA compliant. Most of the existing stretches of sidewalk along this road have either newly planted or established shade trees, and pedestrian-scale lighting can be found near the residential developments along Urbana Pike. There are a few curb extensions along this portion of Urbana Pike and one raised crosswalk at the intersection with Stone Barn Drive. There are no existing transit routes within the project limits. Points of interest along this roadway include a fire department, a community park, elementary school, and a mix of businesses, restaurants, developments, and residences.

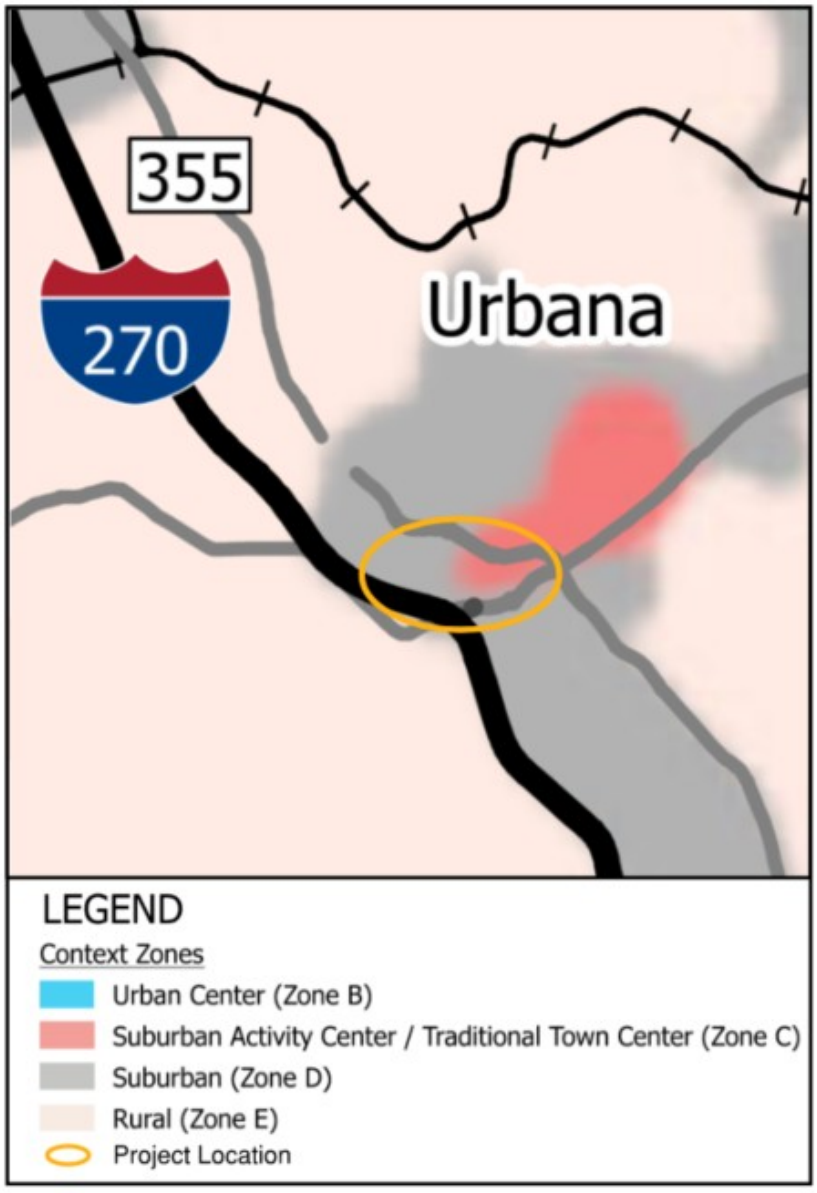


Figure 12: Pedestrian Facility Sample Project Context Zone Map

STEP 1B: CONTEXT ZONE

The second step of the Context Sensitive Design Process is to identify the context zone of the project location. **Figure 12** is an enlarged portion of the Context Zones Map **(Figure 3)**, which shows the context zone of Urbana Pike from MD 355 to Fingerboard Road is a mix of Suburban and Suburban Activity Center / Traditional Town Center. This area is also shown as an area for potential growth in the LFMP Thematic Plan Diagram and the Comprehensive Plan Map.

When taking a detailed look at the specific existing conditions of this roadway, the heavy mix of businesses and restaurants along the frontage of the road mostly presents characteristics of a Suburban Activity Center. Because this area is also considered a potential growth area, it is best to use the more access driven context zone for the context sensitive design process to include more multi-modal features to accommodate future development.

Based on this analysis, the **Suburban Activity Center** context zone will be used for this sample project.

STEP 1C: ROADWAY TYPE

Urbana Pike
source: Google Street View

Urbana Pike from MD 355 to Fingerboard Road is a lower speed, moderate traffic volume, two-lane roadway with a shared street facility for bicyclists. There is on-street parking available and commercial driveway access to small parking lots for individual businesses. This stretch of Urbana Pike provides a connection between residential developments, individual residences, and several nearby existing Boulevards / Parkways and Commercial Streets. Using the Roadway Types section of the Complete Streets Manual (Pages 13 to 17), these existing conditions of the Urbana Pike qualify the roadway as a **Connector Street.**

STEP 2: DESIGN ELEMENTS AND TREATMENTS

The final step in the Context Sensitive Design Process is to use the Design Element Selection Matrices to identify multi-modal design elements that are appropriate for the project given the context zone and the roadway type. **Table 5** shows the recommended design elements for all roadway types within a Suburban Activity Center context zone. When analyzing this chart for a pedestrian facility on a Connector (CN), ADA-compliant sidewalks and curb ramps, continental crosswalks, and shared-use paths are among the recommended elements for this context zone and roadway type. Raised crosswalks and intersections are among some of the optional considerations to include in these conditions as well.

Because this roadway already accommodates bicycles using an existing shared street facility and has intermittent sidewalk stretches along the road, complete sidewalks on both sides of the roadway are proposed in lieu of a shared-use path. No transit facilities are being considered because there are no transit routes within the project limits.

A map of the proposed improvements along Urbana Pike can be found in **Figure 13** which was developed using the design elements recommended in the design element selection matrix**.** All proposed sidewalk connections must be ADA-compliant with ADA-compliant curb ramps and continental crosswalks across all crossing locations. Any existing stretches of sidewalk within this project area should be checked for ADA-compliancy and upgraded as part of this project to ensure a complete and compliant pedestrian network. A raised crosswalk can be considered at the roadway crossing near Urbana Church Road.

NOTES:
1. Confirm existing sidewalks and curb ramps are ADA-compliant. Update as necessary.
2. All proposed sidewalk shall be minimum 5' width and ADA-compliant.
3. Depressed curb and ADA-compliant curb ramps to be installed at all road crossings.

LEGEND
- Proposed Sidewalk
- Proposed Improvements
- Proposed Continental Crosswalk

300' 0 300' 600'
SCALE: 1"=300'

URBANA PIKE FROM MD 355 TO FINGERBOARD ROAD
Context Zone: Suburban Activity Center
Roadway Type: Connector

Figure 13: Urbana Pike Sample Project - Proposed Improvements

Bicycle Facilities

This section provides additional guidance for bicycle facility design elements that enhance roads and streets and can be considered during the development and planning for transportation projects. These recommendations should be considered as supplementary to design guidance found in the County Streets and Roads Design Manual. Specific design values and guidance for these bicycle facility design elements can also be found in design manuals and guidelines published by MDOT SHA, NACTO and FHWA, which are listed under the Complete Streets Additional References on page 52.

Shared Lane Pavement Markings (Sharrows)
source: NACTO

SHARED STREETS (UNMARKED) AND SHARROWS

A shared street is a roadway where vehicles and bicyclists share the travel lanes, either along unmarked roadways or roads with shared lane pavement markings. These shared lane pavement markings or "sharrows" reinforce the legitimacy and awareness of bicycle traffic on the street, recommend proper bicyclist positioning on the roadway, and may be configured to offer directional and wayfinding guidance. Shared street facilities with sharrow pavement markings are preferable over unmarked shared street facilities. Signage to denote a shared street, such as Bicycles May Use Full Lane (BMUFL) signs, should also be incorporated along the roadway to support a complete bikeway network and improve the safety of both bicyclists and drivers by informing drivers that bicyclists might occupy the travel lanes. On shared streets with BMUFL signs, Maryland law permits drivers to cross double yellow lines to pass bicyclists when it is safe to do so. Additional guidance for shared lane markings and the supplemental signage can be found in section 9 of the FHWA MUTCD.

BMUFL Signage
source: Frederick County

Unmarked shared streets or shared streets denoted with sharrow pavement markings can be considered for implementation along roads where vehicular traffic volumes and speeds are low and right-of-way is limited in the area. Shared streets typically work in conjunction with ADA-compliant sidewalks and are not recommended along streets where an existing shared-use path is present. The shared-use path would serve the bicycle needs along the roadway in that location. A striped dedicated bicycle lane is a preferable on-road option compared to shared street facility and should be considered first where space allows within the existing roadway or right-of-way.

Sharrows should be placed in the center of the travel lane to avoid accelerated wear from the vehicular wheel path and to avoid interference from the door path of on-street parking lanes. Enhanced Sharrows, which are installed with a green colored backing or dotted line markings on either side of the bicycle symbol, can be considered to encourage desired lane positioning for bicycles and enhance visibility. Visibility can also be enhanced by increased frequency of sharrow installation. The NACTO Urban Bikeway Design Guide recommends sharrows be placed a maximum of 250 feet apart along bicycle routes with lower vehicular traffic volumes and roughly 50 to 100 feet apart in areas with more moderate traffic volumes or where two discontinuous bicycle facilities are being connected by a shared street facility.

Enhanced Shared Lane Pavement Markings (Sharrows)
source: NACTO

WIDE BIKEABLE SHOULDERS

Wide Bikeable Shoulders on Woodsboro Pike
source: Google Street View

Providing wide bikeable and paved shoulders adjacent to the vehicular travel lanes can provide improved bicycle accommodations on higher speed roadways, create space for temporary storage of disabled vehicles, and preserve the service life of the pavement edges on the roadway. Wide bikeable lanes should be considered in more rural areas where a dedicated bicycle would not fit within the existing roadway or would not fit the roadway type or context.

The minimum width for bikeable shoulders should be four feet where there is no vertical obstruction, like a curb, on the outside edge of the shoulder. Where a curb or obstruction is present, the minimum shoulder width should be five feet to allow for more shy distance on both sides for the bicyclists.

The shoulders can exceed these minimum widths, but should not exceed the width of the adjacent travel lanes to prevent increased vehicular speeds along the roadway. Bikeable shoulder widths are recommended to be wider than the minimum widths when possible to provide additional user comfort, especially in areas where the posted speed limit or the 85th percentile vehicular speeds exceed 50 MPH or if freight and heavy vehicles use the roadway frequently.

Buffered Bicycle Lanes
source: NACTO

Additional considerations for paved shoulders are discussed under Paved Shoulders in the Roadway Facilities section on Page 24.

ON-ROAD BIKE LANES

Dedicated bicycle lanes are portions of the roadway that have been designated for the preferred use of bicyclists by striping, signage, and pavement markings. Bicycle lanes enable bicyclists to ride at a comfortable speed in an area separate from the vehicular travel lanes. The width of a bike lane should be a minimum of five feet wide to provide adequate comfort for bicyclists, however, a width of six feet is preferred. These bike lanes serve to limit interference from surrounding traffic conditions and allow for predictable behavior and movements between bicyclists and motorists. A bike lane is denoted by pavement striping and has no physical barrier, such as bollards, medians, or raised curbs, that serves to physically prevent vehicular encroachment. However, a horizontal separation of the bike lane from the vehicular travel lane can be implemented in the form of a spatial buffer. When a buffer is incorporated into the layout of bicycle lanes, the buffer should be a minimum of five feet wide where possible.

Typical bicycle lanes run in the same direction as the travel lanes and along the right-hand side of the street. These dedicated bike lanes run adjacent to the curb line when no on-street parking is present or between the vehicular travel lanes and parked cars when on-street parking is available. Signage should be incorporated along roadways with dedicated bike lanes to provide a complete bicycle network. The MUTCD outlines guidance for shared lane markings and the supplemental signage. On-road bicycle lanes should be considered for implementation in areas with moderate to low levels of traffic speeds and volumes where bicycle activity is expected.

SEPARATED BIKE LANES

Separated bicycle lanes are located within or directly adjacent to the roadway and provide a physical, vertical separation from the vehicular travel lanes. The vertical separation component distinguishes separated bicycle lanes from other on-road bicycle lanes. These lanes should be a minimum of five feet wide, but additional width provides for added user comfort. The space between the edge of curb and the vertical element should be a minimum of seven feet to accommodate maintenance vehicles for cleaning or snow removal. A minimum buffer of three feet should be implemented adjacent to on-street parking.

Separated bicycle lanes are a beneficial option along roadways with high bicycle activity and moderate vehicular speeds.

Separated Bike Lanes
source: NACTO

PROTECTED INTERSECTIONS

Refer to Protected Intersections in the Roadway Facilities section on page 27.

BIKE SIGNALS, BIKE BOXES, TURN-QUEUE BOXES

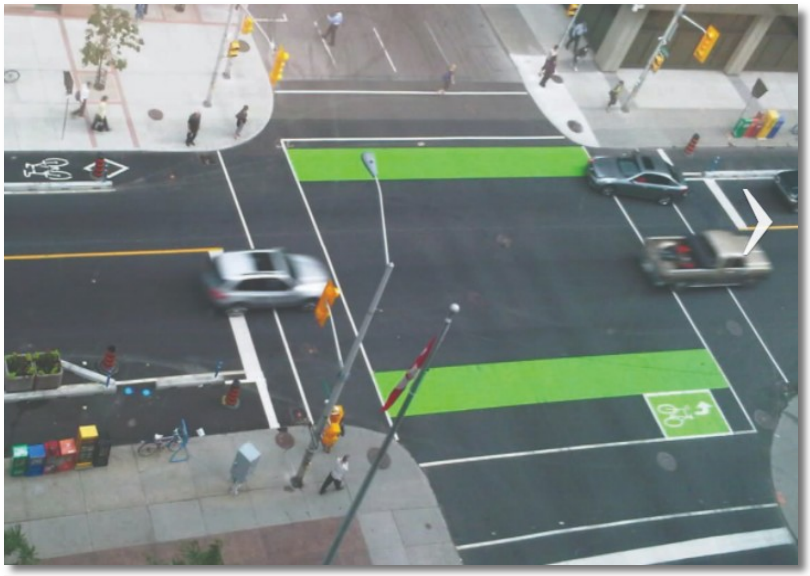
Providing bike signals, bike boxes, and turn queue boxes can help provide safe and efficient navigation for bicyclists through signalized intersections.

Bicycle signal heads can be installed to indicate bicycle signal phases and other bicycle specific movements in combination with an existing conventional traffic signal or hybrid beacon. These signals present bicyclist movements as the priority in the intersection and provide additional safety for the bicyclists. Bicycle signal heads should be considered to help simplify complex intersections. They can also be used when a shared-use path crosses a street, at intersections where a bicycle facility is transitioning from a separated bicycle lane to a regular bicycle lane, or where bicycle movements need priority to allow for safe and efficient navigation through the intersection.

Bike Box at Intersection
source: NACTO

Bike boxes are designated areas to provide a safe and visible location at the head of a traffic lane where bicyclists can get ahead of queuing traffic during a red signal phase. Bike boxes enhance the visibility of bicyclists at an intersection and provide a bike forward stop bar to separate bicyclists from the queued vehicles during a red signal phase. These facilities should be considered at complex intersections with high levels of bicycle activity.

Turn queue boxes provide a safe way for bicyclists to make left turns at multiple-lane, signalized intersections from a separated bicycle lane or standard bicycle lane facility. These boxes allow bicyclists space to wait for a turning opportunity without having to merge into the vehicular travel lanes. Turn queue boxes enhance awareness and visibility of bicyclists in intersections and should be considered for use at complex intersections with high levels of bicycle activity.



Turn Queue Box at Intersection
source: NACTO

SHARED-USE PATHS

Refer to Shared-Use Paths in the Shared-Use Facilities section on page 47.

OFF-ROAD TRAILS

Refer to Off-Road Trails in the Shared-Use Facilities section on page 47.

BICYCLE PARKING

Bicycle parking should be provided in areas that serve as logical terminal points for bicycle trips. For example, parking options for bicycles should be considered near shopping centers, business centers, and near transit shelters. Short term bicycle parking should be implemented within 50 feet of a major destination or transit stop with high bicycle activity. A clear zone should always be provided around bicycle parking to avoid obstructing pedestrian, bicyclist or vehicular traffic on roadways, sidewalks, or shared-use paths. Bicycle racks should be spaced at least three feet apart to allow for convenient access. Additional space for larger bicycles with child trailers and/or cargo carriers should also be taken into consideration, especially near retail locations. Parking for bicycles should always be located in well-lit areas in view of sidewalks or pedestrian paths.

Bicycle Parking
source: NACTO

WAYFINDING

Refer to Wayfinding in the Pedestrian Facilities section on page 32.

SAMPLE PROJECT: BICYCLE FACILITY

This section showcases a sample project for a proposed bicycle facility along **Old National Pike from New Market to Mt. Airy** to provide an additional example of how to use this Complete Streets Manual. This sample project was recognized by Frederick County as a location in need of a completed bicycle facility.

STEP 1A: PROJECT LOCATION

The first step of the Context Sensitive Design Process is identifying the project location and evaluating the existing conditions. Old National Pike connects New Market and Mt. Airy through an approximately six and a half mile long stretch of primarily two-lane roadway. Old National Pike is a Maryland Inventory Historic Property and part of the Historic National Road scenic byway. For more information regarding historic properties and scenic byways, see page 52 for Additional References. The existing conditions of this road vary as it moves throughout New Market, Mt. Airy, and the area between these two locations.

Within New Market, from New Market Middle School to Marley Street, Old National Pike has a speed limit of 25 MPH with on-street parking and intermittent commercial driveway entrances. There are currently no existing bicycle facilities along this stretch of Old National Pike, but existing sidewalks line both sides of the roadway. These sidewalks are equipped with pedestrian scale lighting and shade trees along the entire stretch. There are curb extensions at intersections throughout this section consisting of hatched striping and vertical flex posts that shorten all crosswalk locations. There are no existing public transit routes on Old National Pike within New Market. The street is lined with commercial shops, restaurants, and businesses with building frontages close to the roadway. Points of interest along this roadway include a fire department, a community park, an elementary school, a middle school and a mix of businesses, restaurants, and residences.

Old National Pike in New Market
source: Google Street View

As the road moves from Marley Street east towards Rising Ridge Drive, the existing conditions along Old National Pike change. The speed limit increases and varies between 35 MPH and 40 MPH. The roadway in this section is primarily two-lanes, however, additional turn lanes and merge lanes are provided intermittently to accommodate intersecting roadways and commercial entrances. There are some lengths of roadway with wide shoulders available. There are no bicycle facilities or on-street parking, and existing sidewalks are rare in this section. Businesses and residences are spread out and the roadway is lined with primarily woods or farmland. There is a grocery store, a pharmacy and two small shopping

centers near the intersection of Old National Pike and Morning Gate Lane. Key destinations along this stretch include the Old National Pike District Park.

The portion of Old National Pike from Rising Ridge Drive east to South Main Street at the Frederick County Line has unique existing conditions as well. The speed limit reduces to 30 MPH as it nears Mt. Airy. Commercial entrances become more prevalent, and destinations are closer together. Turn lanes and merge lanes have been incorporated into the majority of this stretch to accommodate these entrances. There are no existing bicycle facilities, on-street parking, or pedestrian scale lighting in this area. There are existing sidewalks along one or both sides of the roadway, with a small stretch of shade trees along the south side of the road. Some notable destinations along this portion include Frederick Memorial Hospital, Twin Ridge Elementary School, Twin Ridge Park, a grocery store, and a hardware store.

STEP 1B: CONTEXT ZONE

The second step of the Context Sensitive Design Process is to identify the context zone of the project location. **Figure 14** is an enlarged portion of the Context Zones Map **(Figure 3)**, which shows the context zones along Old National Pike within and between New Market and Mt. Airy. Because of the larger scale of this sample project, a variety of context zones are found along the roadway.

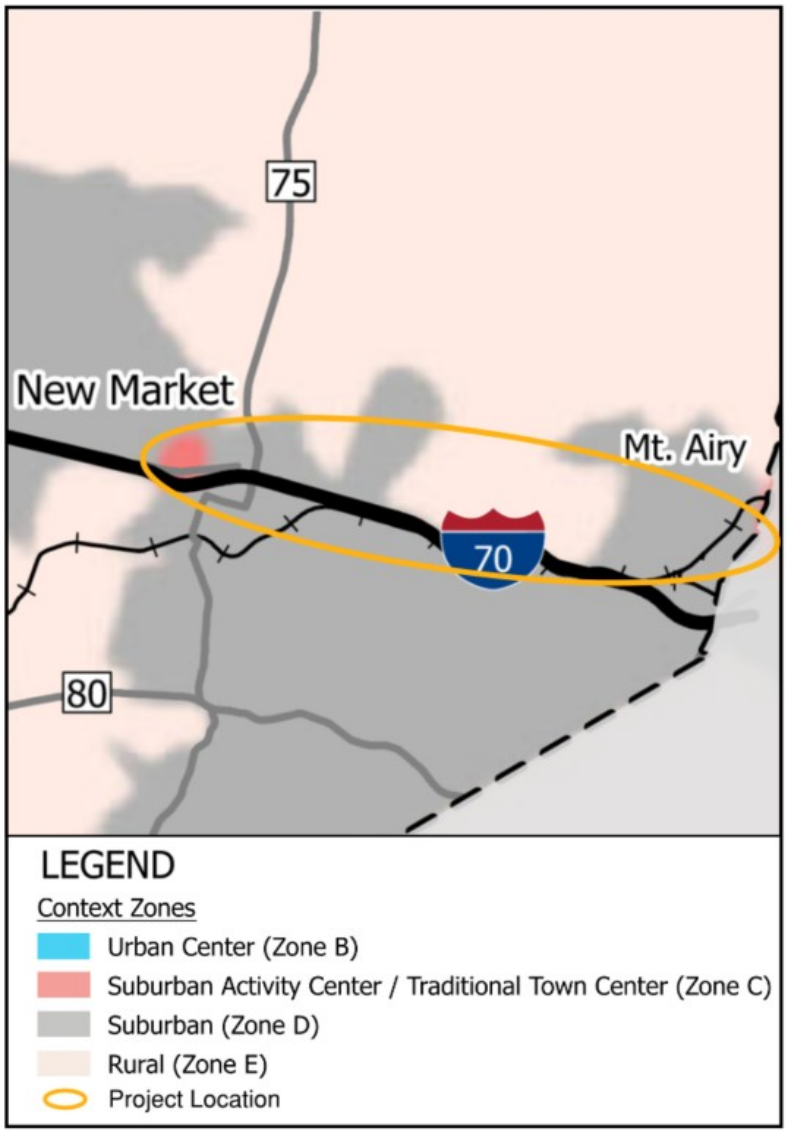


Figure 14: Bicycle Facility Sample Project Context Zone Map

The legend on the map shows that the New Market area is a mix of Suburban Activity Center / Traditional Town Center. The Context Zones Map provides a great starting point to determine the context zone of a project location, but it is important to analyze the existing conditions and layout of the roadway as well to further refine the context zone determination for the project location. Because the heart of New Market, along Old National Pike, has mostly low to mid rise, historical buildings with building frontages close to the roadway and on-street parking, the context zone can be specified as a **Traditional Town Center**.

The part of Old National Pike that runs through a pocket of commercial shopping centers and parking lots near Green Valley Road is shown on the map as a Suburban context zone but is also recognized as a potential growth area in the LFMP Thematic Plan Diagram and the Comprehensive Plan. However, given the commercial and activity driven nature of this area and the potential growth area recognition, the context zone of **Suburban Activity Center** more closely applies to Old National Pike from Marley Street to Rotary Avenue.

Old National Pike between Rotary Avenue and Mt. Airy is a mix of Rural and Suburban context zones, based on the Context Zone Map in **Figure 14.** Further analysis of the characteristics of this portion of the Pike show that the roadway has some small pockets of Suburban features, but is primarily a mix of agricultural uses and green space with scattered development in large-lot residential clusters. These primary features are indicative of the **Rural** context zone.

As Old National Pike nears Mt. Airy, the context zone shown in **Figure 14** becomes Suburban near Rising Ridge Drive with some Suburban Activity Center / Traditional Town Center shown at the County Line where it intersects with South Main Street. The portion of Old National Pike near Rising Ridge Road has a few developments with single-family small lots, a small commercial strip, and some neighborhood level civic and cultural facilities. As the Pike connects to South Main Street, the roadway encounters a dense collection of low-rise commercial and retail structures with setbacks for off-street parking. Mt. Airy is also recognized as a potential growth area in the LFMP Thematic Plan Diagram and the Comprehensive Plan. This area of Old National Pike between Rising Ridge Road and South Main Street can therefore be considered a **Suburban Activity Center** to provide more multi-modal accommodations for future development.

Based on this analysis, the sample project will need to take the varying context zones into account for the different sections of the roadway when determining proposed improvements.

STEP 1C: ROADWAY TYPE

Old National Pike within New Market is a lower speed, moderate traffic volume, two-lane roadway. There is on-street parking available along the road for access to the individual businesses. This stretch of the roadway is pedestrian-friendly and has dense commercial and retail businesses lining both sides of the street. According to the Roadway Types section of the Complete Streets Manual (pages 13 to 17), the existing conditions of Old National Pike through New Market qualify this portion of the road as a **Commercial Street.**

The rest of the project limits along Old National Pike, from east of New Market to Mt. Airy, experience moderate travel speeds with moderate volumes of traffic. This section connects several large residential neighborhoods to larger roadway systems and commercial areas that are spread out across larger distances. Pedestrian facilities only exist near destination points that are close together, like where the Pike connects to South Main Street. According to the Roadway Types section of the Complete Streets Manual (pages 13 to 17), the existing conditions of Old National Pike east of New Market to Mt. Airy qualify this portion of the road as a **Collector.**

Old National Pike between New Market and Mt. Airy
source: Google Street View

STEP 2: DESIGN ELEMENTS AND TREATMENTS

The final step in the Context Sensitive Design Process is to use the Design Element Selection Matrices to identify multi-modal design elements that are appropriate for the project given the context zones and the roadway types. **Tables 4, 5, and 6** shows the recommended design elements for all roadway types within the Rural, Traditional Town Center, and Suburban Activity Center context zones.

When analyzing these tables for a bicycle facility on a Commercial Street (CS), shared streets marked with sharrows are among the recommended or optional design features for a traditional town center. Shared streets were then selected for implementation within New Market due to the limited right-of-way available and on-street parking utilization.

Buffered bicycle lanes are a recommended feature for a Collector (CL) within a Suburban Activity Center context zone, therefore, these were selected as the bicycle facility to navigate through the more complex intersections between Marley Street and Rotary Avenue.

Wide bikeable shoulders are among the recommended or optional design features for a Collector (CL) in a Rural zone. Due to the existing features and characteristics of Old National Pike between Marley Street and Rising Ridge Road, wide shoulders were selected as the bicycle option on this stretch.

A shared use-path is among the optional or recommended bicycle design features for a Collector (CL) within a Suburban Activity Center context and worked well with the existing conditions for the area between Rising Ridge Road and S. Main Street.

An alternative option should be considered to connect Old National Pike from Marley Street to Rotary Avenue using the disjointed and abandoned pieces of Old National Pike that run just north of the I-70 on and off ramps from Green Valley Road. A pedestrian and bicycle tunnel could be constructed beneath Green Valley Road to provide a bicycle connection between the two sections of old roadway. This alternative option would provide a safer route for bicyclists that avoids the large intersections near the Green Valley Road shopping centers.

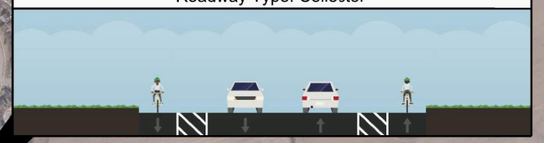
Bicycle parking and wayfinding should be considered near major trip generators, like schools, hospitals, connecting trails, and retail centers.

ADA-compliant sidewalks and curb ramps, continental crosswalks, and shared-use paths are among the recommended elements for this context zone and roadway type. Raised crosswalks and intersections are among some of the optional considerations to include in these conditions as well.

The existing pedestrian facilities along Old National Pike currently provide logical and necessary connection points. Where a proposed bicycle facility requires roadway widening, any existing sidewalks should be rebuilt and upgraded to ADA-compliancy with ADA-compliant curb ramps and continental crosswalks at all crossing locations. Any existing stretches of sidewalk within this project area should be checked for ADA-compliancy and upgraded as part of this project to ensure a complete and compliant multi-modal network. There are no transit routes within the project limits.

A map of the proposed improvements along Old National Pike can be found in **Figures 15A and 15B** which were developed using the recommended and optional bicycle design elements from the design element selection matrices**.**

TYPICAL SECTION: BUFFERED ON-ROAD BIKE LANES
From Marley Street to Rotary Avenue
Context Zone: Suburban Activity Center
Roadway Type: Collector



TYPICAL SECTION: WIDE BIKEABLE SHOULDERS
From Rotary Avenue to Rising Ridge Road
Context Zone: Rural
Roadway Type: Collector

ALTERNATIVE:
Construct a pedestrian / bicycle tunnel under Green Valley Rd. and interchange ramps using abandoned sections of Old National Pike

Connect to residential trail behind Middle School

See Inset 1 for Intersection Layout

GREEN VALLEY RD

OLD NATIONAL PIKE DISTRICT PARK

OLD NATIONAL PIKE

MATCHLINE

I-70

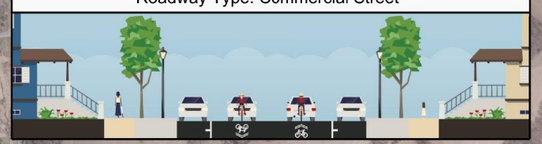
NEW MARKET

NEW MARKET MIDDLE SCHOOL

Consider bicycle parking and wayfinding throughout New Market and near retail centers

BALDWIN RD

TYPICAL SECTION: SHARED STREET "SHARROWS"
From New Market Middle School to Marley Street
Context Zone: Traditional Town Center
Roadway Type: Commercial Street



Connect to residential trail and recreational field

Consider HAWK signal at park entrance

GREEN VALLEY RD

OLD NATIONAL PIKE

MORNING GATE LN

Existing signalized intersection

ROTARY AVE

Use green paint in bike lanes to increase visibility from park entrance to Morning Gate Lane

SCALE: 1"=250'

INSET 1

NOTES:
1. All proposed bike lanes shall be a minimum of 5' width with a 5' buffer where possible.
2. All proposed sidewalk shall be minimum 5' width and ADA-compliant.
3. Confirm existing sidewalks and curb ramps are ADA-compliant. Update as necessary.
4. Provide continental crosswalks at all roadway crossings.

LEGEND
- Proposed Bicycle Facility / Project Area
- Proposed Improvements
- Proposed Sidewalk
- Proposed Roadway
- Proposed Continental Crosswalk

1,000' 0 1,000' 2,000'
SCALE: 1"=1,000'

OLD NATIONAL PIKE FROM NEW MARKET TO MT. AIRY
Context Zone: Traditional Town Center, Suburban Activity Center, and Rural
Roadway Type: Commercial Street, Collector

Figure 15A: Old National Pike Sample Project - Proposed Improvements

Consider bicycle parking and wayfinding near hospital and retail centers

TWIN RIDGE ELEMENTARY SCHOOL

RISING RIDGE RD

MT. AIRY

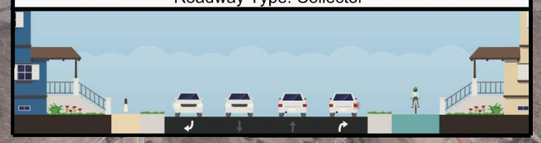
S. MAIN ST.

FREDERICK MEMORIAL HOSPITAL

Provide continental crossing at Rising Ridge Rd. to connect bikeable shoulders to shared-use path on south side

TYPICAL SECTION: WIDE BIKEABLE SHOULDERS
From Rotary Avenue to Rising Ridge Road
Context Zone: Rural
Roadway Type: Collector

TYPICAL SECTION: SHARED-USE PATH
From Rising Ridge Road to S. Main Street
Context Zone: Suburban Activity Center
Roadway Type: Collector



I-70

OLD NATIONAL PIKE

DAMASCUS RD
COMMUNITY
CHURCH

I-70

MATCHLINE

NOTES:
1. All proposed bike lanes shall be a minimum of 5' width with a 5' buffer where possible.
2. All proposed sidewalk shall be minimum 5' width and ADA-compliant.
3. Confirm existing sidewalks and curb ramps are ADA-compliant. Update as necessary.
4. Provide continental crosswalks at all roadway crossings

SHEET 2 OF 2

LEGEND
- Proposed Bicycle Facility / Project Area
- Proposed Improvements
- Proposed Sidewalk
- Proposed Roadway
- Proposed Continental Crosswalk

1,000' 0 1,000' 2,000'
SCALE: 1"=1,000'

OLD NATIONAL PIKE FROM NEW MARKET TO MT. AIRY
Context Zone: Traditional Town Center, Suburban Activity Center, and Rural
Roadway Type: Commercial Street, Collector

Figure 15B: Old National Pike Sample Project - Proposed Improvements

Shared-Use Facilities

This section provides additional guidance for shared-use facility design elements that enhance roads and streets and can be considered during the development and planning for transportation projects. These recommendations should be considered as supplementary to design guidance found in the County Streets and Roads Design Manual. Specific design values and guidance for these shared-use facility design elements can also be found in design manuals and guidelines published by MDOT SHA, NACTO and FHWA, which are listed under the Complete Streets Additional References on Page 52.

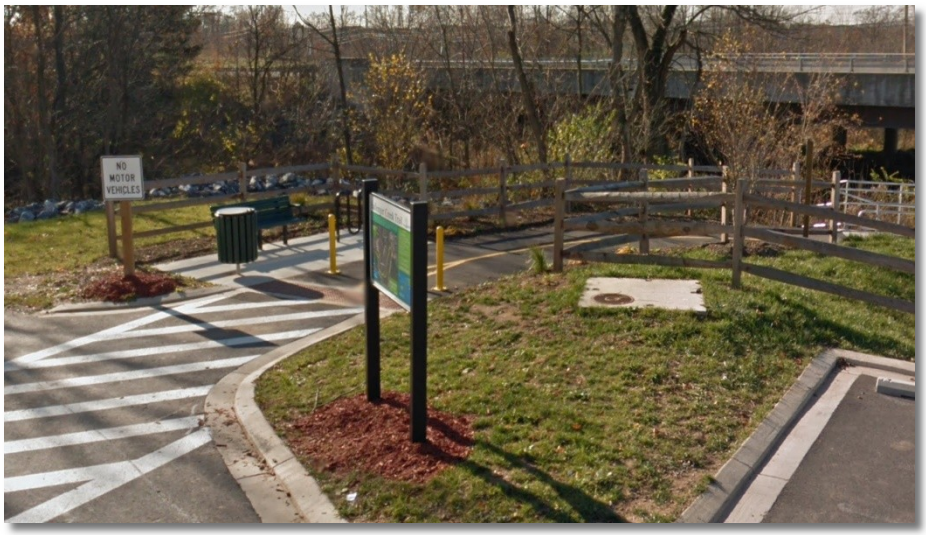
SHARED-USE PATHS

Shared-use paths provide a safe and convenient location for both pedestrians and bicycles to walk and ride in a shared space that is separate from but adjacent to a roadway corridor. Shared-use paths provide an off-road, separated amenity for bicyclists and pedestrians to safely access community facilities and destinations. New and retrofitted shared-use paths must meet ADA design criteria established by the United States Department of Justice and summarized by the MDOT SHA Accessibility Policy and Guidelines for Pedestrian Facilities along State Highways. Shared-use paths should be a minimum of ten feet wide, but a 12 foot width is preferred. These paths must include ADA compliant curb ramps at crossing locations and should not have any physical barriers or obstacles in the pedestrian and bicycle path. Shared-use paths should include a horizontal buffer between the edge of roadway pavement and the edge of the path where possible, with a minimum width of five feet. It is typically beneficial to pair a shared-use path on one side of the roadway with a sidewalk on the opposite side of the roadway.

Shared-Use Path on Urbana Pike
source: Google Street View

OFF-ROAD TRAILS

Off-road trails offer a bicycle and pedestrian facility can serve as either a functional connection or a recreational path and is completely separated from roadway corridors. These trails should be a minimum of ten feet wide but are typically wider as right-of-way is usually less constrained around off-road facilities. Measures such as bollards or fencing should be implemented to prevent vehicular access where the trail crosses a roadway. At roadway trail crossings, continental crosswalks should be installed, and pedestrian crossing signage implemented before the crosswalk to warn drivers of the presence of bicyclists and pedestrians. Raised crosswalks, HAWK signals and RRFBs can be considered for use at trail crossing locations to enhance pedestrian awareness and visibility. Wayfinding signage is beneficial near trail parking lots and entrances or roadway crossings.



Ballenger Creek Trail Entrance
source: Google Street View

SAMPLE PROJECT: SHARED-USE FACILITY

This section showcases a sample project for a proposed shared-use facility along **Crestwood Boulevard from Ballenger Creek Pike to Corporate Drive** and along **Corporate Drive to the Ballenger Creek Trail parking lot** to provide an example of how to use this Complete Streets Manual. This sample project was recognized by Frederick County as a location in need of a completed pedestrian and bicycle facility.

STEP 1A: PROJECT LOCATION

The first step of the Context Sensitive Design Process is identifying the project location and evaluating the existing conditions. Crestwood Boulevard from Ballenger Creek Pike to Corporate Drive is a four-lane roadway with a wide grass median and many entrances to business centers, developments, and shopping centers. There are signalized intersections at Ballenger Creek Pike, Fellingwood Drive, New Design Road, and Corporate Drive. The speed limit on the roadway is 35 MPH from Ballenger Creek Pike to Society Circle, and increases to 40 MPH from Society Circle to Corporate Drive. There is no on-street parking available, and an existing sidewalk stretches almost entirely along the north side of the road. There is a gap in the existing sidewalk between the two entrances of Partners Court. There are sporadic clusters of shade trees, and no roadway or pedestrian-scale lighting. A TransIT Connector bus route runs along the project limits with multiple stop locations. Points of interest along this roadway include Crestwood Plaza, Kaiser Permanente Frederick Medical Center, Children's National Frederick Hospital, several residential developments and apartment complexes, and several large scale business complexes.

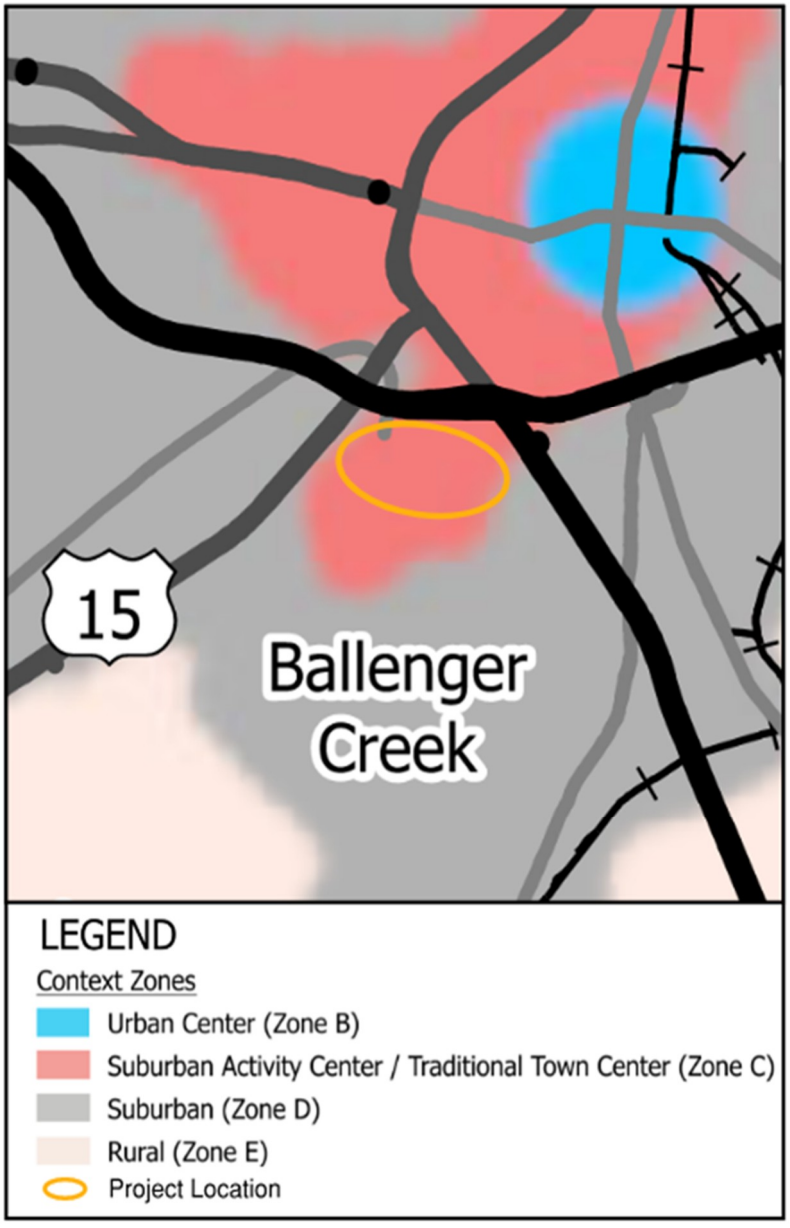


Figure 16: Shared-Use Facility Sample Project Context Zone Map

Corporate Drive from Crestwood Boulevard to the Ballenger Creek Trail parking lot is a primarily two-lane roadway with no center medians, and turn lanes throughout. The speed limit along Corporate Drive is 30 MPH. This road has existing buffered sidewalks along both sides with no on-street parking. There are no bicycle facilities along this roadway. There are existing shade trees along the majority of the sidewalk, but no pedestrian-scale or roadway lighting. A TransIT Connector bus route runs along the project limits and provides one stop location within the project limits. Key destinations near this road are the Ballenger Creek Trail and the Westview Corner Shopping Center.

STEP 1B: CONTEXT ZONE

The second step of the Context Sensitive Design Process is to identify the context zone of the project location. **Figure 16** is an enlarged portion of the Context Zones Map **(Figure 3)**, which shows the context zone of Crestwood Boulevard and Corporate Drive as Suburban Activity Center / Traditional Town Center. This area is also shown as an area for potential growth in the LFMP Thematic Plan Diagram and the Comprehensive Plan Map.

When taking a detailed look at the specific existing conditions of this roadway, the heavy mix of business centers, residential developments, shopping centers, and hospitals along the road are indicative of the Suburban Activity Center. Because this area is also considered a potential growth area, it is best to use the more access driven context zone for the context sensitive design process to include more multi-modal features to accommodate future development.

Based on this analysis, the **Suburban Activity Center** context zone will be used for this sample project**.**

STEP 1C: ROADWAY TYPE

Crestwood Boulevard experiences a moderate to high volume of traffic and serves to connect three major north-to-south roadways, Ballenger Creek Pike, New Design Road, and Buckeystown Pike. This road also serves as a throughput connection towards I-70. Crestwood Boulevard has several signalized intersections, a median or shared center left turn lane throughout the roadway, multiple travel lanes in each direction, and moderate speeds. According to the Roadway Types section of the Complete Streets Manual (pages 13 to 17), these existing conditions of Crestwood Boulevard qualify the roadway as a **Boulevard / Parkway.**

Crestwood Boulevard
source: Google Street View

The small stretch of Corporate Drive within the project limits is a primarily two-lane, moderate speed, moderate traffic volume roadway that provides a connection between the business centers, shopping centers and residential developments in the area. Based on the Roadway Types section of the Complete Streets Manual (pages 13 to 17), these existing conditions of Corporate Drive qualify the roadway as a **Connector.**

Corporate Drive
source: Google Street View

STEP 2: DESIGN ELEMENTS AND TREATMENTS

The final step in the Context Sensitive Design Process is to use the Design Element Selection Matrices to identify multi-modal design elements that are appropriate for the project given the context zone and the roadway type. **Table 5** shows the recommended design elements for all roadway types within a Suburban Activity Center context zone. When analyzing this chart for a shared-use facility on a Boulevard / Parkway (B/P) and a Connector (CN), ADA-compliant sidewalks and curb ramps, continental crosswalks, bicycle lanes, and shared-use paths are among the recommended elements for these context zones and roadway types.

Because Crestwood Boulevard already accommodates pedestrians on one side of the road using an existing sidewalk and the speeds and traffic volumes on this road would present some safety issues with an on-road bicycle facility, a shared-use path is proposed along the south side of the road. A shared-use path will safely accommodate bicycle and pedestrian users in this area. The destinations along this roadway are close enough together to warrant a facility such as a shared use path to serve the bicycle and pedestrian trips between them. This bicycle facility will provide a connection between the bicycle lanes on Ballenger Creek Pike and the entrance of the Ballenger Creek Trail. The shared-use path is proposed to continue along the short stretch of Corporate Drive to maintain consistency in facility type and mitigate changes between facility types along the route. Sidewalk improvements are also proposed to complete the sidewalk along the north side of the roadway.

The project limits are served by a TransIT Connector route with multiple transit stops. Transit shelters, seating, and bicycle parking should be considered at the existing bus stops along Crestwood Boulevard.

A map of the proposed improvements along Crestwood Boulevard and Corporate Drive can be found in **Figure 17** which was developed using the design elements recommended in the design element selection matrix**.** All proposed sidewalk and shared-use path connections must be ADA-compliant with ADA-compliant curb ramps and continental crosswalks across all crossing locations. Any existing stretches of sidewalk within this project area should be checked for ADA-compliancy and upgraded as part of this project to ensure a complete and compliant pedestrian network.

TYPICAL SECTION: SHARED-USE PATH
Crestwood Boulvard: Ballenger Creek Pike to Corporate Drive
Context Zone: Suburban Activity Center
Roadway Type: Boulevard / Parkway

Consider bicycle parking and wayfinding near transit stops, retail centers, business centers, and hospitals.

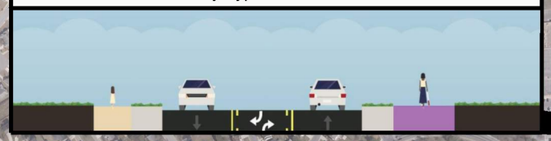
Provide sidewalk between Partners Ct. entrances on east side of road to complete pedestrian network

Provide connection to proposed future bike lanes along New Design Rd.

Connect to bicycle lanes on Ballenger Creek Pike

Provide pedestrian and bicyclist crosswalk across Corporate Dr.

TYPICAL SECTION: SHARED-USE PATH
Corporate Drive: Ballenger Creek Trail to Crestwood Boulevard
Context Zone: Suburban Activity Center
Roadway Type: Connector Street



Connect to Ballenger Creek Trail entrance

I-70
I-270
US 15 / US 340
BALLENGER CREEK PIKE
CRESTWOOD BLVD
NEW DESIGN RD
CRABAPPLE DR
FELLINGWOOD DR
KAISER PERMANENTE FREDERICK MEDICAL CENTER
CHILDREN'S NATIONAL FREDERICK HOSPITAL
PARTNERS CT
CORPORATE DR
WESTVIEW CORNER SHOPPING CENTER
WESTVIEW DR
BUCKEYSTOWN PIKE

NOTES:
1. Proposed shared-use path shall be a minimum of 10' width with a 5' buffer where possible.
2. All proposed sidewalk shall be minimum 5' width and ADA-compliant.
3. Confirm existing sidewalks and curb ramps are ADA-compliant. Update as necessary.
4. Provide continental crosswalks at all roadway crossings.

LEGEND
- Proposed Shared-Use Path / Project Area
- Proposed Improvements
- Existing Bus Stop Location

1,000' 0 1,000' 2,000'
SCALE: 1"=1,000'

CRESTWOOD BOULEVARD AND CORPORATE DRIVE
Context Zone: Suburban Activity Center
Roadway Type: Boulevard / Parkway, Connector Street

Figure 17: Crestwood Boulevard and Corporate Drive Sample Project

Additional Complete Streets References

For further information regarding Complete Streets considerations, design, or other items discussed within the Complete Streets Manual, please see the below references.

GUIDANCE FROM THE FEDERAL HIGHWAY ADMINISTRATION (FHWA)

- 2009 Maryland Manual on Uniform Traffic Control Devices (MdMUTCD) can be found here: https://mutcd.fhwa.dot.gov/pdfs/2009r1r2/pdf_index.htm
- Additional guidance on ADA Compliancy can be found here: https://www.fhwa.dot.gov/civilrights/programs/ada/resources.cfm

GUIDANCE FROM THE AMERICAN ASSOCIATION OF STATE TRANSPORTATION OFFICIALS (AASHTO)

- 2021 Guide for the Planning, Design, and Operation of Pedestrian Facilities, 2nd Edition
- 2012 Guide for the Development of Bicycle Facilities, 4th Edition
- 2018 A Policy on Geometric Design of Highways and Streets, 7th Edition

GUIDANCE FROM NATIONAL ASSOCIATION OF CITY TRANSPORTATION OFFICIALS (NACTO)

- 2014 Urban Bikeway Design Guide, 2nd Edition
- 2013 Urban Street Design Guide, 1st Edition
- 2016 Transit Street Design Guide, 1st Edition

GUIDANCE FOR AMERICANS WITH DISABILITIES ACT (ADA) COMPLIANCY

- 2010 ADA Standards can be found here: https://www.access-board.gov/files/ada/ADA-Standards.pdf
- 2013 Public Rights-of-Way Accessibility Guidelines (with SUP) can be found here: https://www.access-board.gov/files/prowag/PROW-SUP-SNPRM-2013.pdf
- 2015 Architectural Barriers Act (ABA) Standards can be found here: https://www.access-board.gov/files/aba/ABAstandards.pdf

GUIDANCE FROM FREDERICK COUNTY

- 1994 Frederick County Streets and Roads Manual can be found here: https://frederickcountymd.gov/DocumentCenter/View/6567/STREETS-AND-ROADS-DESIGN-MANUAL?bidId=
- 2020 Frederick County Complete and Green Streets Policy can be found here: https://www.frederickcountymd.gov/DocumentCenter/View/334000/Adoption-of-Complete-and-Green-Streets-Policies?bidId=
- 2019 Livable Frederick Master Plan can be found here: https://frederickcountymd.gov/7923/Livable-Frederick-Master-Plans
- 2021 Frederick County Towards Zero Deaths Policy can be found here: https://www.frederickcountymd.gov/DocumentCenter/View/333999/Toward-Zero-Deaths-Policy-and-Action-Plan-Initiation?bidId=
- Other documents can be found here: https://www.frederickcountymd.gov/8010/Transportation-Planning

HISTORICAL GUIDANCE

- 2006 MDOTSHA Context Sensitive Solutions for the Historic National Road Scenic Byway can be found here: https://www.roads.maryland.gov/oed/mhnr-css_final061104.pdf
- 2015 Historic National Road Scenic Byway Corridor Partnership Plan Update can be found here: https://www.roads.maryland.gov/OED/MHNR_guidelines.pdf

Green Streets Manual

Green Streets

Green Streets is a term used to describe a street that incorporates vegetation, open space, and engineered environmental features to reduce stormwater runoff, provide stormwater quality treatment, mitigate the urban heat island effect, and improve community aesthetics. A Green Street provides facilities that clean and filter the captured stormwater before it is discharged into storm sewer systems which transfer the water back to rivers, surface waters, and streams.

Carroll Creek Park *source: VisitFrederick.org*

A Green Street means a street or road that safely and adequately accommodates and incorporates best management practices (BMPs) of environmental site design for addressing stormwater runoff, including using small scale stormwater management practices, nonstructural techniques, and better site planning to minimize the impact of road and sidewalk development on water resources.

According to the United States Environmental Protection Agency: **"A Green Street is a stormwater management approach that incorporates vegetation, soil, and engineered systems to slow, filter, and cleanse stormwater runoff from impervious surfaces. Green Streets are designed to capture rainwater at its source, where rain falls."**

Incorporating Green Street elements into the roadway design process will help promote the environmental sustainability and community health of Frederick County. The incorporation of these elements provides a wide range of benefits for the surrounding area. Green Street elements provide enhanced quality of life and community aesthetic for residents, improved air quality and water quality in the rivers and streams, replenished groundwater supplies, and can be implemented to enhance bicycle and pedestrian safety and traffic calming. The various elements discussed in this manual can be incorporated within County right-of-way in the roadway, roadway shoulders, green space, and other potential locations including parking areas, sidewalks, and trails. This manual will help guide in the selection process for BMPs to use along different roadway types and context zones. Design consideration for selecting BMPs and basic design guidelines for the various types of BMPs are given to help guide the selection of BMPs along a street.

Green Streets Design Considerations

A variety of design considerations should be examined when selecting potential Green Street Infrastructure Best Management Practices (BMPs) for incorporation into a transportation project. This checklist below will be used to help select the best BMP given the specific constraints of a project location. The items in the checklist were developed from the Maryland Stormwater Design Manual. The Green Street design considerations below are summarized for each BMP type in **Table 9.**

WATERSHED

The project's surrounding watershed should be considered when deciding which Green Street BMPs will be implemented as part of the project. Watershed Use Classification are promulgated in the Code of Maryland Regulations (COMAR) Section 26.08.02.08. An interactive map for Maryland's Designated Use Classifications can also be found on the Maryland Department of the Environment's website. Coldwater Watershed information can be found on Maryland Department of Natural Resources website with the Department's Coldwater Resources Mapping Tool.

- ❑ Use I and II watersheds do not have any limitation as to the type of BMP that can be provided.
- ❑ Use III and IV watersheds, as well as any watershed determined to be a Coldwater watershed by the Maryland Department of Natural Resources, should avoid using stormwater features with permanently stored surface water. (ex. Wet Swales)
- ❑ Submerged Gravel Wetlands or Enhanced Surface Sand Filters may be designed to avoid any permanent surface storage when located in Use III and IV watershed and any Coldwater watershed.

KARST AREAS

Karst geology regions are characterized by formations underlain by carbonate rock and typified by the presence of limestone caverns and sinkholes. Karst geology is prone to the formation of sinkholes. Areas of karst geology and sinkholes will require careful selection of Green Street Infrastructure BMPs to ensure the safety of the public and prevent the collapse of the street and surrounding area. If the project is located in an area with karst geology and sinkholes, BMPs that promote infiltration should be avoided or not selected. Information on Karst Areas can be found on the Maryland Geological Survey website.

- ❑ Avoid the use of Pervious Pavement, Reinforced Turf, Infiltration Trenches, Dry Wells, Infiltration Berms, and Landscape Infiltration.
- ❑ Most BMPs will require a liner to prevent infiltration. Non-rooftop Disconnection, Sheet Flow to Conservation Areas, and Grass Swales do not require a liner.
- ❑ Closed systems like tree boxes and boxed bioretentions are acceptable practices.
- ❑ No pooling of water or infiltration is allowed at or near existing sinkholes.

SOIL GROUP

The Hydrologic Soil Group (HSG) and infiltration rate will play a factor in determining which Green Infrastructure BMPs are appropriate for a project site. Some BMPs function better in HSG A or B, while others will function better in HSG C or D. Some can function in all HSGs. Soils that are HSG A or B tend to have better infiltration rates than HSG C or D. BMPs that use or promote infiltration are best suited in HSG A or B, but infiltration rates should be determined with field investigation to ensure the selected BMP will function at the chosen location. Another concern is soil with high erodibility factors. Soils with greater potential for erosion may result in premature failure of BMPs. Soil amendment to recommend depth may be appropriate for some soil types and site conditions. The HSG and erodibility factors for soil can be found on the United States Department of Agriculture Natural Resources Conservation Service Web Soil Survey.

- Permeable Pavement, Infiltration Trenches, Infiltration Berms, and Landscape Infiltration will require minimum infiltration rates to function properly, and infiltration tests will be required to confirm the infiltration rates.
- Permeable Pavement and Reinforced Turf require a Hydrologic Soil Group (HSG) of A, B or C to function and should not be implemented in HSG D.
- Infiltration Trenches and Landscape Infiltration should only be considered in areas of HSG A or B.
- Submerged Gravel Wetlands should be located in a HSG of C or D, or a liner may be required for the practice to function.
- Rain Gardens, Microbioretention and Bioswales may be able to function without an underdrain in HSG A or B, but an infiltration test should be conducted to ensure adequate infiltration rates exist.
- Permeable Pavement, Reinforced Turf, Infiltration Trenches, Infiltration Berms, and Landscape Infiltration may experience premature failure in areas of highly erodible soil due to excess sediment entering the BMPs.

DRAINAGE AREAS

Most Green Street Infrastructure BMPs have a minimum or maximum drainage area that will allow for the BMP to function properly. Offsite drainage areas should be diverted away from BMPs where possible to reduce the required size of the BMP. The County Development Review Office can help to identify different options to meet the drainage area requirements.

- Dry Wells have a drainage area limit of 1,000 square feet.
- Rain Gardens, Landscape Infiltration, and Permeable Pavement have a drainage area limit of 10,000 square feet or ¼ acre.
- Microbioretention Facilities have a drainage area limit of 20,000 square feet or ½ acre.
- Grass Swales, Bioswales, and Wet Swales have a drainage area limit of 1 acre.
- Infiltration Trenches have a drainage area limit of 5 acres.
- Bioretention Facilities have a drainage area limit of 10 acres.
- Submerged Gravel Wetlands should ideally have a minimum drainage area of 1 acre to ensure adequate runoff to support the landscaping in the practice, but smaller drainage areas are possible.
- Infiltration Berms do not have a drainage area limit, but a smaller drainage area should be considered for this practice due to the smaller amount of runoff they will manage.
- Permeable Pavement and Reinforced Turf are self-treating BMPs (meaning they provide treatment for only the area of installation of the BMP) and excess runoff from adjacent areas should be avoided if possible.

SLOPES

The slope of a site should be considered when selecting a Green Street Infrastructure BMP for the project location.

- Grass Swales, Bioswales, and Wet Swales are limited to a maximum 4% longitudinal slope.
- A maximum 5% slope is allowed for Non-Rooftop Disconnection, Sheet Flow to Conservation Areas, Permeable Pavement, and Reinforced Turf.
- 3:1 side slopes are typically the maximum constructed slope for BMPs.

FLOODPLAINS, WETLANDS, FORESTED AREAS, AND STREAMS

Floodplains, wetlands, forested areas, and streams are regulated natural resources. Impacting these resources will require approval or permits from the appropriate regulatory authority. These natural resources are to be identified in the Stormwater Concept Plan prior to going into detailed design plans. Basic information on the locations of wetlands, streams, and floodplains can be found on Maryland's Environmental Resources and Land Information Network (MERLIN Online). The location of wetlands and streams on a specific site must be field delineated by a professional. Information from MERLIN Online should only be used as a guide and is not a substitute for field work. Specific floodplain information can be found on the Federal Emergency Management Agency's (FEMA) website.

- ❑ Green Street Infrastructure BMPs are discouraged in floodplains where fill is required to construct the BMP.
- ❑ Natural wetlands, forested areas, and streams should be conserved as much as possible.
- ❑ Avoid using regulated natural resource areas for a Green Street Infrastructure BMP as much as possible.
- ❑ Impacts to floodplains, wetlands, or streams will require approval and permits from the Maryland Department of the Environment Wetlands and Waterways Program.
- ❑ Impacts to forested area and roadside trees will require approval and permits from the Maryland Department of Natural Resources.

WATER TABLE

The location of the water table is an important consideration in selecting the type of Green Street Infrastructure BMP. Most BMPs will require separation between the groundwater to function properly. If the groundwater elevation is high, a physical barrier can be provided to ensure groundwater does not enter the BMP.

- ❑ Separation of 2 to 4 feet between the groundwater elevation and the bottom of the media layers of a BMP is required for most BMPs.
- ❑ High groundwater is preferred for Submerged Gravel Wetland and Wet Swales.
- ❑ Where high groundwater exists, a physical barrier such as a liner can be provided to separate the BMP from the groundwater and prevent groundwater contamination and drawdown.

UTILITIES

Utilities can affect selection and location of potential Green Street Infrastructure BMPs.

- ❑ BMPs should not be located overtop of underground utilities where possible. Where this is not possible, provide the minimum required clearance between the BMP and the utility. BMP should also be located within County right-of-way or County acquired right-of-way, for maintenance purposes.
- ❑ Overhead utilities should be considered when choosing a location for a BMP. The utilities could interfere with BMP construction and maintenance.

DRAINAGE SYSTEMS

Green Street Infrastructure BMPs are part of the overall drainage system of a street. Consideration must be given to how stormwater runoff will reach a BMP from the street features and how the stormwater runoff will drain away from a BMP.

- ❑ Sheet flow inflow is required for Landscape Infiltration, Infiltration Berms, Grass Swales, Bioswales, Wet Swales, Non-Rooftop Disconnection and Sheet Flow to Conservation Areas.
- ❑ Sheet flow or concentrated inflow is acceptable for Rain Gardens, Microbioretention, Bioretention, Infiltration Trenches, Dry Wells, and Submerged Gravel Wetlands.

- ❑ If the BMPs use an underdrain, the underdrain will need to be daylighted or connected to a storm drain system.
- ❑ BMP overflows will need to be connected to a storm drain system or have safe and stable conveyance for overland flows.
- ❑ Offsite areas should be diverted around the BMPs with swales or storm drain system, while ensuring safe conveyance.
- ❑ Stable storm drain outfalls should be provided to prevent erosion.
- ❑ Storm drain systems located in Karst Areas require water tight joints.

Table 9: Green Street Design Considerations Matrix

GREEN STREETS DESIGN CONSIDERATIONS																					
BMP	NATURAL FEATURES									DESIGN FEATURES											
	Watershed			Geology	Soil Type				Water Table		Drainage Area					Slope			Drainage System		
	Use I and II	Use III and IV	Cold water	Karst Areas	A	B	C	D	High Table Preferred	Separation or Liner Required	Under 1,000 SF	Under 10,000 SF	Up to ½ Acre	Up to 1 Acre	Up to 5 Acre	Up to 4%	Up to 5%	3:1 Side Slopes	Sheet Flow Inflow	Concentrated Inflow	Underdrain Outlet Required
Non-Rooftoop Disconnection	✓	✓	✓	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	✓	✓	-	✓	✓	-
Sheet Flow to Conservation Area	✓	✓	✓	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	✓	✓	-	✓	✓	-
Rain Gardens	✓	✓	✓	O	✓	✓	✓	✓	O	✓	✓	✓	X	X	X	-	-	✓	✓	✓	✓
Landscape Infiltration	✓	✓	✓	X	✓	✓	X	X	X	✓	✓	✓	X	X	X	-	-	✓	✓	X	-
Microbioretention	✓	✓	✓	O	✓	✓	✓	✓	O	✓	✓	✓	✓	X	X	-	-	✓	✓	✓	✓
Infiltration Berms	✓	✓	✓	X	✓	✓	X	X	X	✓	✓	✓	✓	X	X	-	-	✓	✓	X	-
Submerged Gravel Wetlands	✓	O	O	O	O	O	✓	✓	✓	✓	X	X	O	✓	✓	-	-	✓	✓	✓	✓
Grass Swales	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	✓	-	✓	✓	X	-
Bioswales	✓	✓	✓	O	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	X	✓	-	✓	✓	X	✓
Wet Swales	✓	X	X	O	O	O	✓	✓	✓	X	✓	✓	✓	✓	X	✓	-	✓	✓	X	-
Permeable Pavement	✓	✓	✓	X	✓	✓	✓	X	X	✓	✓	✓	X	X	X	✓	✓	-	-	-	-
Reinforced Turf	✓	✓	✓	X	✓	✓	✓	X	-	-	✓	✓	✓	O	X	✓	✓	-	-	-	-
Bioretention	✓	✓	✓	O	✓	✓	✓	✓	O	✓	X	X	X	✓	✓	-	-	✓	✓	✓	✓
Surface Sand Filters	✓	✓	✓	O	✓	✓	✓	✓	O	✓	X	X	X	✓	✓	-	-	✓	✓	✓	✓
Infiltration Trenches	✓	✓	✓	X	✓	✓	O	O	X	✓	X	✓	✓	✓	✓	-	-	✓	✓	✓	-
Dry Wells	✓	✓	✓	X	✓	✓	O	O	X	✓	✓	X	X	X	X	-	-	-	✓	✓	-
LEGEND: ✓ = Recommended O = Acceptable with Proper Design X = Not Recommended - = Not Applicable																					

Context Driven Considerations

After the Green Street design considerations regarding the project's existing conditions are analyzed, the County should also consider the context zone of the project location before finalizing the selection of a BMP. The context zone of a roadway refers to the environment, characteristics, and surrounding activity of the road. The Complete Streets Manual included within this Plan discusses the five different context zones that are found in Frederick County: rural, suburban, suburban activity center, traditional town center, and urban center. There are also eight different roadway types discussed in the Complete Streets Manual that together provide a transportation network with the appropriate mixture of mobility and access within each context zone. Please review the Complete Streets Manual section of this Plan to determine which context zone and roadway type of the potential project location before using the following BMP selection matrices to identify which BMPs are appropriate in each context zone.

Table 10: BMP Selection Matrix: Rural Context Zone

BMP SELECTION MATRIX								
CONTEXT ZONE	**RURAL**							
Roadway Type	F/E	AR	CL	B/P*	CS*	CN	NS	A*
Non-Rooftop Disconnect	X	X	O	O	O	O	O	X
Sheet Flow to Conservation Areas	X	✓	✓	O	O	✓	✓	X
Rain Gardens	O	O	✓	✓	✓	✓	✓	✓
Landscape Infiltration	O	O	✓	✓	✓	✓	✓	✓
Microbioretention	✓	✓	✓	✓	✓	✓	✓	O
Infiltration Berms	✓	✓	O	O	X	X	X	X
Submerged Gravel Wetlands	✓	✓	✓	✓	✓	✓	✓	X
Grass Swales	✓	✓	✓	✓	✓	✓	✓	X
Bioswales	✓	✓	✓	✓	✓	✓	✓	X
Wet Swales	✓	✓	✓	✓	✓	✓	✓	X
Permeable Pavement	X	X	O	O	O	O	O	✓
Reinforced Turf	X	X	O	O	O	✓	✓	✓
Bioretention	✓	✓	✓	✓	✓	✓	✓	X
Surface Sand Filter	✓	✓	✓	✓	✓	✓	✓	X
Infiltration Trenches	✓	✓	✓	✓	✓	✓	✓	X
Dry Wells	X	X	O	O	O	✓	✓	X
LEGEND: ✓ = Recommended O = Optional X = Not Recommended or Not Applicable * = Denotes Roadway Types Not Often Found in Context Zone								

Table 11: BMP Selection Matrix: Suburban Context Zone

BMP SELECTION MATRIX								
CONTEXT ZONE	**SUBURBAN**							
Roadway Type	F/E*	AR	CL	B/P	CS*	CN	NS	A*
Non-Rooftop Disconnect	X	X	O	O	O	O	✓	X
Sheet Flow to Conservation Areas	X	✓	✓	O	O	✓	✓	X
Rain Gardens	O	O	✓	✓	✓	✓	✓	✓
Landscape Infiltration	O	O	✓	✓	✓	✓	✓	✓
Microbioretention	✓	✓	✓	✓	✓	✓	✓	O
Infiltration Berms	✓	✓	O	O	O	X	X	X
Submerged Gravel Wetlands	✓	✓	✓	✓	✓	✓	✓	X
Grass Swales	✓	✓	✓	✓	✓	✓	✓	X
Bioswales	✓	✓	✓	✓	✓	✓	✓	X
Wet Swales	✓	✓	✓	✓	✓	✓	✓	X
Permeable Pavement	X	X	O	O	O	O	O	✓
Reinforced Turf	X	X	O	O	O	✓	✓	✓
Bioretention	✓	✓	✓	✓	✓	✓	✓	X
Surface Sand Filter	✓	✓	✓	✓	✓	✓	✓	X
Infiltration Trenches	✓	✓	✓	✓	✓	✓	✓	X
Dry Wells	X	X	O	O	O	✓	✓	X
LEGEND: ✓ = Recommended O = Optional X = Not Recommended or Not Applicable * = Denotes Roadway Types Not Often Found in Context Zone								

Table 12: BMP Selection Matrix: Suburban Activity Center Context Zone

BMP SELECTION MATRIX								
CONTEXT ZONE	**SUBURBAN ACTIVITY CENTER**							
Roadway Type	F/E*	AR	CL	B/P	CS	CN	NS	A
Non-Rooftop Disconnect	X	O	O	O	O	O	✓	X
Sheet Flow to Conservation Areas	X	X	X	X	X	X	X	X
Rain Gardens	O	✓	✓	✓	✓	✓	✓	✓
Landscape Infiltration	O	✓	✓	✓	✓	✓	✓	✓
Microbioretention	✓	✓	✓	✓	✓	✓	✓	O
Infiltration Berms	✓	X	X	X	X	X	X	X
Submerged Gravel Wetlands	✓	✓	✓	✓	✓	✓	✓	X
Grass Swales	✓	✓	✓	✓	✓	✓	✓	X
Bioswales	✓	✓	✓	✓	✓	✓	✓	X
Wet Swales	✓	✓	✓	✓	✓	✓	✓	X
Permeable Pavement	X	✓	✓	✓	✓	✓	O	✓
Reinforced Turf	X	✓	✓	✓	✓	✓	O	✓
Bioretention	✓	✓	✓	✓	O	O	O	X
Surface Sand Filter	✓	✓	✓	✓	O	O	O	X
Infiltration Trenches	✓	✓	✓	✓	O	O	O	X
Dry Wells	X	X	O	X	O	✓	✓	X
LEGEND: ✓ = Recommended O = Optional X = Not Recommended or Not Applicable * = Denotes Roadway Types Not Often Found in Context Zone								

Table 13: BMP Selection Matrix: Traditional Town Center Context Zone

BMP SELECTION MATRIX								
CONTEXT ZONE	**TRADITIONAL TOWN CENTER**							
Roadway Type	F/E*	AR*	CL	B/P	CS	CN	NS	A
Non-Rooftop Disconnect	X	O	O	O	O	O	O	X
Sheet Flow to Conservation Areas	X	X	X	X	X	X	X	X
Rain Gardens	O	✓	✓	✓	✓	✓	✓	✓
Landscape Infiltration	O	✓	✓	✓	✓	✓	✓	✓
Microbioretention	✓	✓	✓	✓	✓	✓	✓	O
Infiltration Berms	✓	X	X	X	X	X	X	X
Submerged Gravel Wetlands	✓	O	O	O	O	O	O	X
Grass Swales	✓	O	O	O	O	O	O	X
Bioswales	✓	O	O	O	O	O	O	X
Wet Swales	✓	O	O	O	O	O	O	X
Permeable Pavement	X	O	O	O	✓	✓	✓	✓
Reinforced Turf	X	O	O	O	✓	✓	✓	✓
Bioretention	✓	O	O	O	O	O	O	X
Surface Sand Filter	✓	O	O	O	O	O	O	X
Infiltration Trenches	✓	O	O	O	O	O	O	X
Dry Wells	X	O	O	O	✓	✓	✓	X
LEGEND: ✓ = Recommended O = Optional X = Not Recommended or Not Applicable * = Denotes Roadway Types Not Often Found in Context Zone								

Table 14: BMP Selection Matrix: Urban Center Context Zone

BMP SELECTION MATRIX								
CONTEXT ZONE	**URBAN CENTER**							
Roadway Type	F/E*	AR*	CL*	B/P*	CS	CN	NS	A
Non-Rooftop Disconnect	X	O	O	O	O	X	X	X
Sheet Flow to Conservation Areas	X	X	X	X	X	X	X	X
Rain Gardens	O	✓	✓	✓	✓	✓	✓	✓
Landscape Infiltration	O	✓	✓	✓	✓	✓	✓	✓
Microbioretention	✓	✓	✓	✓	✓	✓	✓	O
Infiltration Berms	✓	X	X	X	X	X	X	X
Submerged Gravel Wetlands	✓	O	O	O	X	X	X	X
Grass Swales	✓	O	O	O	O	O	O	X
Bioswales	✓	O	O	O	O	O	O	X
Wet Swales	✓	O	O	O	O	O	O	X
Permeable Pavement	X	O	O	O	✓	✓	✓	✓
Reinforced Turf	X	O	O	O	✓	✓	✓	✓
Bioretention	✓	O	O	O	O	O	O	X
Surface Sand Filter	✓	O	O	O	O	O	O	X
Infiltration Trenches	✓	O	O	O	O	O	O	X
Dry Wells	X	O	O	O	✓	✓	✓	X
LEGEND: ✓ = Recommended O = Optional X = Not Recommended / Not Applicable * = Denotes Roadway Types Not Often Found in Context Zone								

Green Street Infrastructure Best Management Practices

There are a variety of Green Street Infrastructure Best Management Practices that can be utilized to help reduce stormwater runoff and provide stormwater management. This section describes the various practices that can be implemented, provides a description of the design limitations for the practices, and presents suggestions as to where the practice could be located. This information is provided to aid the user in selecting appropriate practices for Green Street design within roadway projects. Frederick County will review and determine the acceptability of selected BMPs. For specific design guidelines, please refer to the 2000 Maryland Stormwater Design Manual.

NON-ROOFTOP DISCONNECTION

A Non-Rooftop Disconnection directs runoff from an impervious surface onto a vegetated area where it can soak into or be filtered over the ground. This disconnects the impervious surfaces from the storm drain system, both reducing runoff and providing stormwater treatment. The disconnection area shall provide a flow path of at least 10 feet but no more than 75 feet. Typically, the disconnection length should be at least as long as the contributing impervious length. A gravel transition strip of one to two feet wide should be provided between the impervious area and the disconnection area. The disconnection area should have an average slope of 5% of less. The drainage area for each disconnection should be less than 1,000 square feet. There should be at least ten feet between the disconnection and the nearest impervious surface of similar or lower elevation to prevent reconnection of the stormwater runoff.

Landscaping typically consists of turf grass but can incorporate trees, shrubs, and other herbaceous plants. Non-Rooftop Disconnection can be located anywhere there is sheet flow runoff from an impervious surface and the disconnection length and slope requirements can be met.

SHEET FLOW TO CONSERVATION AREAS

Sheet Flow to Conservation Areas utilize conservation areas adjacent to a developed area to provide treatment of runoff where it can soak into or be filtered over the ground. Runoff from impervious areas should enter the conservation area as sheet flow. The average contributing overland slope should be 5% or less. The conservation area should be at least 20,000 square feet and have a minimum width of 50 feet, but a recommended width of 100 feet. The areas should also be placed within a conservation easement. Landscaping should be appropriate for a conservation area. Managed turf is not an acceptable landscaping solution for Sheet Flow to Conservation Area.

Sheet Flow to Conservation Areas are best located adjacent to roadways where appropriate slopes and conservation areas can be established.

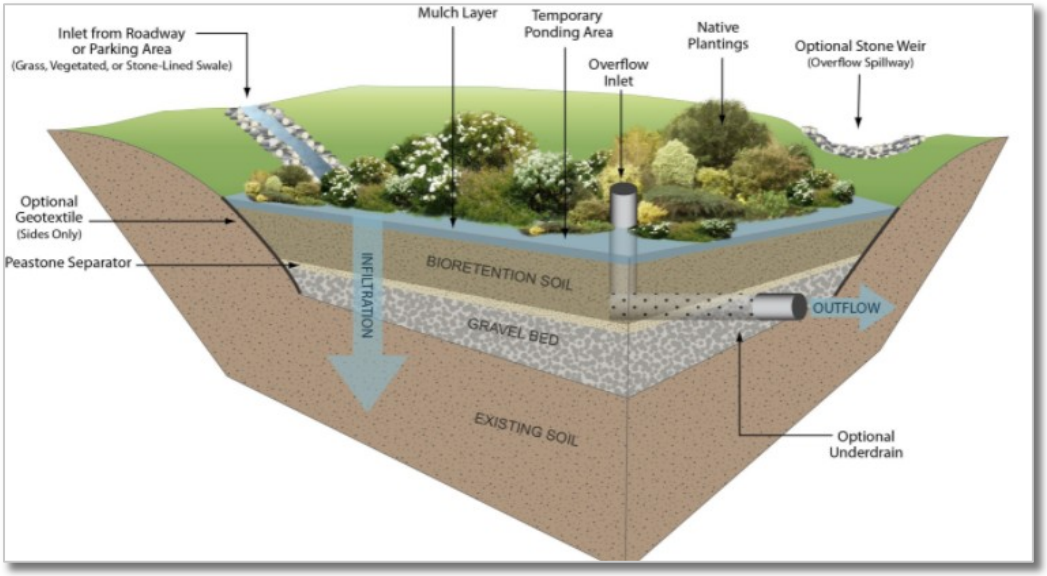


Figure 18: Rain Garden Diagram
source: Massachusetts Department of Environmental Protection

RAIN GARDENS

Rain Gardens are shallow excavated landscape features or shallow saucer-shaped depressions that temporarily hold stormwater for a short period of time. They consist of a six-to-twelve-inch layer of planting soil underneath a two-to-three-inch layer of mulch. Stormwater management treatment occurs as the stormwater filters through the mulch and planting soil. Although typically designed without underdrains, an underdrain

can be provided where the soils have low infiltration rates (Hydrologic Soil Group C and D) or where there is a desire to ensure the facility drains after a rain event. The maximum allowable drainage area is 10,000 square feet (approximately ¼ acre). Conveyance shall enter, run through, and exit a facility in a safe and non-erosive manner. Landscaping can range from formal planting to a simple wetland meadow seed mix and will depend on the facility location.

With their smaller size and drainage area limitation, they can be located in tighter spaces, such as the grass buffer between a roadway and a sidewalk or shared-use path, or in place of a planting bed in a sidewalk. The small size and depth of planting soil make using for the installation of trees impractical.

LANDSCAPE INFILTRATION

Landscape Infiltration uses on-site vegetative planting areas to capture, store, and treat stormwater runoff. They consist of a 12-to-18-inch layer of planting soil with a two-to-three-inch layer of mulch on top. A 12-inch layer of gravel is provided below the planting soil. Stormwater management treatment occurs as the stormwater filters through the mulch and planting soil. The practice is restricted to HSG Type A and B soils to ensure infiltration occurs. The site should be checked to ensure sufficient infiltration is provided. The maximum allowable drainage area is 10,000 square feet (approximately ¼ acre). Safe and non-erosive conveyance to and from a facility should be provided. Landscaping can range from formal planting to a simple wetland meadow seed mix and will depend on where the facility is located.

With their smaller size and drainage area limitation, Landscape Infiltration can be located in tighter spaces, such as the grass buffer between a roadway and a sidewalk or shared use path, or in place of a planting bed on a sidewalk.

MICROBIORETENTION

Microbioretention facilities are similar to Rain Gardens but manage larger drainage areas and have a deeper layer of planting soil. They consist of a 24-to-48-inch layer of planting soil on the bottom with a two-to-three-inch layer of mulch on the top. Stormwater management treatment occurs as the stormwater filters through the mulch and planting soil. An underdrain is usually present but can be omitted if sufficient infiltration rates exist at the site. The maximum allowable drainage area is 20,000 square feet (approximately ½ acre). Safe and non-erosive conveyance to and from a facility is required. Recommended landscaping is similar to the larger bioretention facilities and can support trees and woody vegetation.

Darryl Gardens Microbioretention
source: JMT

While larger than Rain Gardens, Microbioretention facilities can still be located in tighter spaces, but not as easily. They are best located in either the grass buffer between a sidewalk or shared-use path, in place of a planting bed on a sidewalk, in a grass median, or along roadside areas. The larger size and greater depth of planting soil make these more suitable for the installation of trees.

Microbioretention facilities can also take the form of tree boxes or boxed bioretention. In both cases the planting soil is contained within a concrete box. Tree boxes usually use a tree or shrub as the landscaping component, whereas boxed bioretention may utilize a variety of planting on the surface. Tree boxes and boxed bioretention are more compact than a typical Microbioretention facility and may be more easily accommodated in a tight space.

INFILTRATION BERMS

Infiltration Berms are linear mounds of earth composed of soil and stone that are placed along the contour or a gentle slope. Stormwater runoff is filtered through the berm to provide treatment. The berms should be located along the contour at a constant elevation. The contributing slope to the berm should be generally 10% or less. The slide slopes of the berms should be 3:1 or flatter to facilitate mowing for maintenance. The crest of the berm should be two feet wide. The height of the berm will be dependent on the storage required. The berm shall consist of a six-inch layer of compacted topsoil over a gravel or aggregate interior. Landscaping is typically turf grass when mowed, or native meadow seeding with shrubs.

Infiltration berms are best located in places where they can intercept sheet flow runoff from an impervious surface. Roadside areas where the ground drains away from the roadway are ideal areas for the implementation of Infiltration Berms. Infiltration berms are not suitable for use in medians.

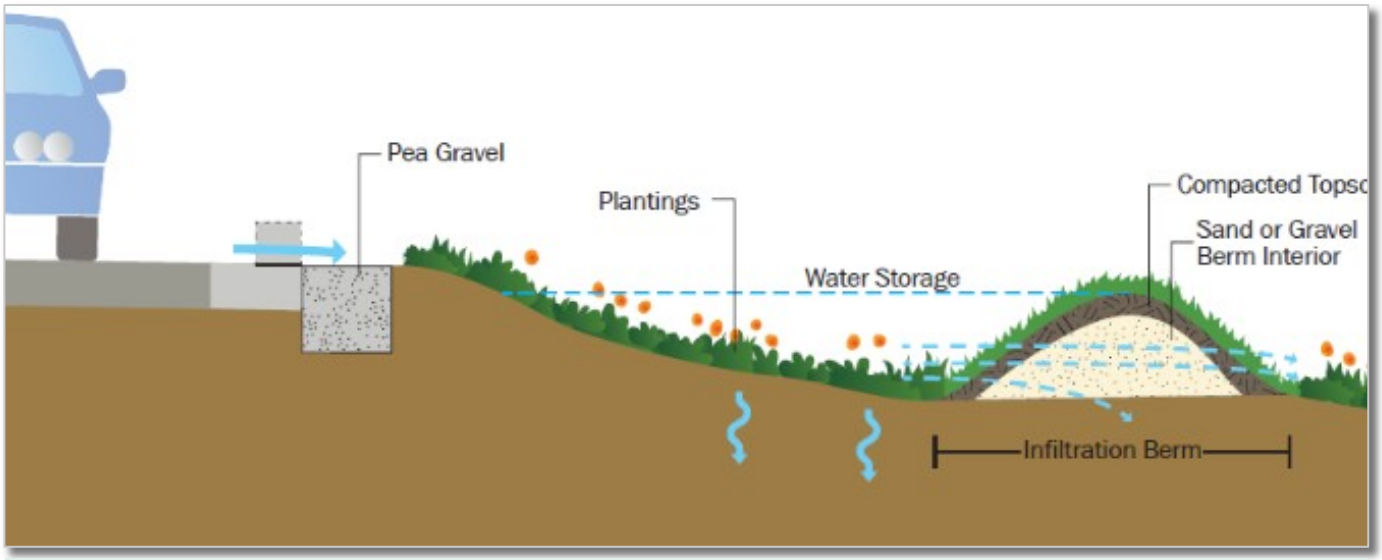


Figure 19: Infiltration Berm Diagram
source: Anne Arundel County

SUBMERGED GRAVEL WETLANDS

Submerged Gravel Wetlands provide treatment using rock media and wetland plants. The system utilizes a perpetually wet rock substrate with planting soil and wetland plants above. Submerged Gravel Wetlands are suggested to have a drainage area of at least one acre to ensure the system does not dry out during periods of drought. The rock substrate should be four feet deep, and the required storage volume should be held in the rock substrate. Concentrated inflows require a forebay for pretreatment. High ground water is preferred, but a liner can be provided to ensure the facility does not drain via infiltration. Safe and no-erosive conveyance to and from a facility should be provided. Landscaping should consist of at least three different wetland species. If an embankment is required to construct the facility, woody plants should be kept off the embankment and at least 15 feet away from the toe of the embankment. Submerged Gravel Wetlands are best located along roadside areas where a larger drainage area can be directed to the practice. These facilities are not well suited for roadway medians.

Submerged Gravel Wetland
source: Montgomery County

GRASS SWALES

Grass Swale in Median
source: Maryland State Highway Administration

Grass Swales are channels that provide conveyance, water quality treatment of stormwater runoff. They consist of a flat bottom trapezoidal channel with a bottom width of between two and eight feet with 3:1 side slopes. The maximum allowed channel slope is 4%. The maximum velocity of the treatment storm is 1.0 foot per second and the 10-year storm event should be safely conveyed with non-erosive velocities and at least six inches of freeboard. Stormwater management treatment occurs as the stormwater filters through the grass. The maximum allowable drainage area is approximately one acre. Drainage infrastructure such as storm drains and bypass ditches can be used to bring the drainage area of the grass swale down to the allowable limit. Conveyance shall only enter a Grass Swale via sheet flow; concentrated inflows should be avoided. Landscaping consists of a grass seed mix.

Grass Swales are typically located in roadway medians or along roadside areas. With a wide enough grass strip between a roadway and a sidewalk or shared-use path, a Grass Swale can be used. Please note that Grass Swales provide a low amount of treatment for their size and a Bioswale may be a better solution if your site needs a lot of stormwater treatment.

Bioswale in Median
source: JMT

BIOSWALES

Bioswales are channels that provide conveyance, water quality treatment and flow attenuation of stormwater runoff utilizing check dams and planting soil. They consist of a flat bottom trapezoidal channel with a bottom width between two and eight feet and 3:1 side slopes. There is a layer of planting soil two to four feet deep. The maximum allowed channel slope is 4%. The maximum velocity of the treatment storm is 1.0 foot per second and the 10-year storm event should be safely conveyed with non-erosive velocities and at least six inches of freeboard. Stormwater management treatment occurs as the stormwater filters through the planting soil. An underdrain is usually present but can be omitted if sufficient infiltration rates exist at the site. The maximum allowable drainage area is approximately one acre. Drainage infrastructure such as storm drains and bypass ditches can be used to bring the drainage area of the bioswale down to the allowable limit. Bioswales can should only receive sheet flow; concentrated inflows should be avoided. Landscaping should not create erosive situations in a swale, so a wetland meadow mix is an ideal landscaping solution. Bioswales are typically located in roadway medians or along roadside areas. A bioswale can also be installed within a wide grass buffer between a roadway and a sidewalk or shared-use path.

WET SWALES

Wet Swale along Roadside
source: Maryland State Highway Administration

Wet Swales are channels that provide conveyance, water quality treatment and flow attenuation of stormwater runoff utilizing check dams. They consist of a flat bottom trapezoidal channel with a bottom width of between two and eight feet and 3:1 side slopes. A check dam holds back the water so that the swale is continuously wet. The maximum allowed channel slope is 4%. The maximum velocity of the treatment storm is 1.0 foot per second and the 10-year storm event should be safely conveyed with non-erosive velocities and at least six-inches of freeboard. Stormwater management treatment occurs in the wet pool. The maximum allowable drainage area is approximately one acre. Drainage infrastructure such as storm drains and bypass ditches can be used to bring the drainage area of the bioswale down to the allowable limit. High ground water is typically required to ensure proper function. Conveyance shall only enter a wet swale via sheet flow; concentrated inflows should be avoided. Landscaping should be able to withstand with a perpetually wet facility. Wet Swales are typically located in roadway medians or along roadside areas. A wet swale can be used between a roadway and a sidewalk or shared-use path if a grass buffer wide enough for the facility is present.

PERMEABLE PAVEMENTS

Permeable Pavement Types
source: USGS

Permeable Pavement consists of a porous surface course over an open graded stone base. The surface course can be porous bituminous asphalt, pervious concrete, or permeable interlocking concrete pavers. The slope of the pavement should be 5%. Pavements should be located in areas where there is sufficient underlying infiltration to ensure they function properly. A minimum stone base of 12 inches is recommended to avoid the installation of overdrains. Shallower stone bases of 6 or 9 inches will require an overdrain to protect the porous surface from freeze/thaw damage. Applications of Permeable Pavement over 10,000 square feet will need to be designed as an infiltration practice. Permeable Pavements should not be considered for roadway travel lanes, but are best located in dedicated parking lanes or on shared-used paths.

Reinforced Turf on Rosemary Lane
Source: Google Street View

REINFORCED TURF

Reinforced Turf consists of interlocking structural units with an interstitial area for placing gravel or growing grass. Reinforced turf should be located on slopes of less than 5%. A sub grade of sand or gravel between 6 and 12 inches should be provided below the structural units.

Reinforced Turf is typically located in areas of light traffic use, dedicated parking areas, or access areas for emergency vehicles such as a median crossover and are ideal for access roads to other stormwater facilities.

Bioretention Facility in Rosaryville State Park
source: JMT

BIORETENTION

Bioretention facilities are larger than Microbioretention facilities, managing an even larger drainage area and a deeper layer of planting soil. They consist of a 30-to-48-inch layer of planting soil with two to three inches of mulch on top. Stormwater management treatment occurs as the stormwater filters through the mulch and planting soil. An underdrain is required to drain the facility. The maximum allowable drainage area is up to 10 acres. Safe and non-erosive conveyance to and from a facility is required. The facilities do require pretreatment. For concentrated inflows, a forebay is required. For sheet inflows, adequate pretreatment is provided when all of the following are provided: (a) 20-foot grass filter strip below a level spreader or optional sand filter layer, (b) gravel diaphragm and (c) a mulch layer. Landscaping is typically a combination of herbaceous and woody planting. If an embankment is required to construct the facility, woody plants should be kept off the embankment and at least 15 feet away from the toe of the embankment. These large facilities may fit in a roadway grass median but are typically located along roadside areas.

SURFACE SAND FILTERS

Surface Sand Filters capture and filter runoff through a sand layer at least 12-inches deep, though more typically the depth of sand is 18-inches. They can include a 3-inch layer of topsoil and can be planted in grass. Stormwater management occurs as the stormwater filters through the sand layers, which captures and traps any sediment in the runoff. An underdrain is required to drain the facility. The maximum allowable drainage area is up to 10 acres. Safe and non-erosive conveyance to and from a facility is required. Pretreatment is required and must be provided in a forebay for concentrated inflows. If an embankment is required to construct the facility, woody plants should be kept off the embankment and at least 15 feet away from the toe of the embankment. These large facilities may fit in a roadway grass median but are typically located along roadside areas.

Surface Sand Filter
source: Montgomery County

INFILTRATION TRENCHES

Infiltration Trenches capture and infiltrate stormwater runoff. Suitable infiltration rates of at least 0.52 inches per hour are required to use an infiltration trench. Infiltration trenches should be avoided in fill areas, though it may be possible to extend the trench down to existing ground to utilize the practice. The drainage area to an infiltration trench is generally 5 acres or less. Pretreatment is required for infiltration trenches to ensure the trenches do not clog.

Infiltration Trenches can be implemented at any location that will meet the required infiltration rate and drainage area limitation. Roadway medians and roadside areas are equally as suitable.

Infiltration Trench
source: Maryland State Highway Administration

DRY WELLS

A Dry Well is an excavated pit filled with gravel that will capture and infiltrate stormwater runoff. Although typically associated with the treatment of roof top runoff, they can be used to treat runoff from smaller impervious areas. In HSG Type A soils, a dry well is restricted to 12 feet in depth. In HSG Type B soils, a dry well is restricted to 5 feet in depth. The minimum depth of gravel media is 18 inches. Appropriate infiltration rates are needed to ensure the function of the dry well. The maximum allowable drainage area for a dry well is 1,000 square feet. Ideally the dry well can be covered with 12 inches of soil.

Dry Wells can be located anywhere that a very small drainage area requires treatment. Ideal locations are between roadways and sidewalks or shared-use paths.

Green Streets: Sample Project – Crestwood Boulevard and Corporate Drive

This section applies the Green Streets Design Considerations and Green Streets Infrastructure BMPs to the sample project from the Shared Use Facilities section in the Complete Streets Manual. The sample project proposed a shared-use path along the south side of Crestwood Boulevard between Ballenger Creek Pike and Corporate Drive, and along the south side of Corporate Drive between Crestwood Boulevard and the Ballenger Creek Trail parking lot. The context zone for this project is a Suburban Activity Center and the roadway types are a Boulevard / Parkway for Crestwood Boulevard and a Connector for Corporate Drive.

STEP 1: GREEN STREETS DESIGN CONSIDERATIONS

The first step towards determining which BMPs can be considered for implementation on this project is to examine the project site for the various green street design considerations discussed on pages 55 to 59.

WATERSHED

The project is in the Lower Monocacy River Watershed, specifically in the sub-watersheds of King Branch, Arundel Branch, Pike Branch and Ballenger Creek. Based on Maryland's Designated Use Classification, the sub-watersheds are all Use III watersheds. In addition, this area is considered Maryland Trout Waters based on the Department of Natural Resources Coldwater Resources Mapping Tool. Based on these determinations, facilities that have permanent surface storage should be avoided. This will eliminate Wet Swales as a possible BMP for the sample project.

KARST AREAS

Mapping from the Maryland Geological Survey shows the project area is underlain with limestone and there are several mapped sinkholes in the project vicinity. With the underlying limestone, there is a greater chance of sinkhole formation.

Based on this information, facilities that promote infiltration should be avoided. In addition, liners should be considered in the design of any recommended facility. These restrictions will eliminate Landscape Infiltration, Infiltration Berms, Permeable Pavement, Reinforced Turf, Infiltration Trenches and Dry Wells from consideration.

SOIL GROUP

Using the Web Soil Survey from the United States Department of Agriculture Natural Resources Conservation Service, the predominate Hydrologic Soil Groups in the project area are Groups B and C. Areas of Hydrologic Soil Group C should not use Landscape Infiltration or Infiltration Berms.

DRAINAGE AREAS

The project corridor is well developed with few large open areas. There is also limited right-of-way in the project corridor. The drainage areas to BMPs will likely be restricted to the existing roadways, sidewalks, and proposed shared use path. The lack of available detailed information makes it difficult to make a BMP selection based on the drainage areas, but available information indicates that drainage areas will likely be on the smaller side, no more than 1 to 2 acres. With proper design, BMPs that require small drainage areas can be incorporated into the project.

SLOPES

A precursory review indicates that much of Crestwood Boulevard seems to be gentle sloping. For the purposes of the sample project design, it is assumed that the roadway slopes are no more than 4% maximum in most areas. These flatter slopes will allow for the installation of Grass Swales or Bioswales in roadside areas.

FLOODPLAINS, WETLANDS, FORESTED AREAS, AND STREAMS

Any regulated natural resources in the project areas will restrict the locations where BMPs can be implemented. These resources may also have an impact on the design of any complete street features. Any impacts to environmental features

should be approved or permitted through the appropriate regulatory authority. The natural resources present in the sample project area were determined using MERLIN Online.

No floodplains were found along the project corridor.

MERLIN Online showed a total of four (4) wetland areas along the project corridor. One located on the north side of Crestwood Boulevard between New Design Road and Foxcroft Drive appears to be an existing stormwater management facility. One located on the north side of Crestwood Boulevard between Foxcroft Drive and Bank Court also appears to be an existing stormwater management facility. An additional two (2) wetlands in the vicinity of the Arundel Branch Stream crossing of Crestwood Boulevard appear to be associated with the stream. BMPs should be avoided in the wetlands and wetland buffers.

The majority of Crestwood Boulevard and Corporate Drive are developed areas. There is one area of forest in the vicinity of Arundel Branch Stream crossing of Crestwood Boulevard.

Several streams cross Crestwood Boulevard. An unnamed tributary of Pike Branch crosses Crestwood Boulevard at the intersection of Farmbrook Drive. King Branch crosses Crestwood Boulevard between Crabapple Drive and Tamarack Avenue. Arundel Branch crosses Crestwood Boulevard between Foxcroft Drive and Bank Court. In addition, an unnamed tributary of Ballenger Creek is shown crossing Corporate Drive between Chairmans Court and Crestwood Boulevard based on the Maryland's Designated Use Classification mapping tool but does not show up on MERLIN Online.

WATER TABLE

No information is available concerning the water table at this level of design. However, since the project location in an area of Karst, most BMPs will need to be lined to ensure infiltration does not occur and the water table will not be a factor that restricts the type of BMPs selected for use.

UTILITIES

Google Street View was used to estimate the utilities that are present in the project site. Most of Crestwood Boulevard appears to have underground electrical and communication lines, with the exception of a portion of Crestwood Boulevard between Hobble Bush Court and New Design Road where the electrical and communication lines are overhead on poles along the north side of the roadway. In addition, there are high voltage electrical transmission lines that cross Crestwood Boulevard near Arundel Branch. The exact location of the underground electrical and communication lines along Crestwood Boulevard cannot be determined at this time. Surface features of sewer lines are not readily apparent, but fire hydrants indicate water service in the area.

Along Corporate Drive, electrical surface features indicate that the corridor has underground electrical and communication lines along on the south side of the roadway. Surface features of sewer lines are not readily apparent, but valves for a water line were observed in the pavement of Corporate Drive.

For the purposes of the sample project design, it is assumed that the utilities will not interfere with the proposed BMP locations. However, more information would be needed to ensure these locations are acceptable with respect to the existing utilities. No BMPs are proposed for the area under the high voltage transmission lines because the utility owners typically restrict what can be placed within the utility right-of-way.

DRAINAGE SYSTEMS

Much of Crestwood Boulevard is an open section roadway where the stormwater runoff will sheet flow into roadside ditches. The roadside ditches either drain to storm drain systems or stream channels. The median of Crestwood Boulevard is curbed. A portion of Crestwood Boulevard is fully curbed and there are also areas of limited curbs near major intersections. Storm drains systems exist in the curbed portion of the roadway. Corporate Drive is completely curbed and has an existing storm drain system.

In the curbed portions of both roadways, grass swales and bioswales are not ideal BMP choices since they would not be able to accept the concentrated inflows. Both practices can be used in the open section portions of Crestwood Boulevard.

After taking into account the Green Street Design Considerations, the following BMPs are recommended or acceptable with a proper design on the sample project: Non-Rooftop Disconnection, Sheet Flow to Conservation Area, Rain Gardens, Microbioretention, Submerged Gravel Wetlands, Grass Swales, Bioswales, Bioretention, and Surface Sand Filters. Grass Swales and Bioswales would not be recommended along Corporate Drive due to the curbed roadway and the inability to direct sheet flow into proposed facilities.

STEP 2: CONTEXT DRIVEN CONSIDERATIONS: BMP SELECTION MATRIX

To continue refining the list of recommended BMPs, the BMP Selection Matrices should be used in conjunction with the context zone and roadway type as determined in the Complete Street Manual. The context zone for both roadways is Suburban Activity Center. The roadway type for Crestwood Boulevard is a Boulevard / Parkway. The roadway type for Corporate Drive is a Connector.

Using the Surburban Activity Center BMP Selection Matrix, **Table 12,** and the previously established list of BMPs based on the Green Street Design Considerations, the following BMPs are recommended or optional for Crestwood Boulevard and Corporate Drive:

Crestwood Boulevard:
Rain Gardens
Microbioretention
Submerged Gravel Wetlands
Grass Swales
Bioswales
Bioretention
Surface Sand Filters
Non-Rooftop Disconnection

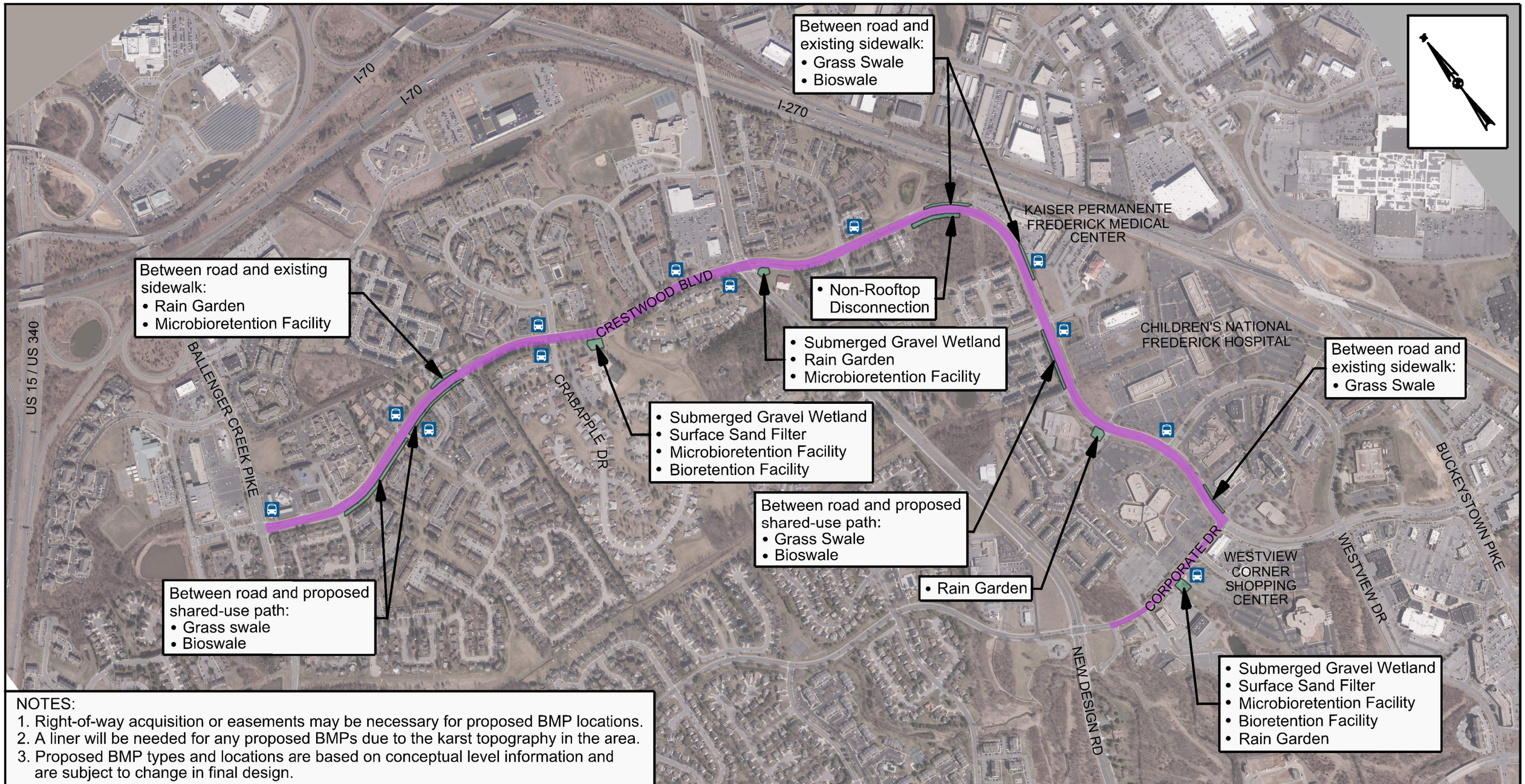
Corporate Drive:
Rain Gardens
Microbioretention
Submerged Gravel Wetlands
Bioretention
Surface Sand Filters
Non-Rooftop Disconnection

STEP 3: GREEN INFRASTRUCTURE BEST MANAGEMENT PRACTICES

Using the above list of BMPs and factoring in the existing site features and the detailed information about the implementation of each BMP on pages 63 to 69, potential locations were selected for installation of BMPs along the project corridor. Multiple BMP types have been suggested in most locations to allow for flexibility in the design, since various factors may ultimately restrict the use of one type of BMP in each location.

A map showing the proposed BMPs along Crestwood Boulevard and Corporate Drive can be found in **Figure 20** on the following page. Additional right-of-way or easements may be required in some locations due to the limited amount of existing right-of-way in the area. Due to the karst area the project is located within, liners will be required on most of the proposed BMPs to prevent infiltration.

GREEN STREETS SAMPLE PROJECT: SHARED-USE FACILITY



NOTES:
1. Right-of-way acquisition or easements may be necessary for proposed BMP locations.
2. A liner will be needed for any proposed BMPs due to the karst topography in the area.
3. Proposed BMP types and locations are based on conceptual level information and are subject to change in final design.

LEGEND
- Proposed Shared-Use Path / Project Area
- Proposed BMP Facility
- Existing Bus Stop Location

1,000' 0 1,000' 2,000'
SCALE: 1"=1,000'

CRESTWOOD BOULEVARD AND CORPORATE DRIVE
Context Zone: Suburban Activity Center
Roadway Type: Boulevard / Parkway, Connector Street

Figure 20: Green Streets Sample Project - Shared-Use Facility

Green Streets: Sample Project – Needwood Road Bike Path / Trail

This section highlights Green Street elements implemented for the Needwood Road Bike Path/Trail located in Montgomery County, Maryland to serve as an example of the recommendations within this Green Streets Manual. A variety of Green Street Infrastructure Best Management Practices were used to meet the stormwater management needs of the project. The context zone for the project is **Suburban**. The Needwood Road roadway type is a **Collector**, and the project added a shared-use path along one side of the roadway for pedestrians, bicyclists, and other users. The project used Rain Gardens, Permeable Pavements, Landscape Infiltration, and Bioswales as Green Street Infrastructure Best Management Practices to provide the required stormwater management. The smaller scale BMPs were used to help manage the stormwater at its source, rather than at a few selected points along the project. Maintenance for the Green Street Infrastructure Best Management Practices is in accordance with the 2000 Maryland Stormwater Design Manual. The maintenance of the facilities was split between Montgomery County and Maryland-National Capital Park and Planning Commission (M-NCPPC) depending on if the BMP was in County Right-of-Way or on M-NCPPC property.

The project is located in a Use IV Watershed and the BMPs used on the project do not include permanently stored surface water. The project site it dominated by Hydrologic Soil Group Type B with a few small areas of Type C and Type D. The BMP were located in the Type B Soils. Soil Borings taken at the proposed BMPs found no groundwater within the depth of the boring. Infiltration test done found infiltration rates primarily more than 0.5 inch/hour, making the selection of BMPs that utilize infiltration possible. There were limited underground utilities in the project area.

RAIN GARDEN

The project has several Rain Gardens, treating small drainage areas that included the Bike Path/Trail and Needwood Road. The Rain Gardens were located between the Bike Path/Trail and the road. The drainage area to the rain gardens were approximatley 4,000 square feet, with a percent imperviousness of approximelty 70%. The rain gardens utilized underdrains to ensure the planting soil would drain completely between these storms. Storm drain systems were not present in the areas of the rain gardens, so the under drains were daylighted, overflows from higher storm envents were allowed to run back onto the roadway. The abililty to outlet the underdrains safely, the small drainge area and available space made the selection of Rain Gardens ideal in this area.

Rain Garden along Needwood Road Bike Path/Trail
source: JMT

Maintenance for a Rain Garden includes removing trash and debris; ensuring the vegetative cover is adequate, removing any invasive species, and replacing any dead or dying plants; when draw down time exceeds 48 hours after a rain even, the top few inches of media should be removed and replaced; and removal of any blockages from inlet grates or pipes.

LANDSCAPE INFILTRATION

The project has several Landscape Infiltration facilities, treating small drainage areas that included the Bike Path/Trail and portions of Needwood Road. The Landscape Infiltration facilities were located between the Bike Path/Trail and the road and along the outside of the Bike Trail/Path. The drainage areas for the Landscape Infiltration were all approximately 9,000 square feet with approximately 40% imperviousness. Overflows from the landscape infiltration were directed overland into the adjacent park area. There was no nearby storm drainage infrastructure to provide conveyance away from the facilities. The higher infiltration rates, larger drainage areas and the ability to discharge the overflows overland safely were factors in selecting landscape infiltration on a portion of the project.

Maintenance for Landscape Infiltration includes removing trash and debris, ensuring the vegetative cover is adequate, removing any invasive species, replacing any dead or dying plants, and removing any blockages from inlet grates or pipes. When draw down time exceeds 48 hours after a rain even, the top few inches of media should be removed and replaced.

Landscape Infiltration along Needwood Road
source: JMT

BIOSWALE

The project has several Bioswales, treating small drainage areas that included the Bike Path/Trail and Needwood Road. The Bioswales were located along the outside of the Bike Path/Trail. The Bioswales had drainage areas under 0.5 acre, with approximately 25% to 50% of that area being impervious. Existing storm drains were used to provide stable conveyance for overflows. The Bioswale underdrains were also connected to the existing storm drain. The Bioswales took advantage of existing drainage patterns as they were located in existing swales. The existing swale and storm drain infrastructure were the primary reasons the Bioswales were implemented along the project.

Maintenance for Bioswales includes removing trash and debris, ensuring the vegetative cover is adequate, removing any invasive species, replacing any dead or dying plants, and removing any blockages from inlet grates or pipes. When draw down time exceeds 48 hours after a rain even, the top few inches of media should be removed and replaced. Check dams that show signs of erosion need to be repaired.

Bioswale along Needwood Road Bike Path / Trail
source: JMT

PERMEABLE PAVEMENTS

Permeable Pavement along Needwood Road
source: JMT

The project used Permeable Pavement for a portion of the Bike Path/Trail. The Permeable Pavement provides self-treatment of the trail area. A photo of some finished segments of Permeable Pavement is shown to the left. The permeable pavement was implemented in areas where the available Right-of-Way was restricted in a portion of the project that was heavily residential. The high infiltration rates available through the project corridor along with the narrow Right-of-Way were driving factors for selection the practice.

Permeable Pavements require frequent maintenance to ensure the pavements continue to function. Vacuuming and power washing the permeable pavements should be done on a seasonal basis. Use of deicers should be avoided, debris and trash removed, and surface damage or spalling needs to be repaired to ensure proper function of the Permeable Pavement areas.

Plant Selection Considerations

There are many considerations to account for when selecting the appropriate plant materials for a transportation project. When determining the best plant options along a roadway, bike path or within a BMP facility, for example, the County should consider the safety concerns, the environmental or locational considerations, and the general corridor and BMP type in question. More details regarding each of these considerations are provided below.

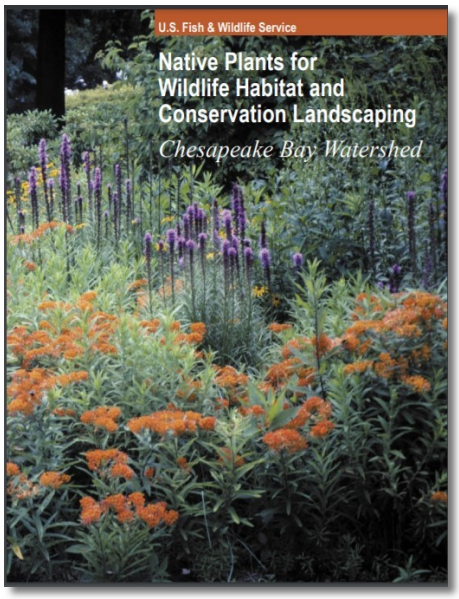
SAFETY

Safety should always be addressed with plant species selection and Crime Prevention through Environmental Design (CPTED) principles. Landscape design of facilities should not create blind spots or encourage gathering areas for illicit activities. Open sight lines along roadways provide users of the space an increased sense of security and safety. For example, shrubs, evergreen, and deciduous options, may be selected based upon mature sizing to ensure that sight lines are kept clear regardless of future maintenance activities employed at the facility. More information regarding the CPTED guidance can be found in the Additional Green Street References section.

ENVIRONMENTAL

Frederick County is located within two USDA Plant Hardiness Zones, zones 6 and 7 and the County's geology includes the Piedmont and Blue Ridge formations. These features and additional environmental conditions such as sun exposure, water regime, and salt tolerance will also guide plant material selection. These aspects must be considered to determine the proper plant species for a successful project. By observing the surrounding vegetation, clues to the existing environmental conditions may be gleaned and aid in developing the proposed plant palette.

Plant survivability is a major factor in determining the success of a green infrastructure facility or plantings along a corridor. Native plant species are recommended to be specified for the facility as they will have the highest survivability rate, in most cases. Utilizing native species will also help to reduce future maintenance requirements such as additional fertilization and watering. Native plant lists and other informative documents are available from many sources, such as the U.S. Fish and Wildlife Services, and can be found in the Additional Green Street References section.



Native Plants for Wildlife Habitat and Conservation Landscaping
source: US Fish & Wildlife Service

GENERAL CORRIDOR

Projects with multi-modal facilities adjacent to roadways should consider shade trees within the buffer area to provide an improved aesthetic and user-level comfort where the context zone and roadway type recommend their implementation. Refer to the Complete Streets Manual to determine the context zone and roadway type of the respective project, then use the Design Element Selection Matrices on pages 19 to 23 to note if shade trees are recommended. Different species of shade trees that are possible options within Frederick County are noted in the Recommended Plant Species section below.

The context zone of the project will guide the plant selection process to ensure that the final product blends well with the project location and context. For example, project sites along more urban and highly visible areas may result in a more ornamental, but functional, plant palette while a rural site may stress a more functional palette with less ornamental features depending on visibility. Projects located along roadways with dense pedestrian and bicycle activity should consider implementing a more ornamental palette of plant materials to enhance the overall user experience. Some different ornamental and functional species of the various plant types to consider with Frederick County are provided in the Recommended Plant Species section below.

BMP TYPE

Once the safety, environmental and general corridor considerations have been accounted for, the specific type of BMP will help to further dictate which plant types are appropriate within a BMP facility. **Table 15,** below, represents the recommended plant types that can be considered within each of the listed BMPs for Frederick County.

Table 15: BMP Plant Type Selection Matrix

BMP PLANT TYPE SELECTION MATRIX						
BMP	PLANT TYPE					
	TREE	SHRUB	PERENNIAL	HERBACEOUS	TURFGRASS	SEED MIX
Non-Rooftop Disconnect	✓	✓	✓	O	✓	✓
Sheet Flow to Conservation Areas	✓	✓	✓	O	X	✓
Rain Gardens	X	✓	✓	✓	✓	✓
Landscape Infiltration	X	O	✓	✓	X	✓
Microbioretention	✓	✓	✓	✓	✓	✓
Infiltration Berms	X	O	O	X	✓	✓
Submerged Gravel Wetlands	X	O	O	✓	X	✓
Grass Swales	X	X	O	X	X	✓
Bioswales	X	X	O	O	X	✓
Wet Swales	X	O	O	✓	X	✓
Permeable Pavement	X	X	X	X	X	X
Reinforced Turf	X	X	X	X	✓	✓
Bioretention	✓	✓	✓	✓	✓	✓
Surface Sand Filter	O	O	O	X	✓	✓
Infiltration Trenches	O	O	O	X	X	✓
Dry Wells	X	X	X	X	✓	✓
LEGEND: ✓ = Recommended O = Optional X = Not Recommended or Not Applicable						

Recommended Plant Species

Within these plant types, there are numerous plant species that are appropriate for installation within green infrastructure facilities in Frederick County. The following sections provide photographs of a few examples of possible plant selections that are available for most projects, however a certified or licensed professional, such as a landscape architect, should be consulted when developing the landscape planting plans for green infrastructure facilities to ensure the success of the project.

TREES

SHADE TREES

In general, shade trees are single stem plants that usually grow to be tall with large canopies. Use of these species is dependent upon the type of facility and the context of the area. Shade trees should be specified to have a minimum branching height of seven feet at installation near a sidewalk or trail to provide clearance for pedestrians and bicyclists. This classification of tree is usually reserved for larger BMP facilities, such as bioretention and microbioretention **(see Table 15)** and may be installed along the periphery of the facility. Shade trees are typically deciduous and may provide visual interest with fall color.

American Holly
source: sussexconservation.org

Willow Oak
source: buyvatrees.com

Bald Cypress
source: Texas Tech University

Red Maple ‘Red Sunset’
source: Kaspar Nursery

Black Gum
source: Northern Ireland Specialist Tree Nursery

American Sycamore
source: thetreecenter.com

ORNAMENTAL TREES

In general, ornamental trees are plants that usually grow to be smaller in stature and may be single stem or multistem depending upon the species and desired effect. Use of these species is dependent upon the type of facility and the context of the area. Ornamental trees should not be utilized directly adjacent to sidewalks or trails unless there is sufficient offset to allow the tree to grow naturally without excessive pruning or reshaping. This classification of tree is usually reserved for larger BMP facilities, such as bioretention and microbioretention **(see Table 15)** and may be installed along the periphery of the facility or within the facility. When installing within a BMP facility, care must be exercised to adhere to minimum offsets from underdrains, observation wells, weirs, etc. Ornamental trees are typically deciduous and may provide visual interest with spring flowering and/or fall color.

Eastern Redbud
source: smartseedsemporium.com

'Winter King' Green Hawthorn (spring and winter)
source: Siteone.com, coastalpoint.com

Shadblow Serviceberry
source: Halka Nursery

Sweetbay Magnolia
source: thomsonslandscaping.com

Flowering Dogwood
source: pixiesgardens.com

SHRUBS

Shrubs are versatile plants that may be deciduous or evergreen and utilized in most BMP situations except swales, reinforced turf, and dry wells **(see Table 15)**. They vary in size and shape offering many diverse physical characteristics depending upon the species. Use of these plants is dependent upon the type of facility and the context of the area. Careful design consideration should be practiced when installing shrubs directly adjacent to sidewalks or trails to ensure there is sufficient offset to allow the shrub to grow naturally without excessive pruning or reshaping. CPTED principles must be examined with shrub locations to increase the safety of the users of the space by maintaining sight lines. Shrubs are versatile and may be installed along the periphery of the facility or within the facility. When installing within a facility, care must be exercised to adhere to minimum offsets from underdrains, observation wells, weirs, etc. Choosing the appropriate shrub and shrub combinations will provide visual year-round interest and pleasant aesthetics.

Dwarf Fothergilla
source: Hinsdale Nurseries

Redtwig Dogwood (summer and winter)
source: University of Minnesota Extension, Coloradohardyplants.com

Spicebush
source: The Morton Arboretum

'Shamrock' Inkberry Holly
source: raveplants.com

PERENNIALS

Perennials are plants that are present during the growing season and die back during the winter months only to return the following spring. There are seemingly endless selections that may be utilized in most BMP situations except swales, reinforced turf, and dry wells **(see Table 15)**. They vary in size and shape offering many diverse physical characteristics depending upon the species. Use of these plants is dependent upon the type of facility and the context of the area. Careful design consideration should be practiced when installing some perennials directly adjacent to sidewalks or trails to ensure there is sufficient offset to allow the plant to grow naturally without excessive pruning or reshaping. CPTED principles must be examined with perennial locations to increase the safety of the users of the space by maintaining sight lines. Perennials are versatile and may be installed along the periphery of the facility or within the facility. Installing within a facility, care must be exercised to adhere to minimum offsets from underdrains, observation wells, weirs, etc. Choosing the appropriate perennial and perennial combinations will provide visual year-round interest and pleasant aesthetics.

'Fireworks' Goldenrod
source: gardenia.net

Purple Coneflower
source: worldoffloweringplants.com

Joe Pye Weed
source: joyfulbutterfly.com

Blue False Indigo
source: gardenmaking.com

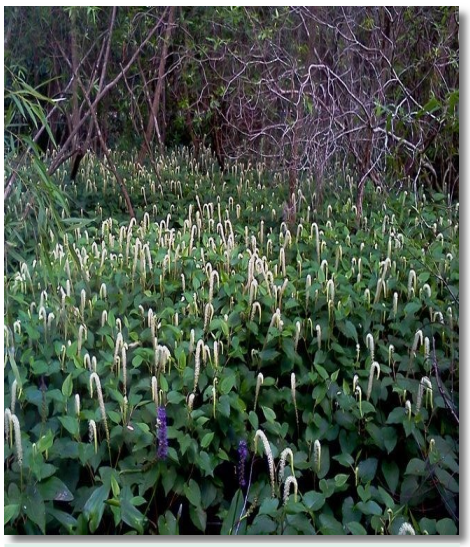
'Shenandoah' Red Switchgrass
source: McKay Nursery

Blueflag Iris
source: ernstseed.com

HERBACEOUS PLANTS

Herbaceous plants are typically found in wet situations and may be like perennials in that they may be present during the growing season and dying back during the winter months only to return the following spring. There are seemingly endless selections that may be utilized in BMP situations that have standing water for periods of time, such as microbioretention and bioretention **(see Table 15)**. They vary in size and shape offering many diverse physical characteristics and wildlife benefits depending upon the species. Use of these plants is dependent upon the type of facility and the context of the area. When installing herbaceous plants within a facility, care must be exercised to adhere to minimum offsets from underdrains, observation wells, weirs, etc. Choosing the appropriate herbaceous plant palette in combination with other categories of plant species will provide visual year-round interest and pleasant aesthetics.

Tussock Sedge
source: perennialfarmmarketplace.com



Lizard's Tail
source: azgardens.com

Arrow Arum
source: plants.ifas.ufl.edu

Cinnamon Fern
source: directgardening.com

Softstem Bulrush
source: perennialfarmmarketplace.com

TURFGRASS AND SEED MIXES

Turfgrass is typically found around the periphery of BMPs in residential areas to stabilize the drainage area into the BMP or in situations utilizing reinforced turf, see photo. The seed mixes associated with turfgrass are usually mow-able mixes that might be found in your front yard. Sun exposure will be a determining factor into the specific species of seed that may be incorporated into the mix and the potential for a more shade tolerant mix. In some circumstances, the turfgrass may be installed as sod to obtain quick establishment of the turfgrass. Other situations may dictate the desire for a more meadow-oriented species mix in areas of less mowing maintenance. Conservation seed mixes are readily available to provide wildlife benefits while wet meadow mixes may be implemented in swales **(see Table 15)**. Choosing an appropriate seed mix in combination with other categories of plant species will provide visual year-round interest and pleasant aesthetics.

Reinforced Turf on Rosemary Lane
Source: Google Street View

Tall Grass Meadow Mix
source: roundstoneseed.com

Maintaining Green Streets

Inspection and maintenance of Green Street Infrastructure Best Management Practices are important measures to ensure the long-term operation and success of Green Streets. BMPs need periodic maintenance and inspection to ensure they remain functional, providing the desired reduction and treatment of stormwater runoff. This section will provide basic guidance for the inspection frequency and maintenance requirements for each type of BMP discussed in this Manual to aid in the selection of BMPs for roadways.

NON-ROOFTOP DISCONNECTION

Maintenance for areas of Non-Rooftop Disconnection is no different than that required for other lawn or landscaped areas. The areas should be protected from future compaction and, in commercial areas, from foot traffic. Any debris or trash found should be removed and disposed of properly.

SHEET FLOW TO CONSERVATION AREAS

Sheet Flow to Conservation Areas require minimal maintenance. The Conservation Areas should remain unmanaged other than routine debris and trash removal and the repair of any areas of concentrated flow.

RAIN GARDENS

Rain Gardens should be inspected and maintained on a periodic basis to ensure proper function and long-term performance. The table below outlines some of the basic maintenance and inspection activities for a Rain Garden and the frequency these activities should be undertaken.

Table 16: Rain Garden Maintenance Requirements

RAIN GARDEN MAINTENANCE REQUIREMENTS				
Activity	**Frequency**			
	MONTHLY	SEASONALLY / AFTER MAJOR STORM	ANNUALLY	AS NEEDED
Remove trash and debris	✓	✓	✓	✓
Remove invasive species and weeds	✓	✓	✓	✓
Replenish mulch		✓		✓
Check for and repair eroded areas	✓	✓	✓	✓
Cut back dead vegetation			✓	✓
Replace top layer of media if standing water remains for more than 48 hours		✓		✓
Remove accumulated sediment			✓	✓
Replace mulch layer completely			✓	
Mow grass areas and remove clippings	✓			✓
LEGEND: ✓ = Recommended				

LANDSCAPE INFILTRATION

Landscape Infiltration should be inspected and maintained on a periodic basis to ensure proper function and long-term performance. During the first year of operation, it is important to inspect the facility after every major storm event to ensure the facility is functioning and to remove any sediment and replace any areas of poorly established vegetation. Sediment accumulation can cause Landscape Infiltration facilities to fail. The table below outlines some of the basic maintenance and inspection activities for Landscape Infiltration and the frequency these activities should be undertaken.

Table 17: Landscape Infiltration Maintenance Requirements

LANDSCAPE INFILTRATION MAINTENANCE REQUIREMENTS				
Activity	**Frequency**			
	MONTHLY	SEASONALLY / AFTER MAJOR STORM	ANNUALLY	AS NEEDED
Remove trash and debris	✓	✓	✓	✓
Remove invasive species and weeds	✓	✓	✓	✓
Check for and repair eroded areas	✓	✓	✓	✓
Replace top layer of media if standing water remains for more than 48 hours		✓		✓
Remove accumulated sediment	✓	✓	✓	✓
Mow grass areas and remove clippings	✓			✓
LEGEND: ✓ = Recommended				

MICROBIORETENTION

Microbioretention facilities should be inspected and maintained on a periodic basis to ensure proper function and long-term performance. **Table 18** outlines some of the basic maintenance and inspection activities for a Microbioretention facility and the frequency these activities should be undertaken.

Table 18: Microbioretention Maintenance Requirements

MICROBIORETENTION MAINTENANCE REQUIREMENTS				
Activity	**Frequency**			
	MONTHLY	SEASONALLY / AFTER MAJOR STORM	ANNUALLY	AS NEEDED
Remove trash and debris	✓	✓	✓	✓
Remove invasive species and weeds	✓	✓	✓	✓
Replenish mulch		✓		✓
Check for and repair eroded areas	✓	✓	✓	✓
Cut back dead vegetation			✓	✓
Replace top layer of media if standing water remains for more than 48 hours		✓		✓
Remove accumulated sediment			✓	✓
Replace mulch layer completely			✓	
Mow grass areas and remove clippings	✓			✓
LEGEND: ✓ = Recommended				

INFILTRATION BERMS

Infiltration Berms require regular inspection to ensure that the ponding water does not create a nuisance and to identify any areas of concentrated flow that require repair to ensure sheet flow. Vegetation should also be present at all times and any missing vegetation repaired or replaced. **Table 19** outlines some of the basic maintenance and inspection activities for Infiltration Berms and the frequency these activities should be undertaken.

Table 19: Infiltration Berms Maintenance Requirements

INFILTRATION BERMS MAINTENANCE REQUIREMENTS				
Activity	**Frequency**			
	MONTHLY	SEASONALLY / AFTER MAJOR STORM	ANNUALLY	AS NEEDED
Remove trash and debris	✓	✓	✓	✓
Remove invasive species and weeds	✓	✓	✓	✓
Check for and repair eroded areas		✓		✓
Check for signs of concentrated flow and repair to restore to sheet flow		✓	✓	✓
Mow grass areas and remove clippings	✓			✓
Remove accumulated sediment		✓	✓	✓
LEGEND: ✓ = Recommended				

SUBMERGED GRAVEL WETLANDS

Submerged Gravel Wetlands should be inspected and maintained on a periodic basis to ensure proper function and long-term performance. The table below outlines some of the basic maintenance and inspection activities for Submerged Gravel Wetlands and the frequency these activities should be undertaken.

Table 20: Submerged Gravel Wetlands Maintenance Requirements

SUBMERGED GRAVEL WETLANDS MAINTENANCE REQUIREMENTS				
Activity	**Frequency**			
	MONTHLY	SEASONALLY / AFTER MAJOR STORM	ANNUALLY	AS NEEDED
Remove trash and debris	✓	✓	✓	✓
Remove invasive species and weeds	✓	✓	✓	✓
Replenish mulch		✓		✓
Check for and repair eroded areas	✓	✓	✓	✓
Cut back dead vegetation			✓	✓
Replace top layer of pea gravel chimney standing water remains for more than 48 hours		✓		✓
Remove accumulated sediment in forebay			✓	✓
Mow grass areas and remove clippings	✓			✓
LEGEND: ✓ = Recommended				

GRASS SWALES

Grass Swales are relatively low maintenance, typically needing only requiring periodic mowing. The table below outlines some of the basic maintenance and inspection activities for Grass Swales and the frequency these activities should be undertaken.

Table 21: Grass Swales Maintenance Requirements

GRASS SWALES MAINTENANCE REQUIREMENTS				
Activity	Frequency			
	MONTHLY	SEASONALLY / AFTER MAJOR STORM	ANNUALLY	AS NEEDED
Remove trash and debris	✓	✓	✓	✓
Mow grass side slopes and remove clippings	✓	✓	✓	✓
Mow channel		✓		
Remove accumulated sediment	✓	✓	✓	✓
Check for and repair eroded areas			✓	✓
LEGEND: ✓ = Recommended				

BIOSWALES

Bioswales should be inspected and maintained on a periodic basis to ensure proper function and long-term performance. Maintenance is similar to Rain Gardens and Microbioretention. The table below outlines some of the basic maintenance and inspection activities for a Bioswales and the frequency these activities should be undertaken.

Table 22: Bioswale Maintenance Requirements

BIOSWALE MAINTENANCE REQUIREMENTS				
Activity	Frequency			
	MONTHLY	SEASONALLY / AFTER MAJOR STORM	ANNUALLY	AS NEEDED
Remove trash and debris	✓	✓	✓	✓
Remove invasive species and weeds	✓	✓	✓	✓
Replenish mulch		✓		✓
Check for and repair eroded areas	✓	✓	✓	✓
Cut back dead vegetation			✓	✓
Replace top layer of media if standing water remains for more than 48 hours		✓		✓
Remove accumulated sediment			✓	✓
Mow grass areas and remove clippings	✓			✓
Repair any erosion on check dams		✓	✓	✓
LEGEND: ✓ = Recommended				

WET SWALES

Wet Swales should be inspected and maintained on a periodic basis to ensure proper function and long-term performance. The table below outlines some of the basic maintenance and inspection activities for Wet Swales and the frequency these activities should be undertaken.

Table 23: Wet Swale Maintenance Requirements

WET SWALE MAINTENANCE REQUIREMENTS				
Activity	**Frequency**			
	MONTHLY	SEASONALLY / AFTER MAJOR STORM	ANNUALLY	AS NEEDED
Remove trash and debris	✓	✓	✓	✓
Remove invasive species and weeds	✓	✓	✓	✓
Repair any erosion on check dams		✓	✓	✓
Check for and repair eroded areas	✓	✓	✓	✓
Cut back dead vegetation			✓	✓
Mow grass areas and remove clippings	✓			✓
Remove accumulated sediment			✓	✓
LEGEND: ✓ = Recommended				

PERMEABLE PAVEMENT

Permeable Pavement requires frequent maintenance to ensure proper function and long-term performance. The maintenance will require the use of a vacuum sweeper. The placement of erodible materials on Permeable Pavement should be avoided. The use of deicers should be done in moderation. When plowing snow, the blade of the snowplow should be set one-inch higher than normal to protect the surface and snow piles should not be placed on Permeable Pavement. The table below outlines some of the basic maintenance and inspection activities for Permeable Pavement and the frequency these activities should be undertaken.

Table 24: Permeable Pavement Maintenance Requirements

PERMEABLE PAVEMENT MAINTENANCE REQUIREMENTS				
Activity	**Frequency**			
	MONTHLY	SEASONALLY / AFTER MAJOR STORM	ANNUALLY	AS NEEDED
Remove trash and debris	✓	✓	✓	✓
Sweep, vacuum, and powerwash surface to reduce sediment accumulation		✓		✓
LEGEND: ✓ = Recommended				

REINFORCED TURF

Maintenance for Reinforced Turf requires less intensive maintenance when compared to Permeable Pavement. Deicers should not be used to avoid killing grass that may be growing on vegetated Reinforced Turf. When plowing snow, the blade of the snowplow should be set one-inch higher than normal to protect the surface and snow piles should not be placed on Permeable Pavement. The table below outlines some of the basic maintenance and inspection activities for Permeable Pavement and the frequency these activities should be undertaken.

Table 25: Reinforced Turf Maintenance Requirements

REINFORCED TURF MAINTENANCE REQUIREMENTS				
Activity	**Frequency**			
	MONTHLY	SEASONALLY / AFTER MAJOR STORM	ANNUALLY	AS NEEDED
Remove trash and debris	✓	✓	✓	✓
Remove accumulated sediment from the surface to ensure function.		✓		✓
LEGEND: ✓ = Recommended				

BIORETENTION

Bioretention facilities should be inspected and maintained on a periodic basis to ensure proper function and long-term performance. The table below outlines some of the basic maintenance and inspection activities for a Bioretention facility and the frequency these activities should be undertaken.

Table 26: Bioretention Maintenance Requirements

BIORETENTION MAINTENANCE REQUIREMENTS				
Activity	**Frequency**			
	MONTHLY	SEASONALLY / AFTER MAJOR STORM	ANNUALLY	AS NEEDED
Remove trash and debris	✓	✓	✓	✓
Remove invasive species and weeds	✓	✓	✓	✓
Replenish mulch		✓		✓
Check for and repair eroded areas	✓	✓	✓	✓
Cut back dead vegetation			✓	✓
Replace top layer of media if standing water remains for more than 48 hours		✓		✓
Remove accumulated sediment in forebay		✓		✓
Replace mulch layer completely			✓	
Mow grass areas and remove clippings	✓			✓
Inspect and repair all structural components			✓	✓
LEGEND: ✓ = Recommended				

SURFACE SAND FILTER

Surface Sand Filters should be inspected and maintained on a periodic basis to ensure proper function and long-term performance. The table below outlines some of the basic maintenance and inspection activities for a Surface Sand Filter and the frequency these activities should be undertaken.

Table 27: Surface Sand Filter Maintenance Requirements

SAND FILTER MAINTENANCE REQUIREMENTS				
Activity	**Frequency**			
	MONTHLY	SEASONALLY / AFTER MAJOR STORM	ANNUALLY	AS NEEDED
Remove trash and debris	✓	✓	✓	✓
Remove invasive species and weeds	✓	✓	✓	✓
Mow grass areas and remove clippings from surface and side slopes	✓			✓
Check for and repair eroded areas	✓	✓	✓	✓
Cut back dead vegetation			✓	✓
Replace top layer of sand if standing water remains for more than 48 hours		✓		✓
Remove accumulated sediment in forebay		✓		✓
Inspect and repair all structural components			✓	✓
LEGEND: ✓ = Recommended				

INFILTRATION TRENCHES

Infiltration Trenches should be inspected and maintained on a periodic basis to ensure proper function and long-term performance. The table below outlines some of the basic maintenance and inspection activities for an Infiltration Trench and the frequency these activities should be undertaken.

Table 28: Infiltration Trenches Maintenance Requirements

INFILTRATION TRENCHES MAINTENANCE REQUIREMENTS				
Activity	**Frequency**			
	MONTHLY	SEASONALLY / AFTER MAJOR STORM	ANNUALLY	AS NEEDED
Remove trash and debris	✓	✓	✓	✓
Check for and repair eroded areas	✓	✓	✓	✓
Mow grass areas and remove clippings from surface and side slopes	✓			✓
Replace top layer of sand if standing water remains for more than 48 hours		✓		✓
Cut back dead vegetation			✓	✓
Remove accumulated sediment in forebay or pre-treatment areas		✓		✓
LEGEND: ✓ = Recommended				

DRY WELLS

Dry Wells should be inspected and maintained on a periodic basis to ensure proper function and long-term performance. The table below outlines some of the basic maintenance and inspection activities for a Dry Wells and the frequency these activities should be undertaken.

Table 29: Dry Wells Maintenance Requirements

DRY WELLS MAINTENANCE REQUIREMENTS				
Activity	**Frequency**			
	MONTHLY	SEASONALLY / AFTER MAJOR STORM	ANNUALLY	AS NEEDED
Remove trash and debris	✓	✓	✓	✓
Check for and repair eroded areas	✓	✓	✓	✓
Mow grass areas and remove clippings from surface and side slopes	✓			✓
Replace top layer of sand if standing water remains for more than 48 hours		✓		✓
LEGEND: ✓ = Recommended				

Additional Green Streets References

For further information regarding the Green Streets considerations, design, or plant selections, please see the below references.

GUIDANCE FROM MARYLAND DEPARTMENT OF THE ENVIRONMENT (MDE)

- 2000 MDE Maryland Stormwater Design Manual can be found here: https://mde.maryland.gov/programs/water/stormwatermanagementprogram/pages/stormwater_design.aspx

GUIDANCE FROM FREDERICK COUNTY

- 2020 Complete and Green Streets Policy can be found here: https://www.frederickcountymd.gov/DocumentCenter/View/334000/Adoption-of-Complete-and-Green-Streets-Policies?bidId=
- 2019 Livable Frederick Master Plan can be found here: https://frederickcountymd.gov/7923/Livable-Frederick-Master-Plans
- Guidance for Maintaining Rain Garden, Bioswale, and Micro-bioretention Facilities can be found here: https://www.frederickcountymd.gov/DocumentCenter/View/300401/oes_bmpbro_matinenance_092717lr1A?bidId=
- Guidance for Maintaining Dry Wells can be found here: https://www.frederickcountymd.gov/DocumentCenter/View/300400/oes_bmpbro_drywells_092717lr1A?bidId=
- Guidance for Maintaining Porous Pavement can be found here: https://www.frederickcountymd.gov/DocumentCenter/View/300402/oes_bmpbro_pavement_092717lr1A?bidId=
- Guidance for Maintaining Stormwater Management Ponds can be found here: https://www.frederickcountymd.gov/DocumentCenter/View/300403/oes_bmpbro_pond_092717lr1A?bidId=

GUIDANCE ON PLANT SELECTION

- 2003 U.S. Fish & Wildlife Service - Native Plants for Wildlife Habitat and Conservation Landscaping for the Chesapeake Bay Watershed can be found here: https://www.fws.gov/Chesapeakebay/pdf/NativePlantsforWildlifeHabitatandConservationLandscaping.pdf
- University of Maryland Extension - Recommended Native Plants for Maryland can be found here: https://extension.umd.edu/resource/recommended-native-plants-maryland
- Alliance for the Chesapeake Bay - Chesapeake Bay Native Plant Center can be found here: https://www.nativeplantcenter.net/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