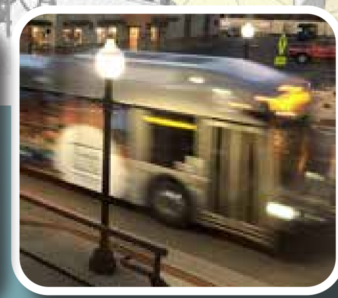

MULTIMODAL SYSTEM DESIGN GUIDELINES

March 2020

DRPT

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ACKNOWLEDGEMENTS

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In 2019, DRPT undertook an update to the Multimodal System Design Guidelines, led by Wood Hudson (Statewide Transit Planner) and under the leadership of Grant Sparks (Manager of Transit Planning and Corridor Development). DRPT would like to express gratitude to the Working Group that contributed to this 2020 Update to the Multimodal System Design Guidelines, as well as the Steering Committee for the original 2013 Guidelines.

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CHAPTER 1

Introduction & Benefits of Multimodal System Planning and Design

The Evolution of Multimodal Planning and the Multimodal System Design Guidelines

Throughout most of the 20th Century, transportation planning focused on making it easier for people to drive a personal automobile anywhere they wanted to go. Yet as the construction of the Interstate Highway System drew to a close, communities across the nation began to realize the inequitable and undesirable consequences of this sole focus on the automobile. By the 1990s, profound shifts in the transportation planning profession were occurring. The Intermodal Surface Transportation Efficiency Act of 1991 called for a more integrated and connected multimodal transportation system and quadrupled federal funding for bicycle and pedestrian facilities. Communities across the nation developed bicycle and pedestrian plans. Interest in and demand for public transit has also grown, and communities are paying greater attention to the ways in which transportation planning decisions affect public health and quality of life.

Figure 1: Tysons Corner Metrorail Station. The new Tysons Silver Line station and associated multimodal improvements at street level show the challenges and opportunities of retrofitting multimodal connectivity into existing contexts. (Image Credit: Wikimedia Commons).

"Multimodal" has become a common term in transportation planning, and it is used to describe anything that involves more than one mode of transportation. It is often used as an antonym to "automobile-oriented" and implies that transportation planning efforts accommodate bicyclists, pedestrians, and public transit in addition to, and sometimes at a higher priority than, automobiles.

Multimodal transportation planning in Virginia has greatly advanced in importance and application since the 1990s. In 2013, the Virginia Department of Rail and Public Transportation (DRPT) developed the Multimodal System Design Guidelines (referred to as "the Guidelines" or "MMSDG" throughout this document). The 2013 Guidelines were the culmination of over two years of study, review and outreach to establish a comprehensive resource for local planners, engineers, designers, policy and decision makers, and anyone else engaged in multimodal planning throughout Virginia. The guidelines provided a common language and set of best practices for planning and designing multimodal streets and places across the Commonwealth. The Guidelines bridged Virginia's statewide multimodal policy priorities with local-level implementation efforts through a systematic approach tailored to the Virginia context that reflected the latest national guidance from a variety of industry-leading organizations.

Since 2013, multimodal planning in Virginia and across the nation has evolved with increasing speed. Cities across the country have advanced the practice with new approaches for transit, bicycles, and pedestrians. Organizations like the National Association of City Transportation Officials (NACTO), the American Association of State Highway Transportation Officials (AASHTO), the Institute of Transportation Engineers (ITE), and the Federal Highway Administration (FHWA) have produced new guidance documents with more sophisticated approaches and design solutions to recognize different bicyclist skill and comfort levels, better integrate transit into urban street design, and more holistically improve walkability. At the same time, the Virginia Department of Transportation (VDOT) and DRPT have made new investments to promote active transportation, systematically increase pedestrian and bicyclist safety, and elevate transit options across the Commonwealth. Virginia's SMART SCALE project prioritization process has changed the way transportation projects are funded, placing a new emphasis on access to multimodal travel choices. Most recently, innovations like dockless bikeshare, scooters, and microtransit initiatives have joined the repertoire of options for shared mobility.

Figure 2: Virginia Capital Trail Map. The Virginia Capital Trail is an example of the profusion of multimodal projects that have been implemented in Virginia since the Multimodal System Design Guidelines were first adopted in 2013. (Image Credit: Wikimedia Commons)

Since these Guidelines were first adopted in 2013, Virginia has seen a blossoming of multimodal projects and initiatives in every context: urban, suburban and rural. Below is a list of a few projects highlighting the range of multimodal projects across the Commonwealth in diverse contexts:

Urban projects:

- Metroway Bus Rapid Transit, Arlington
- Pulse Bus Rapid Transit, Richmond
- Tide Light Rail and Elizabeth River Trail, Norfolk
- Franklin Street Two-Way Separated Bike Lane, Richmond

Suburban and Large Town Projects:

- Virginia Capital Trail, Williamsburg to Richmond
- Rectangular Rapid Flashing Beacons on W&OD Trail, Loudoun County
- Riverwalk Trail, Danville
- Contra-Flow Bike Lanes, Charlottesville

Rural and Small Town Projects:

- Virginia Creeper Trail, Abingdon and surrounding area
- Bicycle improvements on Business 29, Town of Amherst
- Huckleberry Trail, Blacksburg

These projects have brought benefits to both large and small communities through expanding personal travel freedom of choice and safety, increasing tourism revenue and reducing vehicle trips.

This 2020 update of the Multimodal System Design Guidelines reflects these advancements and changes. The updated Guidelines incorporate the latest design guidance from national industry leaders and address new multimodal mobility trends and technologies. They include new implementation case studies and design examples and reflect the latest funding and policy frameworks in Virginia. The 2020 update to the Guidelines was guided by a working group of staff from DRPT, VDOT, and the Office of Intermodal Planning and Investment. References to additional guidance documents are provided throughout.

Figure 3: Franklin Street Two-Way Protected Bike Lane. The two-way bike lane on Franklin Street in downtown Richmond is one example of multimodal projects implemented in a variety of urban, suburban, and rural contexts since the Multimodal System Design Guidelines were first adopted in 2013. The City of Richmond has currently completed 32 miles of bike lanes, and more bike infrastructure projects have been designed and are in the pipeline. (Image Credit: EPR, P.C.)

Figure 4: 23rd & Clark Metroway Bus Rapid Transit Station. The Metroway in Arlington County was Virginia's first Bus Rapid Transit project (Image Credit: Wikimedia Commons)

The Context of Multimodal Planning in Virginia

From Tysons Corner to Warm Springs, communities across Virginia are unique and diverse, with a variety of travel needs and preferences. Multimodal transportation options are important and beneficial in all types of communities – including small rural towns and transitioning suburban areas, in addition to dense urban areas. Multimodal transportation planning actively identifies and addresses the utilitarian and recreational mobility needs of people who cannot or choose not to drive. It provides safe and convenient choices for getting around that need not involve driving a car.

Figure 5: Brick Sidewalk in Gloucester, VA. Although multimodal planning is most often thought of in a dense urban context, even historic rural centers can benefit from enhanced walkability of their streets.

Communities across the rural-to-urban spectrum in Virginia are experiencing population aging, a decreasing middle class, and the desire to spur economic development and improve public health by improving travel options and encouraging active transportation. By providing safe, viable, and enjoyable options for walking, bicycling, and taking transit, communities of all shapes and sizes across Virginia can ensure residents can age in place, make trips without needing to own a car, and have opportunities for daily exercise.

Transportation planning throughout Virginia occurs on multiple levels. At the federal level, the US Department of Transportation (USDOT) outlines policy focus areas and specific initiatives that set the tone for state funding initiatives and programs. For example, in 2014, then-US Secretary of Transportation Anthony Foxx declared pedestrian and bicyclist safety as a top priority for the USDOT and launched the Safer People, Safer Streets Initiative to conduct new research, develop new resources, and highlight existing tools for improving pedestrian and bicycle safety. FHWA's Bicycle and Pedestrian Safety Program provides funding, policy guidance, program management, and resource development.

Pedestrian and bicyclist safety has also become a focused policy goal at the state level. In 2018, VDOT developed its first statewide Pedestrian Safety Action Plan to address the continually increasing rate of pedestrian fatalities. More broadly, VDOT's Arrive Alive Strategic Highway Safety Plan expresses a goal of reducing deaths and serious injuries on Virginia's public roads by 50 percent by 2030, including for pedestrians and bicyclists. Safety for all users is a goal of VTrans – Virginia's statewide transportation plan. VTrans also identifies Needs for bicycle and pedestrian accessibility, safety, and other categories to serve as an eligibility screening criteria for SMART SCALE, the objectively competitive funding program for transportation projects in Virginia. SMART SCALE

Figure 6: Downtown Norfolk. Virginia's established downtown areas can benefit from multimodal planning principles to enhance the safety, economic vitality and livability of their streets and public spaces.

prioritizes locally submitted candidate projects by awarding points to projects that improve walkability, access to multimodal choices, and transit access to jobs. Projects also receive scoring points for reducing fatal and injury crashes, including crashes involving transit vehicles, bicyclists, and pedestrians. Finally, in order to monitor progress of these efforts, the Commonwealth Transportation Board in 2018 adopted targets for reducing non-motorized fatalities and serious injuries, in compliance with federal legislation.

At the metropolitan planning area level, Metropolitan Planning Organizations (MPOs) develop long range transportation plans through which communities express their vision for safe and connected multimodal networks and identify specific projects for improvements. MPOs and Planning District Commissions (PDCs) work with individual localities to develop specific multimodal plans, identify funding resources, and implement projects. The Thomas Jefferson PDC's Jefferson Area Bicycle and Pedestrian Plan is an example of integrated planning bicycle and pedestrian network planning that spans urban and rural contexts and bridges localities' individual planning efforts with state safety and funding initiatives.

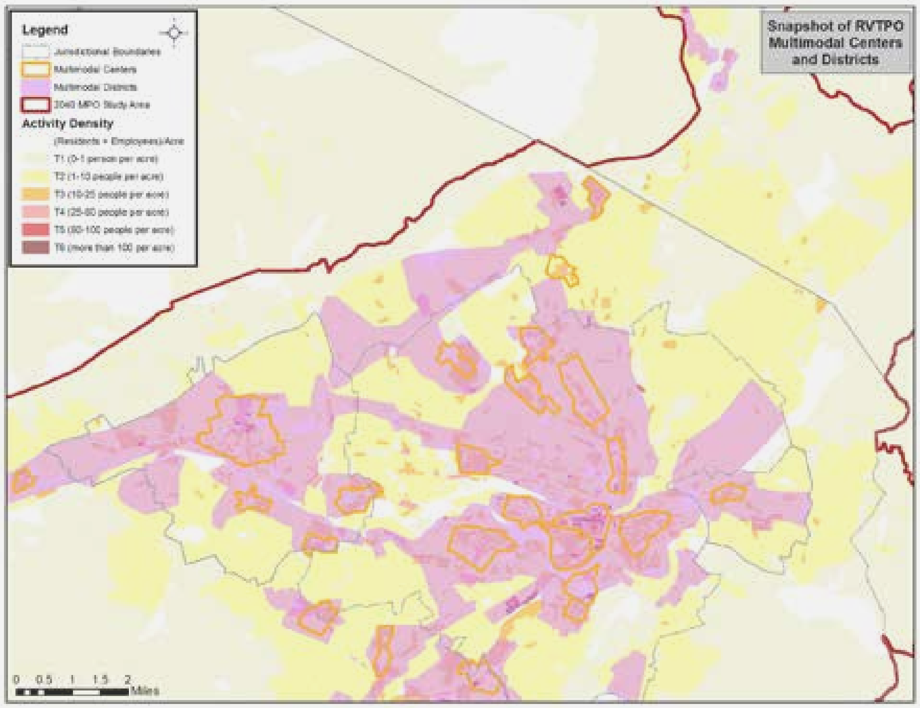


Figure 7: Roanoke Valley Multimodal Districts and Centers. The Roanoke Valley TPO used the Multimodal Guidelines to inform the development of its Long Range Transportation Plan, Vision 2040. (Image Credit: Roanoke Valley Transportation Planning Organization)

On the local level, localities generally implement and construct on- and off-road facilities and improvements for people walking, biking, and using transit. Independent cities, the counties of Arlington and Henrico, and some towns own and maintain their road systems and generally have autonomy in roadway design decisions, although additional design requirements can apply if state or federal funds are used. VDOT owns and maintains the primary and secondary roads in all counties in Virginia except for Arlington and Henrico, and localities work with VDOT and the MPOs to identify and implement multimodal improvements that are usually constructed and maintained by VDOT. Some localities also implement transit stop or station improvements while working with a separate regional entity that provides the transit service.

It is important to note that the standards used in these Guidelines are not intended to conflict with the standards used by any other modal agency in the Commonwealth, including VDOT road design standards, which have been considered in the development of these Guidelines.

Localities have adopted policies to promote multimodal transportation, including Complete Streets and Vision Zero policies. Localities can also receive direct funding for small and moderate improvements through federal programs like Transportation Alternatives.

DRPT and VDOT

DRPT has as its core mission "to facilitate and improve the mobility of the citizens of Virginia and to promote the efficient transport of goods and people in a safe, reliable and cost-effective manner." DRPT works in concert with Virginia's other modal agencies to implement the Commonwealth's overall transportation vision and to ensure the safe and effective movement of people and goods throughout Virginia.

The impetus for these Guidelines dates to the development of the Governor's Strategic Multimodal Plan in 2010. The plan's vision of coordinating multimodal improvements and planning throughout the Commonwealth led to DRPT developing the Multimodal System Design Guidelines beginning in 2010. These Guidelines have helped to implement DRPT's mission by increasing communication and coordination on the best practices for multimodal transportation planning with transportation planning professionals, decision-makers and the general public.

Through a diverse steering committee representing the many stakeholders involved in multimodal planning in Virginia, the 2013 Guidelines were shaped and guided throughout their development to ensure that they fulfilled this purpose of collaborative communication. Coordination with VDOT has been of critical importance throughout both the original development of these Guidelines in 2013 and the 2020 update, since VDOT is the agency with primary oversight of Virginia's state-maintained roadway corridors. Furthermore, VDOT's Bicycle and Pedestrian Accommodations Policy has influenced new roadway design and construction projects to increase safety and accessibility for pedestrians and bicyclists.

It is important to note that the standards used in the development of these Guidelines are not intended to conflict with the standards used by any other modal agency in the Commonwealth, including VDOT road design standards. VDOT's road design standards have been considered in the development of these Guidelines. In general, these Guidelines do not conflict with, but meet or exceed, VDOT road design standards.

As guided by the collective experience of the steering committee, these Guidelines are intended to serve as a collective resource – to establish a common language and set of best practices that can be used to characterize effective multimodal planning in the Commonwealth.

Mission and Goals of the Multimodal System Design Guidelines

Through a deliberate process with the steering committee, an overall project mission and goals were established to give direction to the development of the Guidelines document. Based on the ongoing steering committee feedback from the meetings, the following mission statement was developed in 2012 as a benchmark and guiding direction for all elements of the Guidelines:

Mission of the Multimodal System Design Guidelines

The Multimodal System Design Guidelines will provide guidance on how to plan multimodal corridors, places and regions throughout the Commonwealth of Virginia. The purpose of the Guidelines is to establish common statewide principles and best practices for multimodal planning that can be used as a resource and model by local planners, engineers, designers, policy and decision makers, and anyone else engaged in multimodal planning throughout Virginia.

In addition, three basic goals for the project were established at the beginning of the process as a general direction.

Goals of the Multimodal System Design Guidelines

- Create a statewide resource for local planners, engineers, designers, policy and decision makers, and anyone else engaged in multimodal planning throughout Virginia.
- Identify integrated land use, transportation and urban design approaches to support multimodal mobility.
- Provide guidelines to help planners optimize transit investments and reduce reliance on single occupancy vehicles.

Figure 8: Virginia Creeper Trail. The Virginia Creeper Trail in the vicinity of Abingdon demonstrates the significant tourism potential of multimodal recreational projects in rural areas of the state. (Image Credit: Wikimedia Commons)

The Multimodal System Design Guidelines will provide guidance on how to plan multimodal corridors, places and regions throughout the Commonwealth of Virginia. The purpose of the Guidelines is to establish common statewide principles and best practices for multimodal planning that can be used as a resource and model by local planners, engineers, designers, policy and decision makers, and anyone else engaged in multimodal planning throughout Virginia.

Advances in technology and changes in policy direction will occur over time, and the Guidelines will be updated periodically to reflect these changes. Although the content of the Guidelines will evolve over time, the Mission and Goals of the Guidelines – to serve as a resource for multimodal planning with common statewide principles and best practices – will remain the same.

Below is a list of the benefits commonly cited by the transportation industry of multimodal planning and providing a multimodal transportation system.

Benefits of a Connected Multimodal Transportation System

1. Cost-Efficient Use of Public Dollars
    a. Benefits more travelers with the same amount of money (move more people, not necessarily more vehicles
    b. Optimizes use of existing facilities instead of building new ones
2. Energy Conservation
    a. Reduce emissions through fewer vehicle trips and shorter vehicle trips
3. More Transportation Choices
    a. Eliminates constraints caused by lack of car access
    b. Provides mode, time, location, and route choices and flexibility
4. Mobility and Opportunity Equity
    a. Better meets the basic transportation needs of populations with low incomes and disabilities.
    b. Provides more opportunities for employment access, educational opportunities, health care, and social connectedness
5. Public Health
    a. Enables a safer environment for people who walk and bike – fewer crashes and lower fatality rates
    b. Promotes active lifestyles through more opportunities for walking and biking
    c. Provides more access to a wider range of healthy goods and services
6. Economic Vitality[1]
    a. Provides greater accessibility to existing and future workforces
    b. Attracts businesses through more multimodal transportation options for employees
    c. Increases property values by making places more accessible and livable
7. Increased Capacity for Moving People
    a. Gives more modal choices that can move more people compared to increasing the number of vehicle travel lanes
    b. Allows communities to grow without adding as much congestion
8. Quality of Life
    a. Designs streets as places to spur social interaction
    b. Supports greater sense of community through more accessible places and corridors

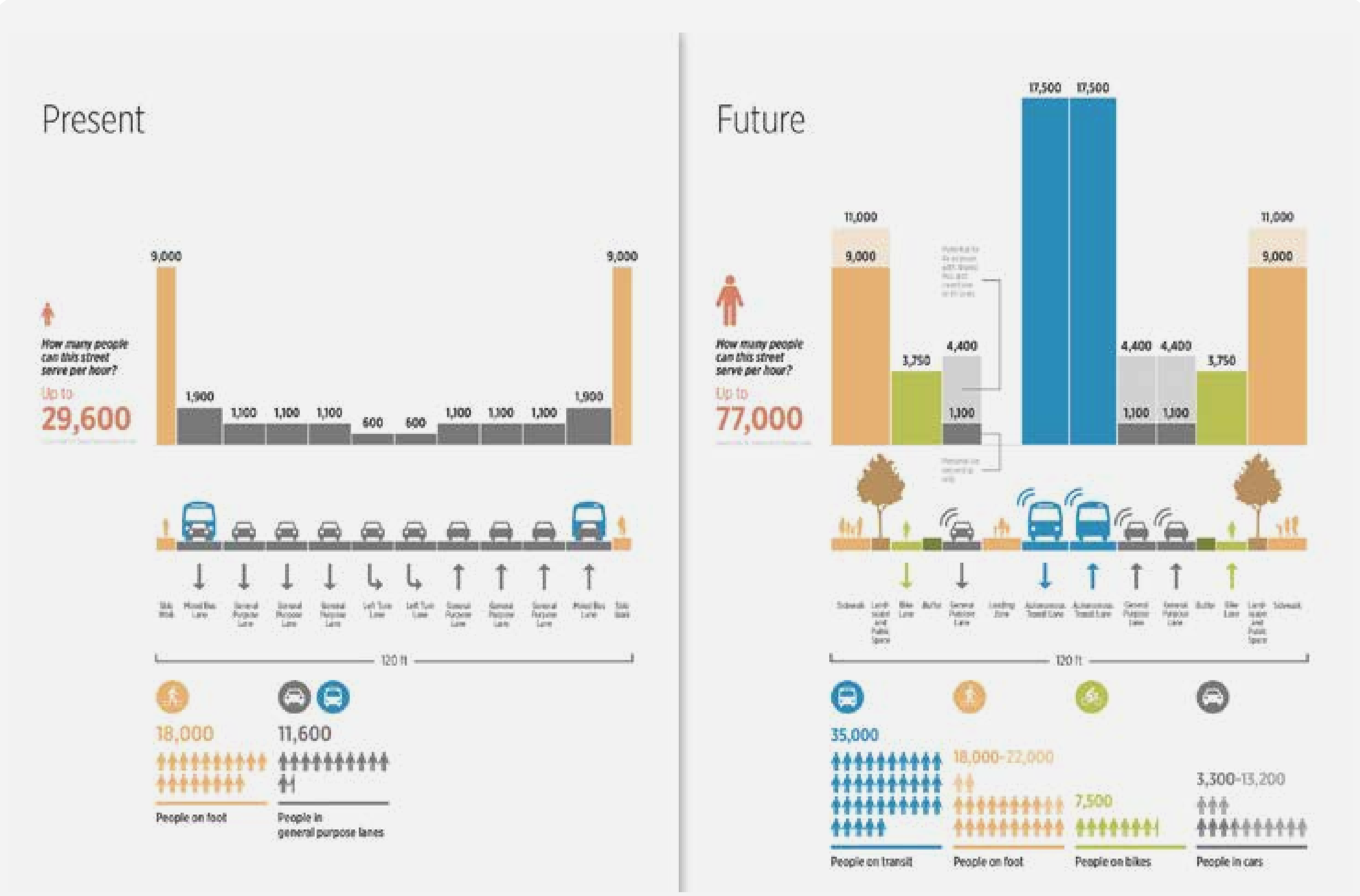


Figure 9: Multimodal Corridor Capacity Present and Future. Ride-hailing service Lyft developed a street redesign for Wilshire Boulevard in Los Angeles, CA and shows how the multimodal improvements increase person-carrying capacity with fewer vehicle lanes. (Image Credit: Perkins+Will, Nelson/Nygaard & Lyft)

A Note on Sources

The original development of the Multimodal System Design Guidelines included an extensive review of comparable studies and standards nationally. The original Guidelines used two primary source materials extensively in the development of the corridor design standards:

1. the "Designing Walkable Urban Thoroughfares: A Context Sensitive Approach" guidebook jointly developed by ITE and the Congress for New Urbanism (CNU), and
2. the VDOT Road Design Manual.

The first of these sources, the ITE/CNU Guidebook was a commonly cited industry standard at the time of the original Guidelines development. In particular, areas of context sensitive street standards comprehensive parameters for corridor design elements and a widely familiar typology of multimodal corridors (boulevard, avenue, street, etc.) influenced the development of the original Guidelines. The second of these sources, the VDOT Road Design Manual, is an important set of standards for roadway design in Virginia, as it defines standards for the design of streets to be accepted into statewide maintenance.

In general, the VDOT standards were used as the minimum standards and ITE/CNU's parameters as the optimum design standards recommended for most corridor design elements in the original 2013 Guidelines.

As part of the 2020 update to the Guidelines, a robust review of new guidance documents was performed. Appendix G includes a summary of the new guidance documents reviewed and incorporated into this update that have been published since 2013. These documents include a variety of new guidebooks from NACTO, FHWA, the Federal Transit Administration (FTA), and AASHTO, among others.

In the Corridor Matrix (Appendix A), which contains the corridor design standards in these Guidelines, the VDOT Road Design standards generally remain the minimum standards. The optimal design standards reflect guidance from the most recently published guidebooks recommended for most corridor design elements. All minimum and optimal values in the Corridor Matrix conform to the VDOT Road Design Manual. The Corridor Matrix Annotations Document (Appendix B) explains the optimal and minimum values in the Corridor Matrix in more detail and provides specific references to each guidebook. The Annotations Document refers readers who are interested in learning more about specific design considerations for each element or treatment type to each specific guidebook for more information.

Figure 10: Decorative Sidewalk Paving in Roanoke. Decorative sidewalk paving not only enhances the pedestrian experience but can also connect visitors with local history.

CHAPTER 2

The Multimodal System Plan - Building the Foundation for Multimodal Planning

This chapter lays out the foundation of multimodal planning upon which these Guidelines are built – The Multimodal System Plan. Multimodal System Plans are not a new concept. They can be done in a variety of forms, whether as part of a regional long-range transportation planning project or as part of a city or county comprehensive transportation plan. A Multimodal System Plan is simply a comprehensive look at all the modal transportation networks in an area, whether auto, transit, bicycle or pedestrian, along with the key land use destinations and centers that they connect.

Multimodal considerations should be integrated into the development of a long-term transportation network, both in order to achieve greater diversity of travel choices and to improve the overall operation of the transportation system.

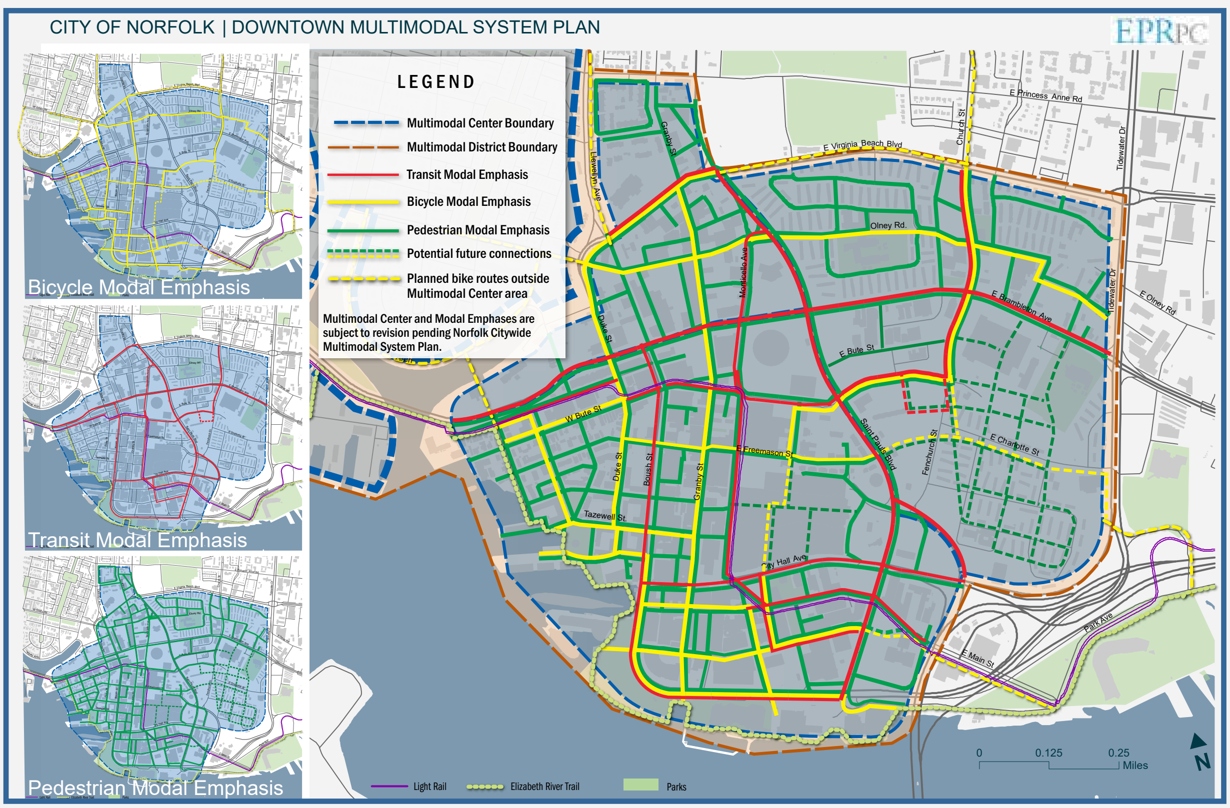


Figure 11: Downtown Norfolk Multimodal System Plan. The City of Norfolk prepared a multimodal system plan for its downtown area that shows the network connectivity for bicycling, walking, and transit. (Image Credit: EPR, P.C.)

Key Concepts and Definitions Used in These Guidelines

What is a Multimodal System Plan?

A Multimodal System Plan is simply a comprehensive look at all the modal transportation networks in an area, whether auto, transit, freight or bike/ped, along with the key land use destinations and centers that they connect.

There are several basic concepts and terminologies used in these Guidelines. These concepts are all integral to the development of a Multimodal System Plan, and they are described below with sample illustrations. A Multimodal System Plan is an integrated land use and multimodal transportation plan that shows the key

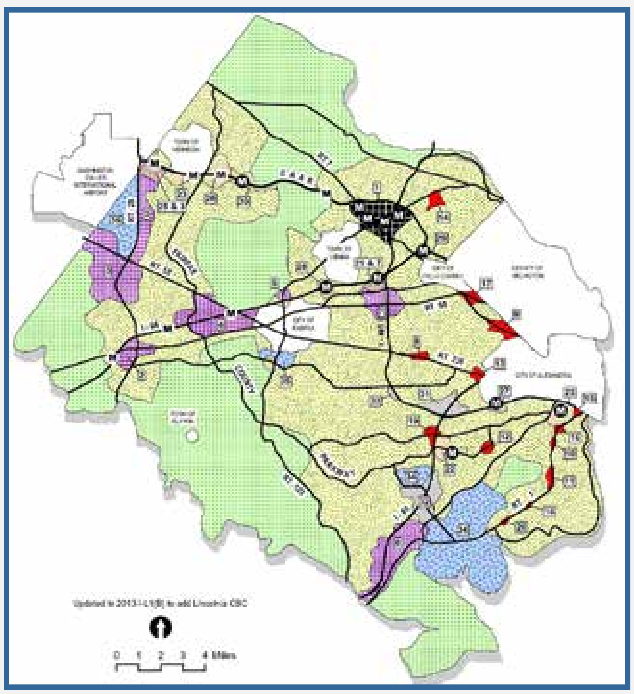


Figure 12: Special Planning Areas in Fairfax County. Fairfax County's Special Planning Areas could be considered Multimodal Districts. (Image Credit: Fairfax County, VA)

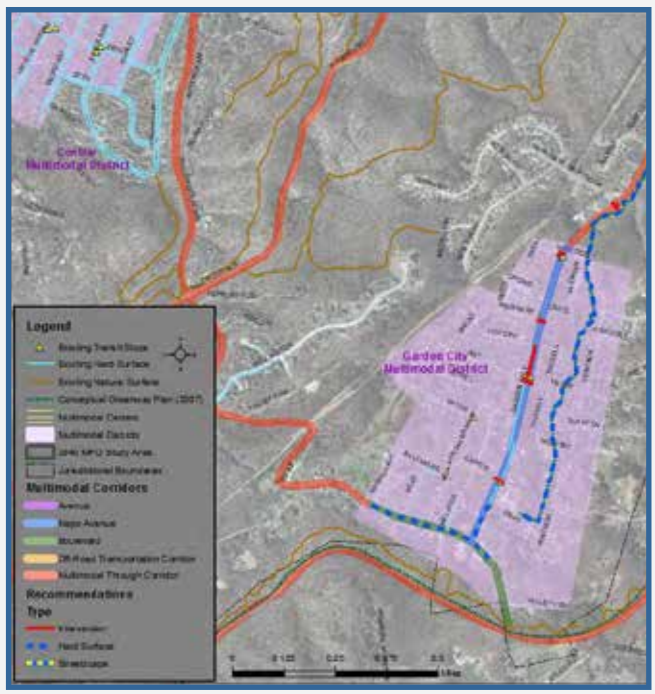


Figure 13: Pedestrian Facility Recommendations in the Garden City Multimodal District. A detail of the Roanoke Valley Multimodal System Plan showing the Multimodal Corridor types and pedestrian facility recommendations in the Garden City Multimodal District.

Multimodal System Plan

Multimodal Districts, Centers, and Multimodal Corridors in a region and ensures that there is a connected circulation network for all travel modes. A Multimodal System Plan can either be done "from scratch" (without using any prior modal or land use plans), or more often by assembling all of the existing land use and transportation plans into a unified whole. In this latter case, the Multimodal System Plan neither establishes any new policies nor changes any existing policies – it merely brings together existing land use and transportation policies into a single unified plan.

Typically, developing a Multimodal System Plan is a mapping and analysis exercise and consists primarily in gathering together the GIS layers from existing modal plans and land use plans so they are all integrated. However, as regions and localities in Virginia may use slightly different terminology and approaches to their land use and transportation planning, the Multimodal System Plan is also a way to assemble their existing plans into a standardized technical and graphic language for ease of communication with each other or with state agencies. In addition, the exercise of developing a Multimodal System Plan will quite often highlight any disconnects in a multimodal circulation network, such as potential gaps in a trail network or a need to connect the regional transit plan to the bike or pedestrian plan. The Multimodal System Plan is also an opportunity for the regional or local entity to address these disconnects by adding policies and actions to fix them in the future. Ideally, the Multimodal System Plan will show that all the multimodal networks in a region are part of a continuous and connected system of circulation that offers a diversity of travel choices. The diagram to the right shows the overlays that make up a Multimodal System Plan, and the methodology for developing it is described later in this chapter.

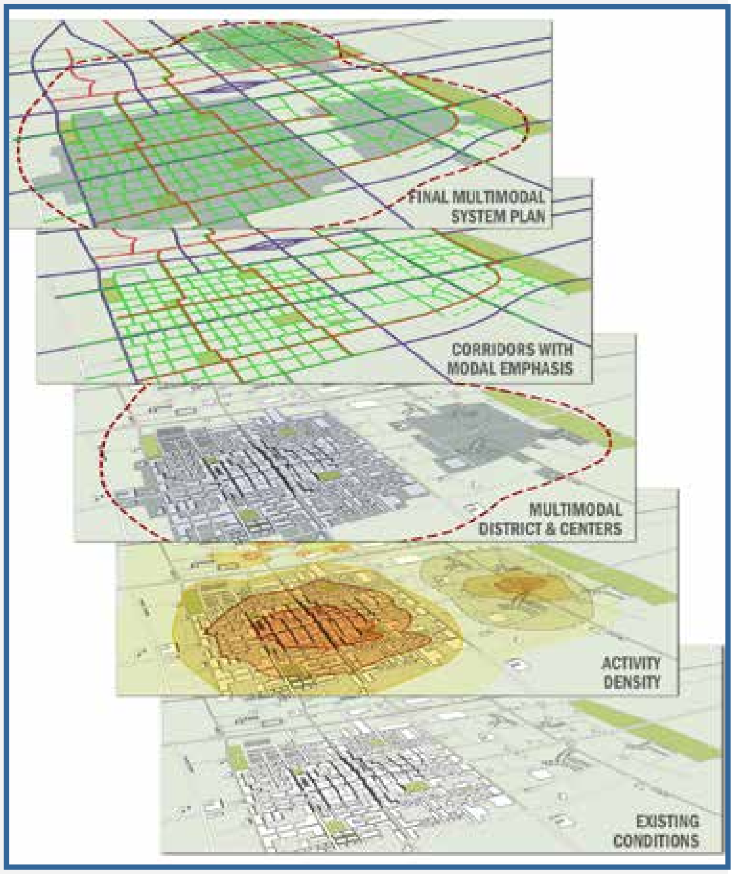


Figure 14: Multimodal System Plan. Diagram showing the overlays of land use and transportation networks by mode that make up a Multimodal System Plan.

The exercise of developing a Multimodal System Plan will quite often highlight any disconnects in a multimodal circulation network, such as potential gaps in a trail network or a need to connect the regional transit plan to the bike or pedestrian plan.

Modal Emphasis

One of the most important concepts in these Guidelines is that of Modal Emphasis. Modal Emphasis is the designation of one or more travel modes that should be emphasized in the design of the cross-section for a corridor. It is important to note, however, that Modal Emphasis does not always mean that other travel modes are excluded; other modes should still be accommodated in a typical Multimodal Corridor to the greatest extent practicable. For example, a corridor that passes through a dense urban downtown that is walkable, bikeable, and has extensive transit service could be designated with Modal Emphases of Pedestrian, Bicycle and Transit. By contrast, a corridor that carries a lot of high-speed auto traffic and premium commuter transit service but few bicyclists and pedestrians could be designated with only a Transit Modal Emphasis, but may still accommodate other modes in some fashion.

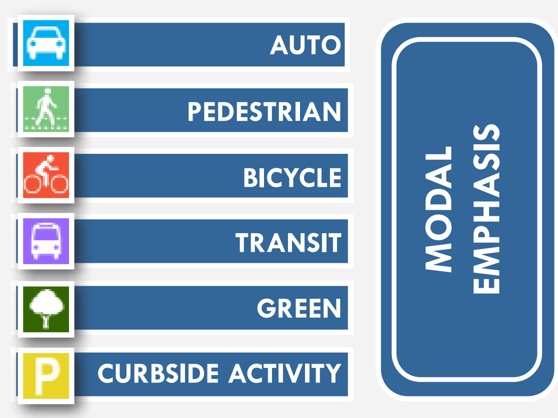
Modal Emphasis means that a travel mode may be emphasized on a corridor through certain design features but that other modes are still accommodated, although not always in an optimal way depending on right-of-way or other constraints. Modal Emphasis is an important technique for looking at travel mode accommodation within a Multimodal System Plan and helps make it clear how continuous the circulation pattern is for each mode in a region. While there may occasionally be cases where some modes are excluded (as in a pedestrian-only street, for example), the basic principle followed in these Guidelines is to accommodate all travel modes within a Multimodal Corridor.

The Modal Emphasis approach adopted in these Guidelines is a Complete Streets approach. It starts with the same principle of accommodating all modes from the Complete Streets perspective. It goes beyond this principle, however, in that it also allows certain modes to go beyond minimum accommodation and be optimized according to the Multimodal System Plan for the region or locality.

What is Modal Emphasis?

Modal Emphasis is the designation of travel mode or modes that should be emphasized in the design of the cross section for a corridor. For example, a corridor that passes through a dense urban downtown that is walkable, bikeable, and has extensive transit service could be designated with a Modal Emphasis of Pedestrian, Bicycle, and Transit, especially if those designations fit with any prior standalone bicycle, pedestrian, or transit plans.

There are six Modal Emphases used in these Guidelines and corridors may carry any combination of these Modal Emphases:



It should be noted that two of the Modal Emphases – Green and Curbside Activity – are not travel modes per se. However, they are included in the consideration of Modal Emphasis because they have a significant impact on roadway cross-section design. For example, a Green Modal Emphasis roadway may need extra right-of-way width to allow for tree planting in the median or along sidewalks, and a roadway with Curbside Activity Modal Emphasis will need to accommodate on-street parking or a flex zone for a variety of pick-up, drop-off, and delivery activities. It should also be noted that accommodations for automobile use are assumed on all corridors unless specifically excluded in rare cases such as a pedestrian-only street.

The Modal Emphasis chosen for a particular corridor should always come from its Modal Emphasis designation on the Multimodal System Plan. In fact, these Guidelines are intended to allow roadway designers and engineers to refer back to the Multimodal System Plan as the basis for deciding how to design any feature of a particular corridor.

The Overview of the Multimodal System Plan later in this chapter describes how Modal Emphasis is used at the regional scale in the development of a Multimodal System Plan. Chapter 5 of these Guidelines discusses how Modal Emphasis is used at the corridor scale to design a multimodal cross-section for a roadway. It is important to understand, however, the critical linkage between these two scales in planning for multimodality.

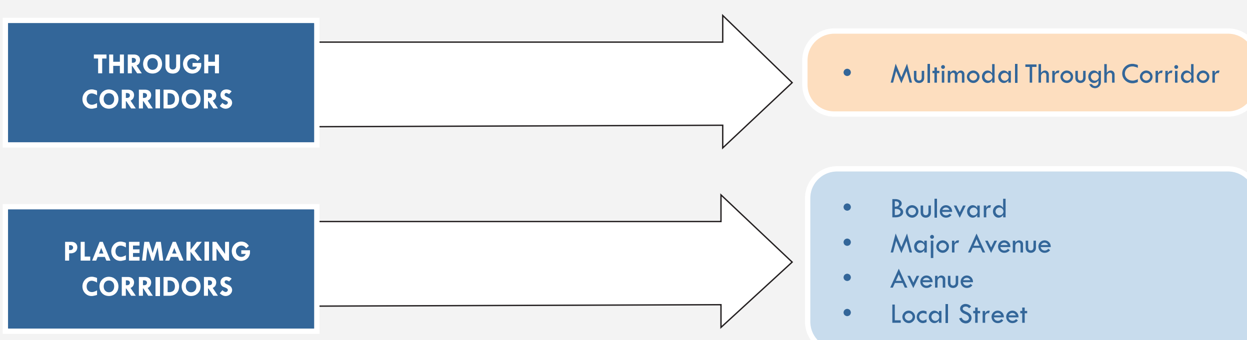
Multimodal Corridors

The prime goal of the Multimodal System Plan is to ensure a connected multimodal transportation network for an area. Multimodal Corridors that move people through a region are the building blocks for such a system. A Multimodal Corridor, as used in these Guidelines, is generally a roadway that accommodates multiple modes (or in special cases a trail or rail right-of-way) and includes all the area within the right-of-way, as well as the adjacent building context zone. As explained previously, a true multimodal transportation system is one where travelers of every mode have a connected network of corridors to move within and between destinations. Without first developing a Multimodal System Plan that identifies connected networks for each travel mode, the design of any individual corridor may lead to disconnected or underused facilities that fail to provide safe and convenient connections for people who bike, walk, and ride transit.

These Guidelines introduce a typology of Multimodal Corridors that is based on overall characteristics such as their general function in a network, their surrounding context and their Modal Emphasis. Chapter 5 of these Guidelines explains how to design and retrofit corridors to best fulfill their multimodal function within the larger regional multimodal transportation system. There are six basic types of Multimodal Corridors used in these Guidelines, divided into two broad categories of corridors – Through Corridors and Placemaking Corridors, as detailed in Chapter 5.

What is a Multimodal Corridor?

A Multimodal Corridor, as used in these Guidelines, is generally a roadway that accommodates multiple modes and includes all of the area within the public right-of-way, as well as the adjacent building context zone.



Corridor Design

Without first developing a Multimodal System Plan that identifies connected networks for each travel mode, the design of any individual corridor may lead to disconnected or underused facilities that fail to provide safe and convenient connections for pedestrians, bicyclists, and transit riders.

Figure 15: Arlington Boulevard in Arlington County. Arlington Boulevard (US 50) near Courthouse Road is an example of a Multimodal Through Corridor that accommodates all travel modes, including bicyclists and pedestrians with shared-use paths on both sides of the road (Image Credit: Bing Maps)

What is a Multimodal District?

A Multimodal District is any portion of a city or region of any size that has good multimodal connectivity – either currently or proposed.

Multimodal Districts and Multimodal Centers

An additional core concept used in these Guidelines is that of Multimodal Districts and Multimodal Centers. A Multimodal District is any portion of a city or region of any size that has good multimodal connectivity – either currently or proposed in the future. Multimodal connectivity in this context means the relative ease of making trips without needing access to a car and can be gauged by metrics such as the number of bus routes or safe walking or biking paths available. In addition, Multimodal Districts have land use characteristics that support multimodal travel, such as higher densities and mixed uses.

Much of the developed portions of Richmond, Norfolk, or Alexandria, for example can be considered as a series of Multimodal Districts. Multimodal Districts can be quite extensive, and because of their size, they can be further broken down into specific Multimodal Centers.

Unlike Multimodal Districts, Multimodal Centers are much smaller areas of even higher multimodal connectivity and more intense activity, roughly equivalent to a 10-minute walkshed, which can be approximated by a one-mile diameter circle. This 10-minute walkshed is a general rule of thumb in planning practice for the

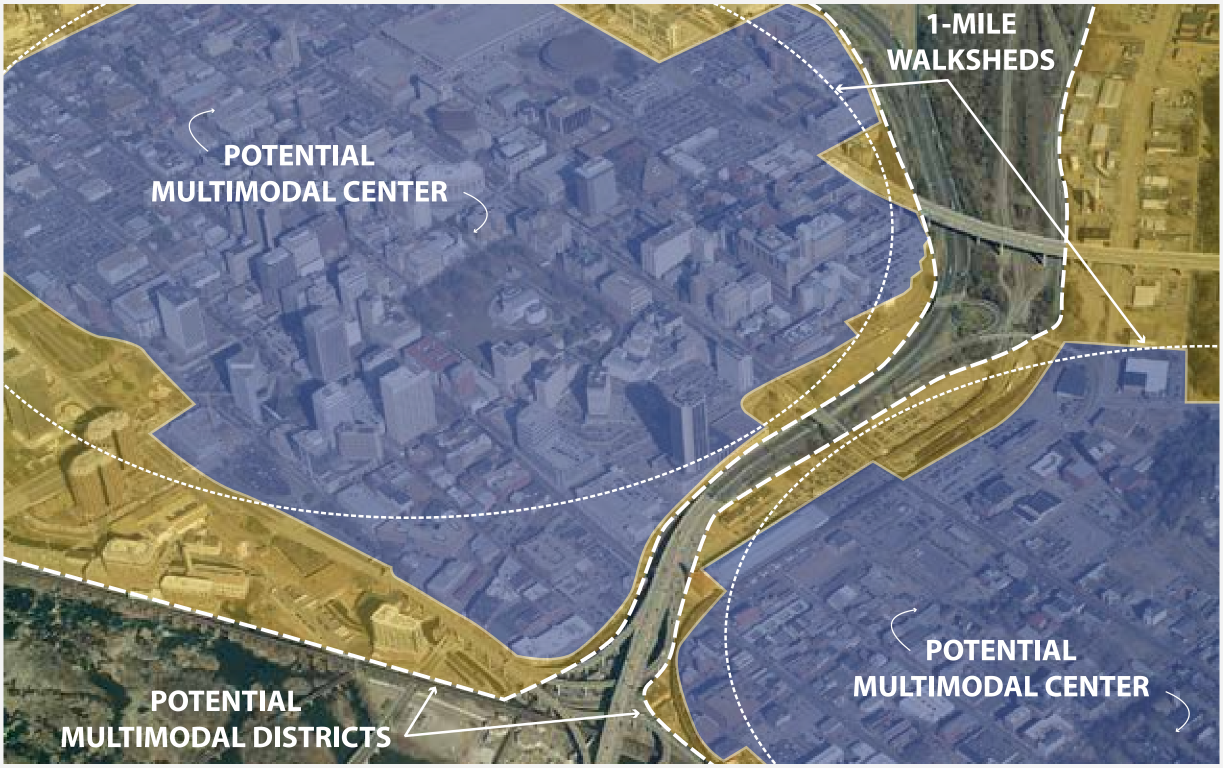


Figure 16: Aerial view of Richmond. Potential Multimodal Districts and Centers illustrated in Downtown Richmond.

maximum area that people will practically access by walking in the course of daily activities. Multimodal Center boundaries in practice may vary from this shape, in order to conform to existing walkable districts or to avoid barriers such as rivers or high-speed highways. Multimodal Districts can be quite large – for example, large sections of a city can be defined as a Multimodal District. However, Multimodal Centers are much smaller areas defined by a walkshed that can serve as a primary focus for providing more multimodal connectivity and higher density development. Multimodal Centers are also often centered on a key local destination, such as a transit stop or key intersection within a downtown that is also a local center of development intensity, population and/or employment. There are seven types of Multimodal Centers used in these Guidelines, ranging on a scale from dense urban to low intensity rural centers:

P-6	Urban Core
P-5	Urban Center
P-4	Large Town or Suburban Center
P-3	Medium Town or Suburban Center
P-2	Small Town or Suburban Center
P-1	Rural or Village Center
SP	Special Purpose Center

These Multimodal Center types are further explained and illustrated in Chapter 3 of these Guidelines. Designating Multimodal Districts and Multimodal Centers in a region helps to identify priority locations for focusing multimodal connectivity improvements where they can potentially create the most public benefit.

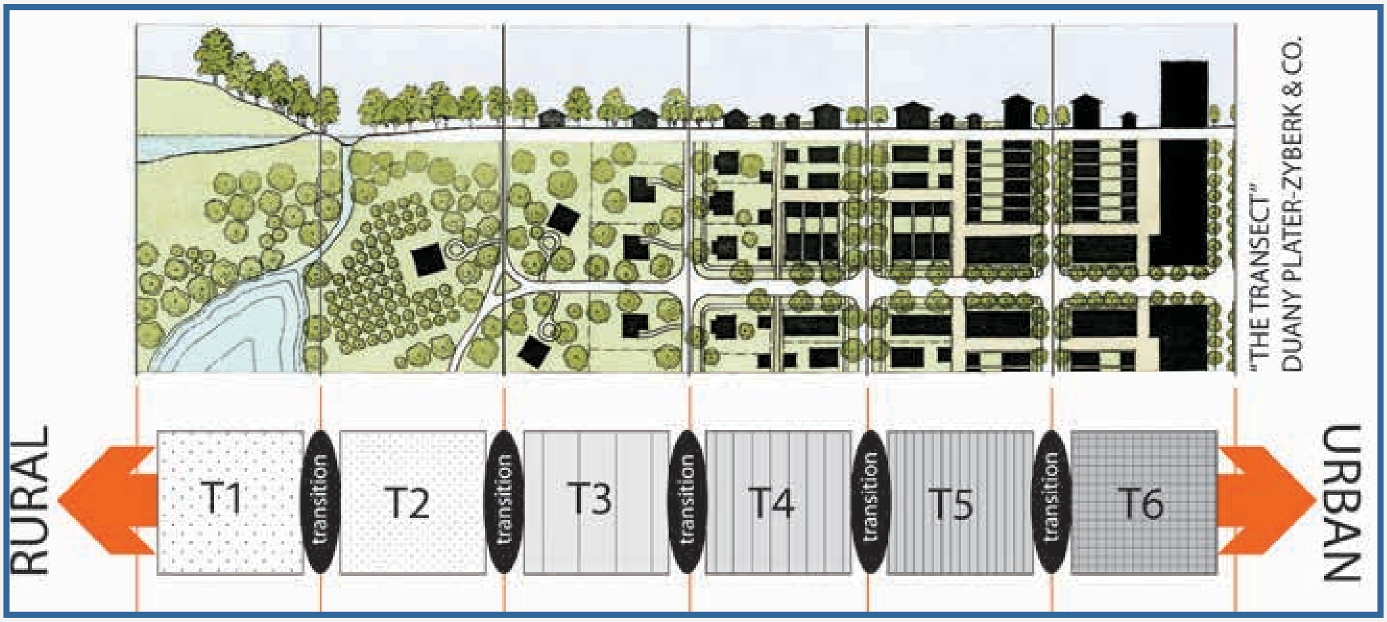


Figure 17: The Transect Diagram. The Transect describes the range of natural and built environments across a spectrum of density. Places can be classified into one of the six different Transect Zones or "T-Zones" depending on the density or intensity of the land uses in an area.

The Transect and Activity Density

The final core concepts used in these Guidelines are those of the Transect and Activity Density. Activity Density is simply a way to combine the density of existing or future population and jobs in an area to allow them to be classified more simply. Activity Density for an area is the sum of people and jobs in the area divided by the acreage, yielding a total density of jobs plus people per acre. The Transect is a relatively common way of describing density and intensity of development in the urban planning profession.

The Transect is a way to describe the range of natural and built environments from the countryside to the center of the city as a set of bands of uniform density called Transect Zones or "T-Zones." Each T-Zone defines a consistent scale of density and intensity of development and the whole complement of streets, buildings and open space that goes along with that level of intensity. In Chapter 3 of these Guidelines, a standard table of T-Zone densities is defined for all of Virginia using Activity Densities. This table of Transect Zone densities and typical characteristics was developed through an analysis of real Virginia places, ranging from large urban downtowns to rural village centers. Throughout these Guidelines, this system of Transect densities has been used to define the types and surrounding contexts of both Multimodal Centers and Multimodal Corridors. The Activity Densities for each Transect Zone can reflect either existing or future densities, although typically, future, planned densities should be considered in the development of a Multimodal System Plan.

The Transect

Throughout these Guidelines, this system of Transect densities has been used to define the types and surrounding contexts of both Multimodal Centers and Corridors.

Overview of the Multimodal System Plan

The previous sections of this chapter introduced the key concepts and definitions used in these Guidelines. As noted, all of these concepts are integral to the development of a Multimodal System Plan, which is the basic foundation for the whole planning methodology used in these Guidelines. The following is an outline of how to develop a Multimodal System Plan at a regional scale. The methodology is described through a case study of a hypothetical region in Virginia. The case study represents a range of land use contexts, from rural to urban, and can serve as a sample of conditions found statewide as an introduction on how to develop a Multimodal System Plan.

As mentioned previously, the goal of a Multimodal System Plan approach is to link together prime destinations and areas of activity in a region in order to make both the places and their connections safer, and more accessible and provide a wider array of travel choices for the population. There are a few basic steps in designing a Multimodal System Plan that incorporate all of the separate aspects of these Guidelines – Multimodal Corridors, Multimodal Centers, and Modal Emphasis - into a unified whole. The process chart in Figure 18 shows the general approach for developing a Multimodal System Plan.

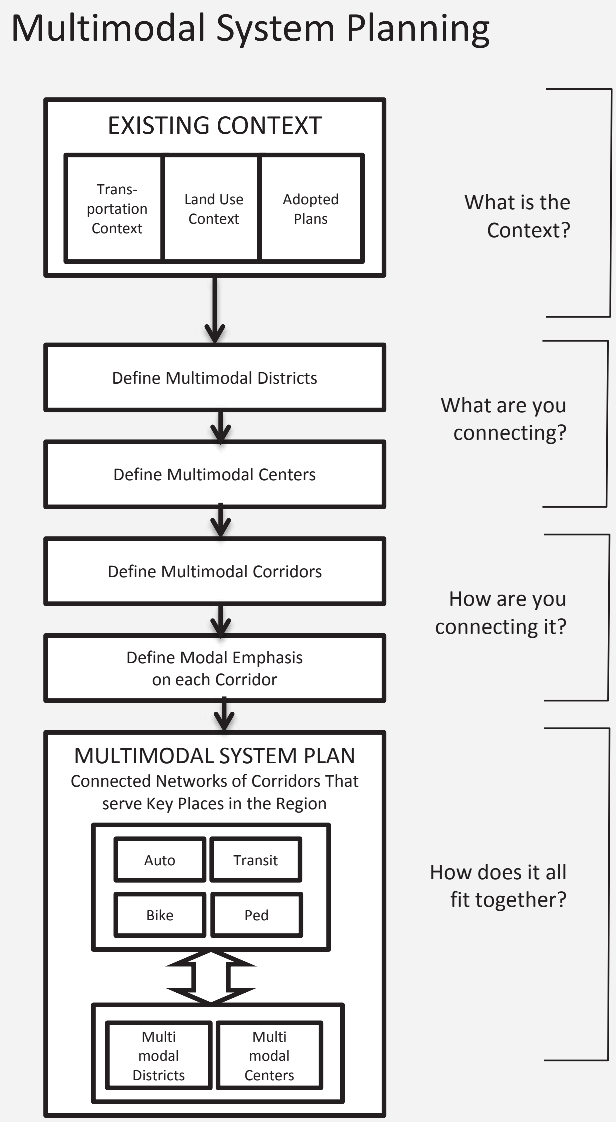


Figure 18: The Recommended Planning Process for a Multimodal System Plan.

Step 1 – Ensuring Public Engagement and Ongoing Input

A Multimodal System Plan is ultimately designed for the public, and as such, should reflect the perceptions, opinions, and concerns of the public served by the plan. The public should be factored into the creation of the plan, and the plan should clearly address existing issues that have been identified by the public, policy makers, and leaders in the area. Key destinations in a region should be identified through a public process as well as by measurable analysis, and destinations such as schools, universities, hospitals, and job centers can play a key role in the designation of Multimodal Districts, due to their land use and high potential accessibility via transit, pedestrian, and bicycle modes.

Figure 19: Public Process. Public Involvement for multimodal planning can often involve workshops with interactive exercises and activities.

Effective public involvement tools that can be used during the development of a Multimodal System Plan can include community surveys, place-making field trips, sidewalk inventories and assessments, and focus groups. As with any public planning process, the first steps should involve broadly engaging the public and stakeholders in a project, and that involvement should be maintained through the analysis, visioning, and design and planning phases. Although this document is not intended to address the entire public involvement process or the general details of the planning process for a regional transportation plan, some best practices for the initial stages of project initiation include:

- Early and continual involvement of the public and stakeholders in the project in meaningful ways through interactive meetings, and various traditional and innovative means to get continual input
- Active outreach to stakeholders, particularly people who travel by modes other than or in addition to personal vehicles – ensuring participation by people who walk, ride a bicycle, or take transit occasionally for unusual trips, for commute travel to work, or for a variety of trips including regular errands, as well as outreach to minority and underserved populations.
- Equal outreach to, and representation of, all stakeholders in the planning process.
- Clear information and education about the agency and jurisdictional roles and constraints within the process, including funding constraints, legal constraints, and obligations.

Step 2 – Analyzing Existing and Future Population and Employment

The analysis phase of a Multimodal System Plan can be quite complex and involve a variety of transportation, land use, safety, economic, demographic, and many other types of data collection. The particular aspects of this data collection and analysis from a multimodal perspective include elements such as:

- A clear picture of the regional trends for growth and land use change in the planning time horizon.
- The current and future relationships between land uses and the transportation system.
- Anticipated travel trends and growth of travel by various modes.
- The key areas of activity and destinations in the region that serve as focal points for future growth or existing activity and prime locations for generating multimodal trips, either now or in the future.
- The role of thoroughfares in the network and their current and anticipated future Modal Emphases.

From this type of data, a picture can be assembled of the future patterns of transportation and land use in the region. This is the core information needed to build a Multimodal System Plan, so that future networks can be designed to better accommodate all users and modes in a region in a connected manner. A series of maps in Figures 20 through 27 show a simplified analysis of the broad land use and transportation systems for a hypothetical region. An actual planning process would involve many more steps and varieties of data than is shown in these graphics, but the sequence of illustrations shows a basic analysis of the existing and future land use intensity and the future networks by travel mode.

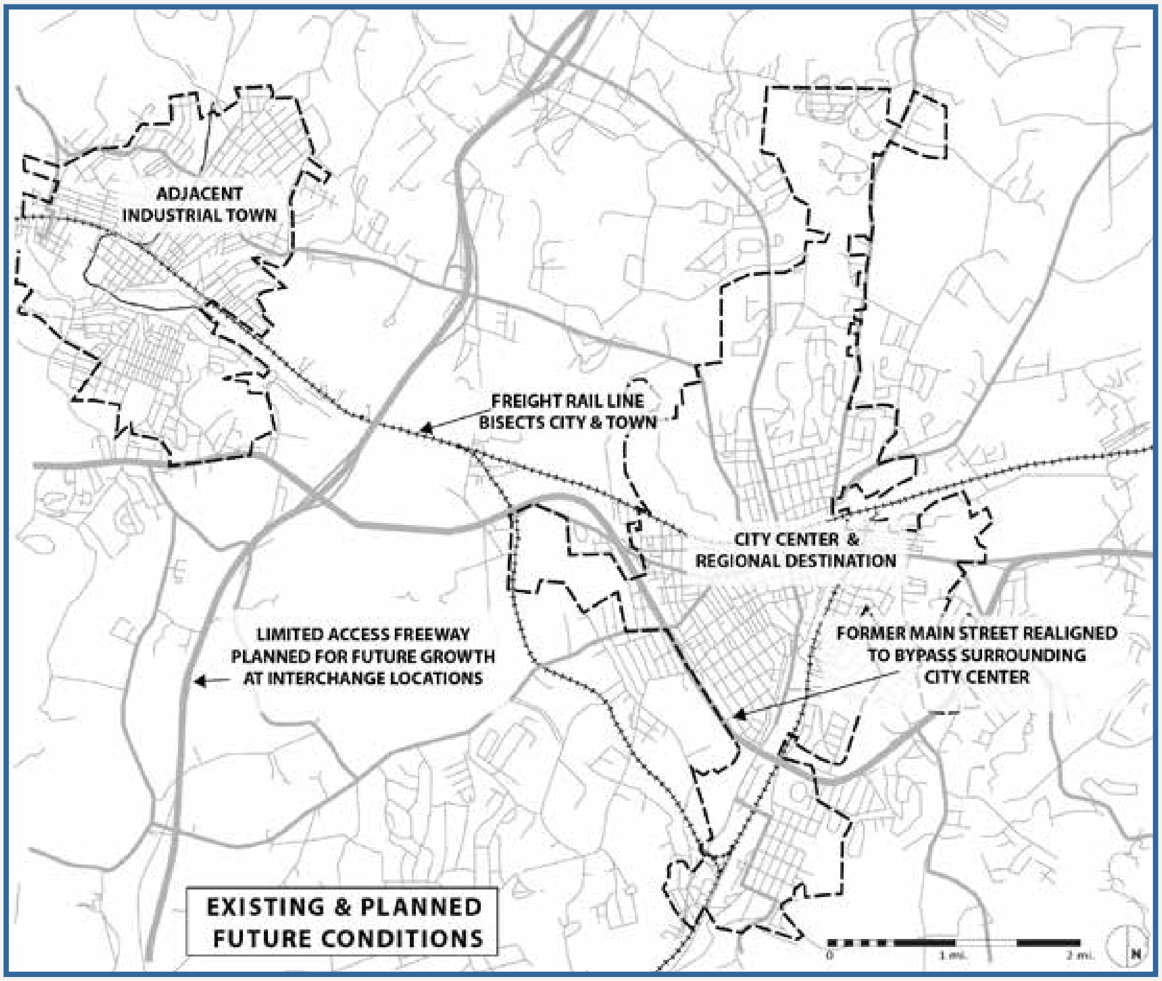


Figure 20: Hypothetical Region Map. A hypothetical region showing a historic city center, surrounding suburban and rural areas and an adjacent industrial town.

Once the data for a region is assembled, one of the key analyses that should be performed is mapping the pattern of existing and anticipated future regional population and employment density and intensity. The data for this analysis typically comes from several sources, including local comprehensive plans and prior regional plans and studies, population and employment projections[2] and recently approved or proposed development projects.

The data for this analysis of the pattern of regional population and employment density and intensity. The data for this analysis typically comes from several sources, including local comprehensive plans and prior regional plans and studies, population and Employment projections[9] and recently approved or proposed development projects.

[2] In Virginia, standard population projections are done by the Virginia Employment Commission for cities and counties. Employment projections can be estimated using several private sources, such as Woods and Poole and ESRI Business Data.

Figure 21 shows the first step in this analysis – to summarize existing and future population and employment density in terms of a simple gradient of Activity Densities using the Transect Zones. Chapter 3 describes the specific metrics of Activity Density by Transect Zone in greater detail. Note that Figure 21 combines population and employment as total Activity Density. This is useful for very general and large-scale transportation planning purposes as it aggregates any kind of trip-generating activity into a single measure. Note also that future Activity Density is included in the analysis along with existing Activity Density. Projections for future population and employment are usually available in a locality's comprehensive plan or future land use plan and it is important to include these in any type of analysis for a Multimodal System Plan.

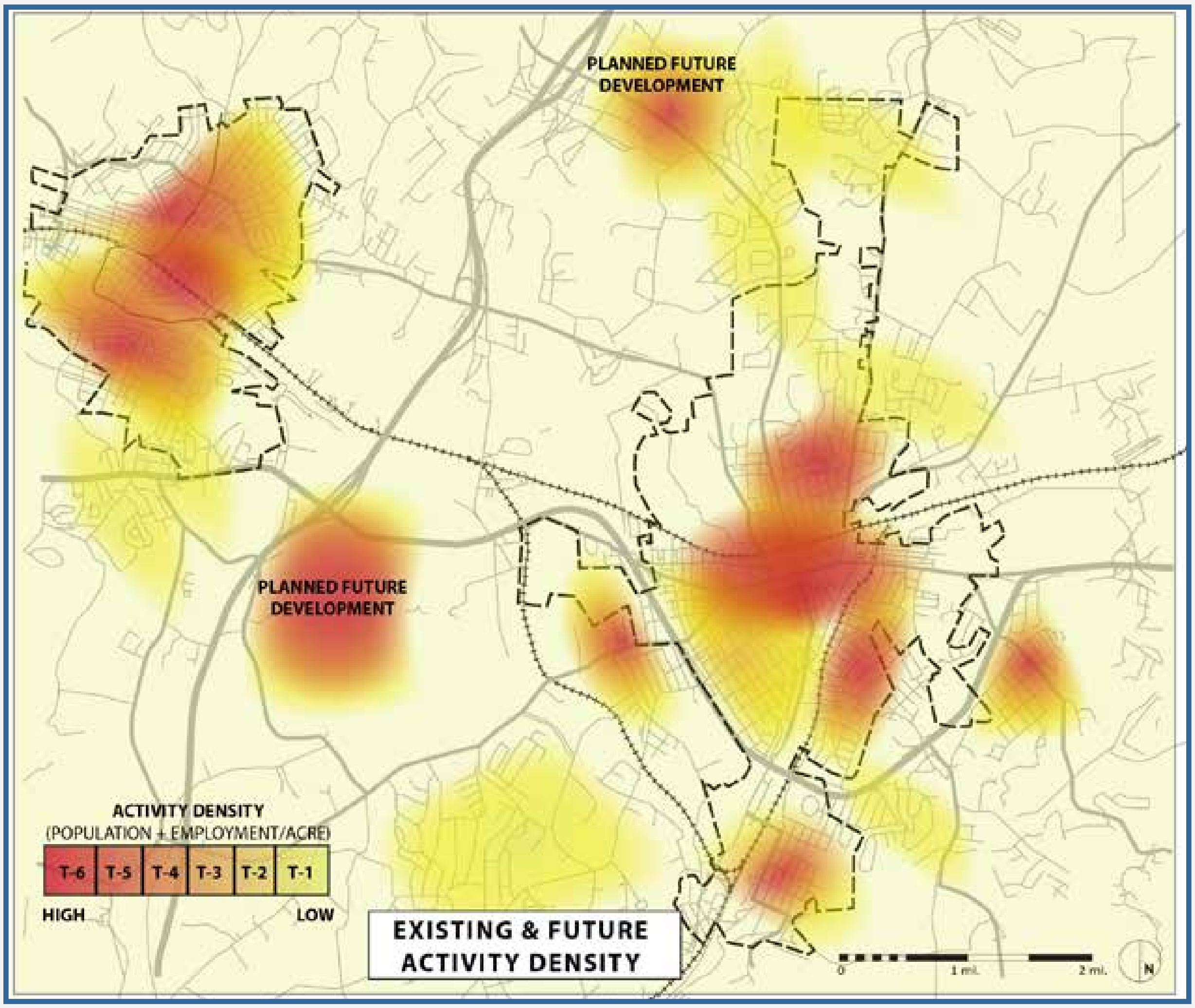


Figure 21: Existing and Future Activity Density. This map shows a simple "heat map" of the relative density of jobs and population in the region.

Step 3 – Designating Multimodal Districts and Centers

The analysis from Step 2 will yield a very broad picture of existing and future population and employment in a region. The next step in building a Multimodal System Plan is to take the already identified future growth pattern and use it to designate potential Multimodal Districts based on both existing and future development.

Multimodal Districts are generally broad swaths of land area designated by a locality or region to have at least a moderate level of multimodal connectivity[3], either now or in the future. Multimodal Districts are typically areas having moderate to high Activity Density, and they may overlap with areas defined by local policy documents as urban growth boundaries, service districts, mixed use neighborhoods, etc.

As shown in Figure 22, areas with the highest Activity Density form the basis for the Multimodal Districts in the hypothetical example (areas outlined with dashed red lines). However, the designation of Multimodal Districts should look beyond just Activity Density and also take into account those areas that have or will have in the future a combination of high density, good travel options and well-connected street grids. These factors are also important to consider when defining those areas of the region that should form part of an interconnected system of Multimodal Districts in the future.

In cases where a detailed plan of existing and future growth areas is lacking, an approximation of existing and future growth can be made based on existing population and employment data and the combined comprehensive plans in all the localities in the region. In most cases, however, the MPO or PDC will have compiled local land use projections and will have a summary of future growth, based on policy designations in local comprehensive plans, that can be used as the basis for determining potential Multimodal Districts.

From this basic framework of Multimodal Districts, a series of Multimodal Centers can be developed within each Multimodal District, based on walkable neighborhoods and transit linkages.

[3] Multimodal connectivity describes the relative ease of making trips without needing access to a car, and can be gauged by a variety of metrics, including the number of transit options and safe walking and biking paths available. Areas with low multimodal connectivity have very few if any transit options, may lack connected sidewalks, crosswalks, and facilities for bicyclists, and are typically auto-oriented. In areas with moderate or high multimodal connectivity, multimodal transportation options may exist, but there may still be some gaps, and some trips may require a car. The ITE/CNU Guidebook Designing Walkable Urban Thoroughfares: A Context Sensitive Approach explains the concept of network connectivity and provides various indices and targets for desirable connectivity (see Chapter 3 in the ITE/CNU Guidebook).

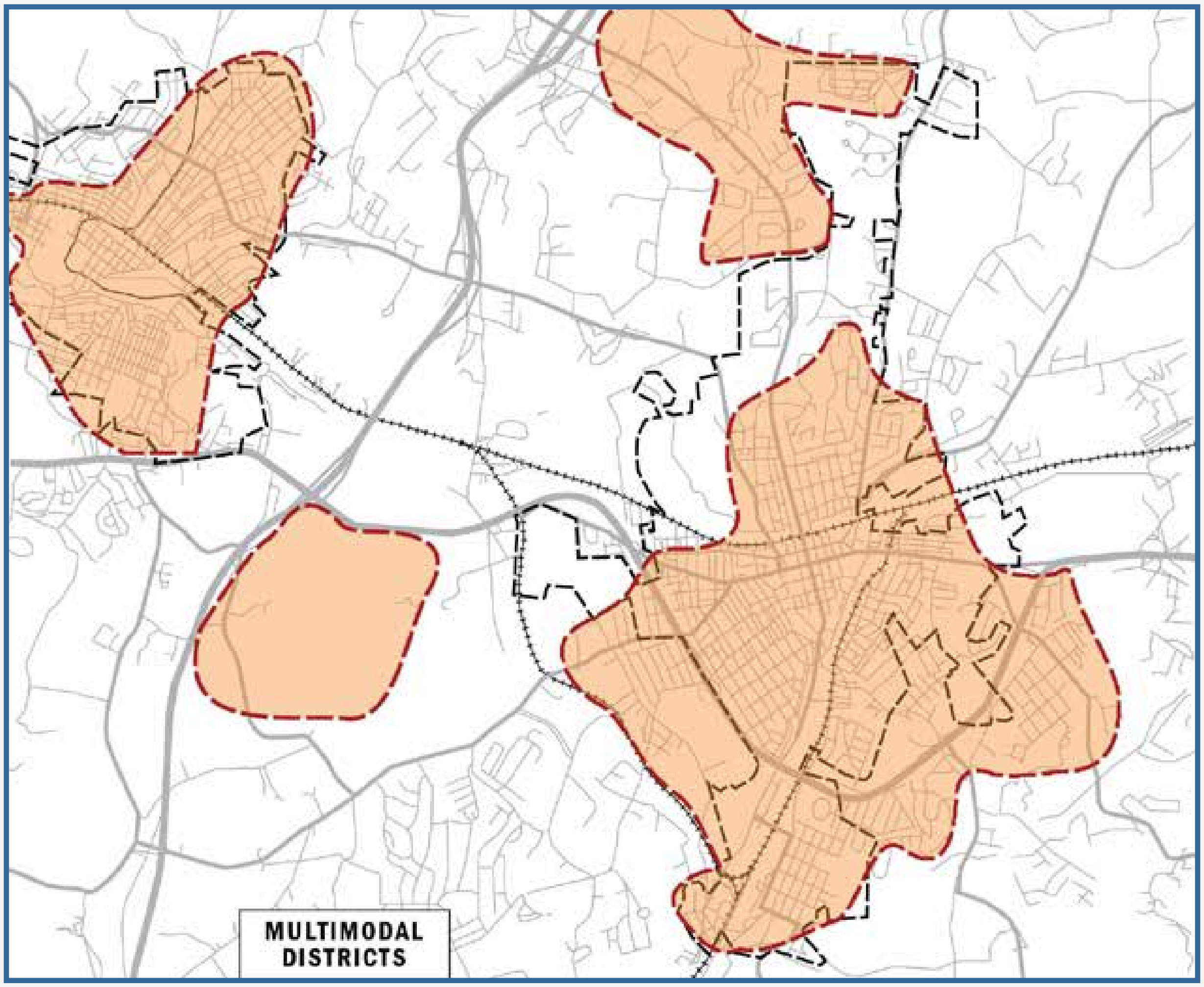


Figure 22: Potential Multimodal Districts. Map showing areas that are identified as future Multimodal Districts based on their high activity density and good potential multimodal connectivity - either existing or planned.

Step 4 – Designating Multimodal Centers

The next step in the planning process is to look closer at each Multimodal District and define the future Multimodal Centers. Whereas a Multimodal District can be defined as the broader areas having, either now or in the future, a moderate level of multimodal connectivity with good multimodal characteristics such as high density and a closely spaced walkable street network; a Multimodal Center is a smaller area of high multimodal connectivity and more intense activity, roughly equivalent to a 10-minute walk-shed, which can be approximated by a one-mile diameter circle. This 10-minute walk-shed forms the nucleus for activities and destinations within easy walking distance. It is this close proximity of destinations and lack of barriers (such as rivers or high speed highways) that makes walking a viable form of transportation for most trips, and thus leads to high levels of multimodal connectivity.

Figure 23 illustrates the difference between a Multimodal Center and a Multimodal District in Ballston, Virginia.

As shown in Figure 24, the one-mile diameter circles are used to approximate the locations of potential Multimodal Centers within each Multimodal District. Then, in Figure 25, these one-mile circles are morphed into more organic-looking shapes as they are modified by natural or man-made barriers, or by parcel-level designation on local governments' future land use maps and zoning codes. Despite these modifications, the organic-looking shapes of Multimodal Centers should roughly retain the general scale of the one-mile walkshed. This translation is discussed in more detail in Chapter 7.

The specific types of Multimodal Centers and their characteristics will be discussed in Chapter 3 and will also be used to determine the Multimodal Corridor types in the detailed design of corridors. Figure 25 does not show how the Multimodal Centers in this hypothetical region can be classified based on the typology of Multimodal Centers used in these Guidelines. The designation of these types of Multimodal Centers, however, is discussed in more detail in Chapter 3.

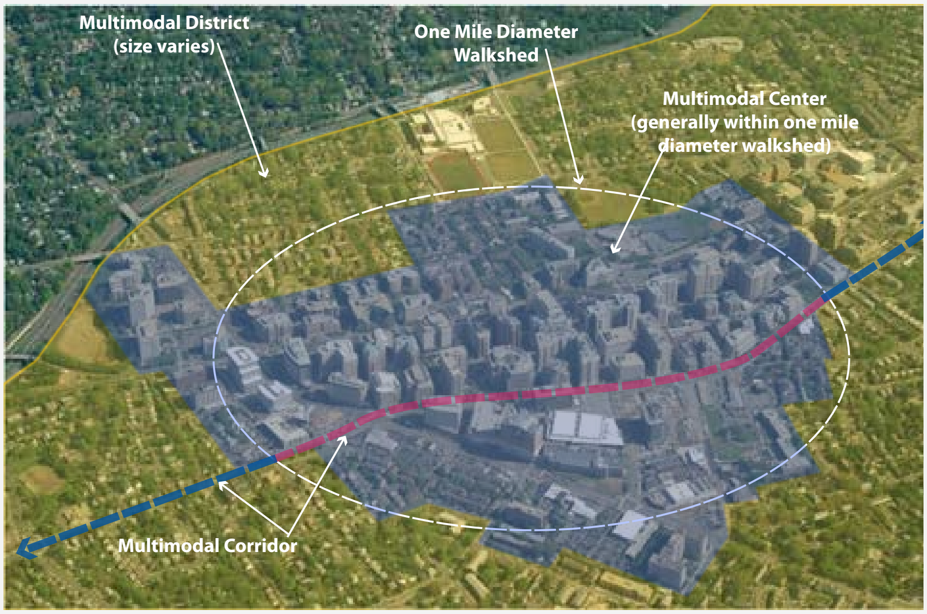


Figure 23: The Difference between Multimodal Districts and Centers as illustrated in Ballston, Virginia.

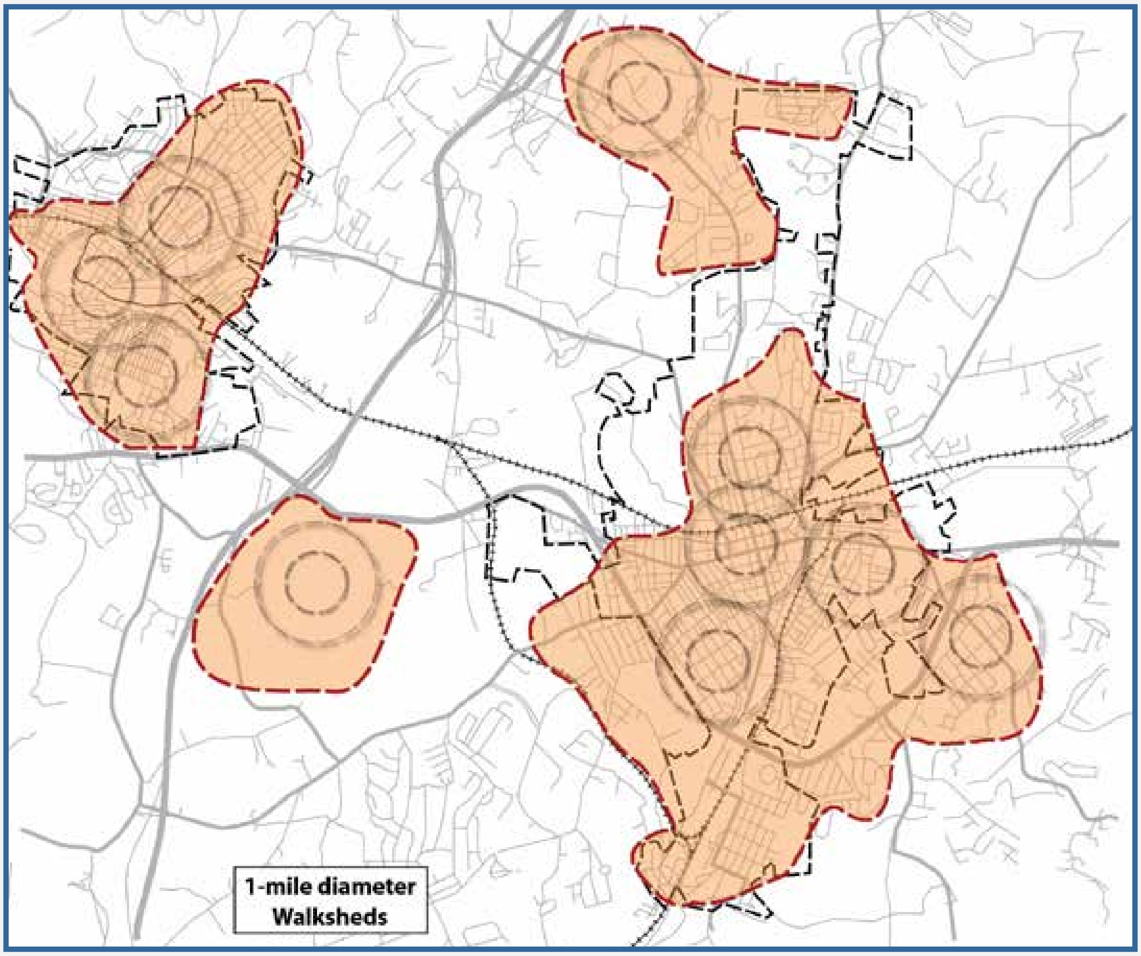


Figure 24: One-Mile Walksheds within each Multimodal District. Multimodal Centers are smaller areas within each Multimodal District that are generally described within a one-mile walkshed. The inner circle has a quarter-mile radius, and the outer circle has a half-mile radius. The one-mile diameter walkshed approximates a 10-minute walk from the outer edge to the center point."

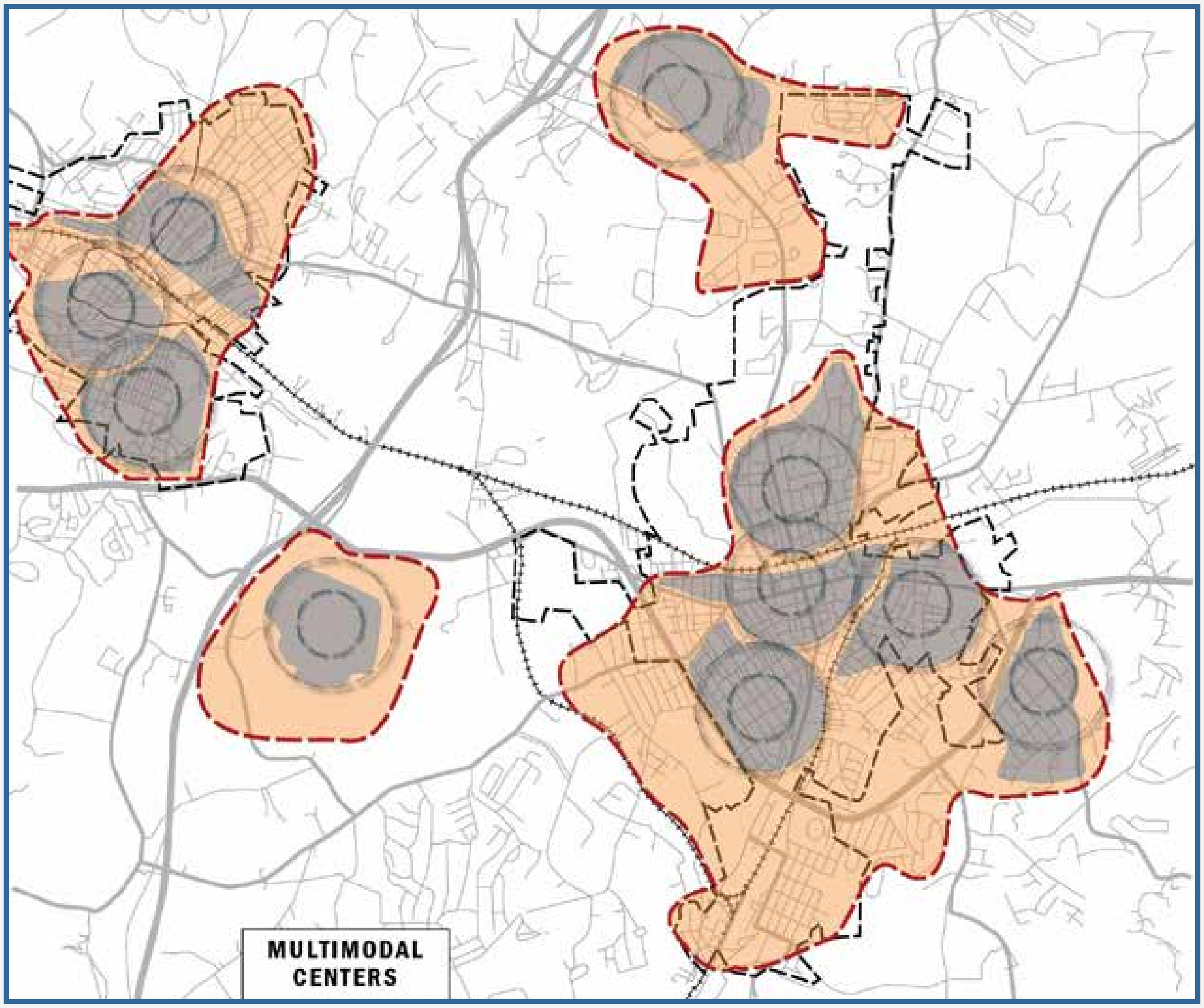


Figure 25: Multimodal Centers within each Multimodal District. Multimodal Centers are areas of highest multimodal connectivity and have a mix of uses and close proximity of destinations such that most trips can be made by walking. Multimodal Centers are designated roughly according to one-mile diameter circles, but morphed to fit actual conditions and barriers to connectivity such as rivers or high speed highways.

Step 5 – Designating Multimodal Corridors

The previous steps established the basic designation of Multimodal Districts and Multimodal Centers in the Multimodal System Plan. These are the key areas that need moderate and high levels of multimodal connectivity within the region's transportation system. The next step in the analysis is to look at existing and future transportation networks in the region. The series of maps in Figure 26 shows the primary transportation networks for the region by mode, including transit, bicycle, and pedestrian (auto mode is assumed on all networks in this case). These maps serve as the basis for determining the Modal Emphasis of each corridor. Each of these modal networks is shown on a separate map along with the Multimodal Centers for reference.

These modal networks represent the long-range proposed networks, and not just the existing networks. Ideally, localities or regions have already identified these networks either through their comprehensive planning process or through specific modal plans, such as a Regional Pedestrian Plan, a Regional Bicycle or Greenway Trails Plan, and a Regional Transit Plan or Transit Development Plan. If localities have not developed similar plans, the Multimodal System Planning Process is an opportunity to identify which corridors could provide the best connections for each travel mode to the various destinations throughout a region.

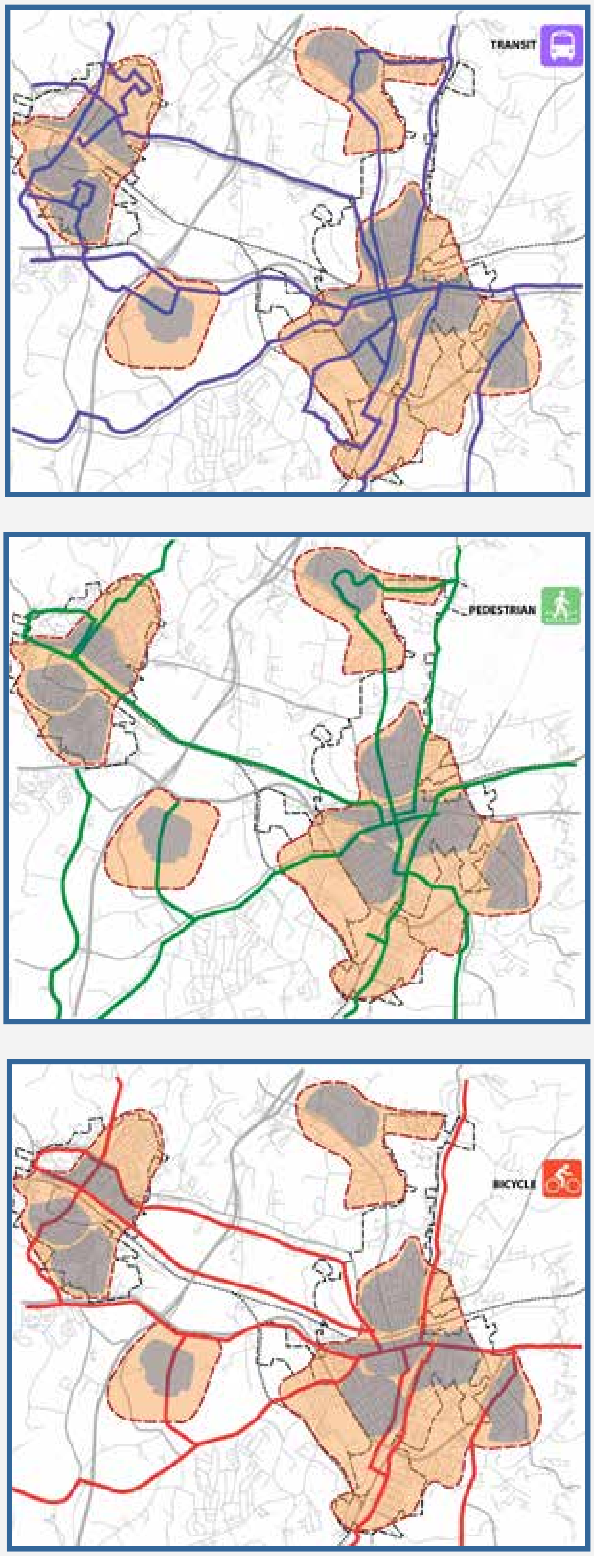


Figure 26: Modal Networks. These maps show the networks for each mode – Transit, Pedestrian, and Bicycle.

After assembling the mapping of all the modal networks, it is important to look for any gaps or discontinuity in each network, as well as to look for opportunities to connect the gaps in the networks in order to develop more connected circulation systems in the region. These gaps can be identified and addressed as part of the process of developing a Multimodal System Plan.

These Multimodal Corridors and modal networks represent the heart of the Multimodal System Plan. However, there are other critical components of a truly multimodal regional transportation system that are not addressed in great detail in these Guidelines. High-Occupancy Vehicle (HOV) facilities in major metropolitan areas are also important to encourage people to travel by modes other than driving alone. Connectivity is crucial in an HOV network. Providing direct connections to high capacity transit, such as HOV-only ramps to park-and-ride facilities for Metrorail further encourages residents to use transit for daily transportation needs. Taxicabs and mobile app-based ride-hailing services also provide critical links in the multimodal system, especially at train, bus, and light rail transit stations, and have the potential to partner with transit agencies to provide human services transportation. In addition, providing access for non-auto modes and for transit to water-based transportation facilities is essential for linking destinations in areas like Hampton Roads.

The next step in the transportation analysis is to assemble all of the modal networks onto one map, to show each network as part of a whole multimodal system. Figure 27 shows all of the modal networks from Figure 26 overlaid onto one map, along with the Multimodal Centers.

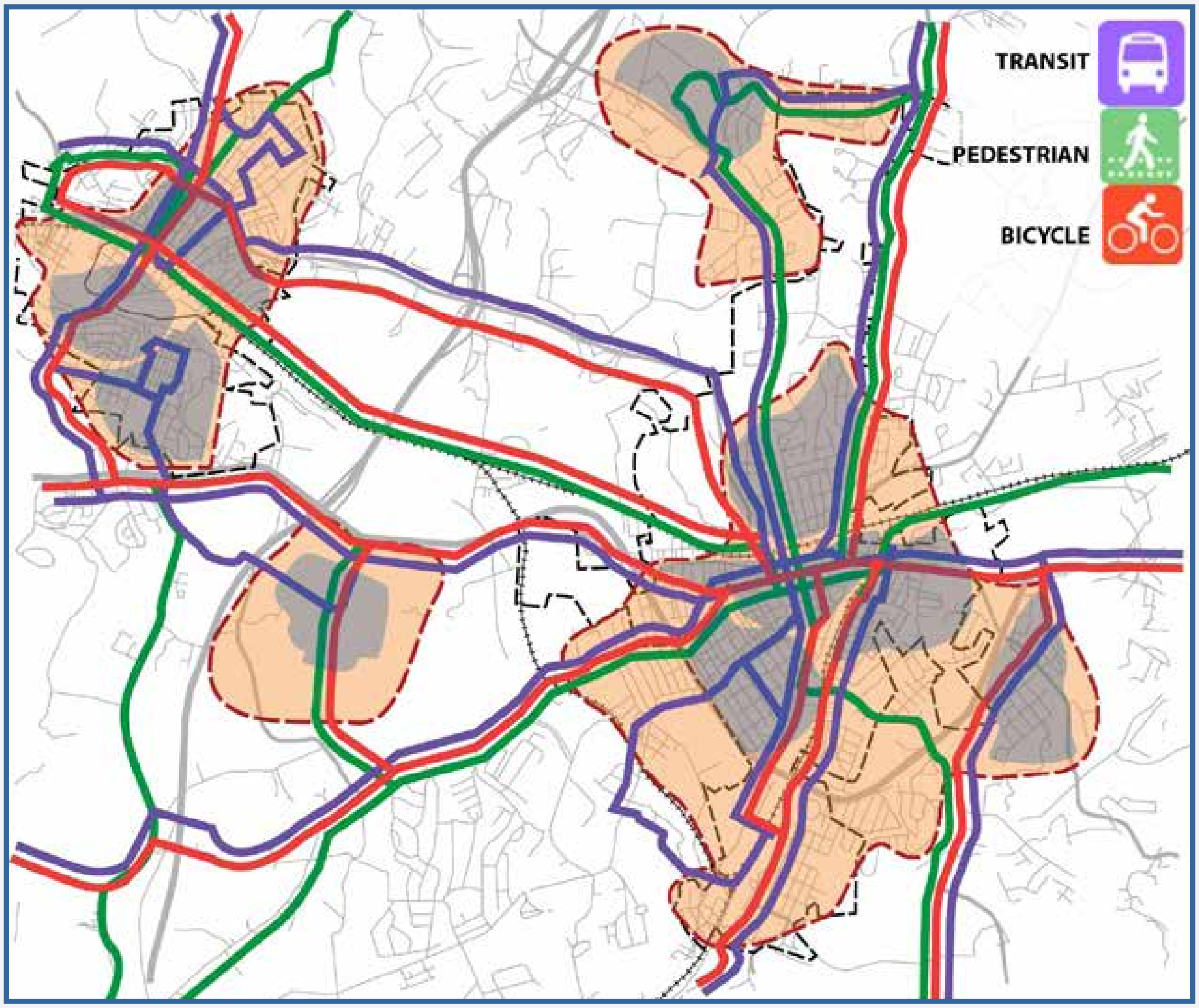


Figure 27: Multimodal Corridors with Modal Emphasis. The modal networks have been assembled onto one map and define the Modal Emphasis for each corridor.

By assembling all the modal networks onto one map, the Modal Emphasis for each of the major corridors has been identified.[4] To be clear, Modal Emphasis only defines the modes that are given particular emphasis in the design of a cross section – each Multimodal Corridor can still accommodate all modes regardless of its Modal Emphasis. Figure 27 identifies each corridor's Modal Emphases. It does not, however, identify the Multimodal Corridor Types. More discussion of the Multimodal Corridor typology and designations is in Chapter 5 of these Guidelines.

[4] Note that Green and Curbside Activity Modal Emphases are not designated at this scale. These Modal Emphases are typically designated at a closer scale, either through a small area plan for a Multimodal District or Multimodal Center, or incorporated in the corridor design phase. In addition, more detailed pedestrian and bicycle Modal Emphases for local streets are not shown at this scale but should be shown in a more detailed scale of the Multimodal System Plan.

Step 6 – The Final Multimodal System Plan

The final step in developing a Multimodal System Plan is to put everything together on a single map. The Multimodal System Plan should show the Multimodal Centers by type, the Multimodal Corridors by type and the Modal Emphasis for each corridor. As this is a complicated map for a whole region, Figure 21 shows a detail of what this would look like in one of the Multimodal Centers. It shows several Multimodal Through Corridors and a Major Avenue serving a Multimodal Center. Figure 29 shows a similar example superimposed on an aerial view of Downtown Roanoke. As mentioned, a more detailed explanation of the typologies of Multimodal Centers and Multimodal Corridors is given in Chapters 3 and 5 of these Guidelines. a more detailed explanation of the typologies of Multimodal Centers and Multimodal Corridors is given in Chapters 3 and 5 of these Guidelines.

The designation of Multimodal Corridors and Modal Emphasis through the Multimodal System planning process is not a substitute for developing more detailed modal plans. Regional bicycle plans, for example, often specify which particular types of facilities (on-road bike lanes, off-road paved trails, etc.) would be best for each corridor. Similarly, transit development plans often require in-depth studies on separate right-of-way configurations and anticipated funding sources. The designation of Multimodal Corridors and Modal Emphasis in the Multimodal System Planning Process does not need to go into this much detail, but localities and regions should develop these more specific modal plans to better assess the feasibility and options for implementing these networks.

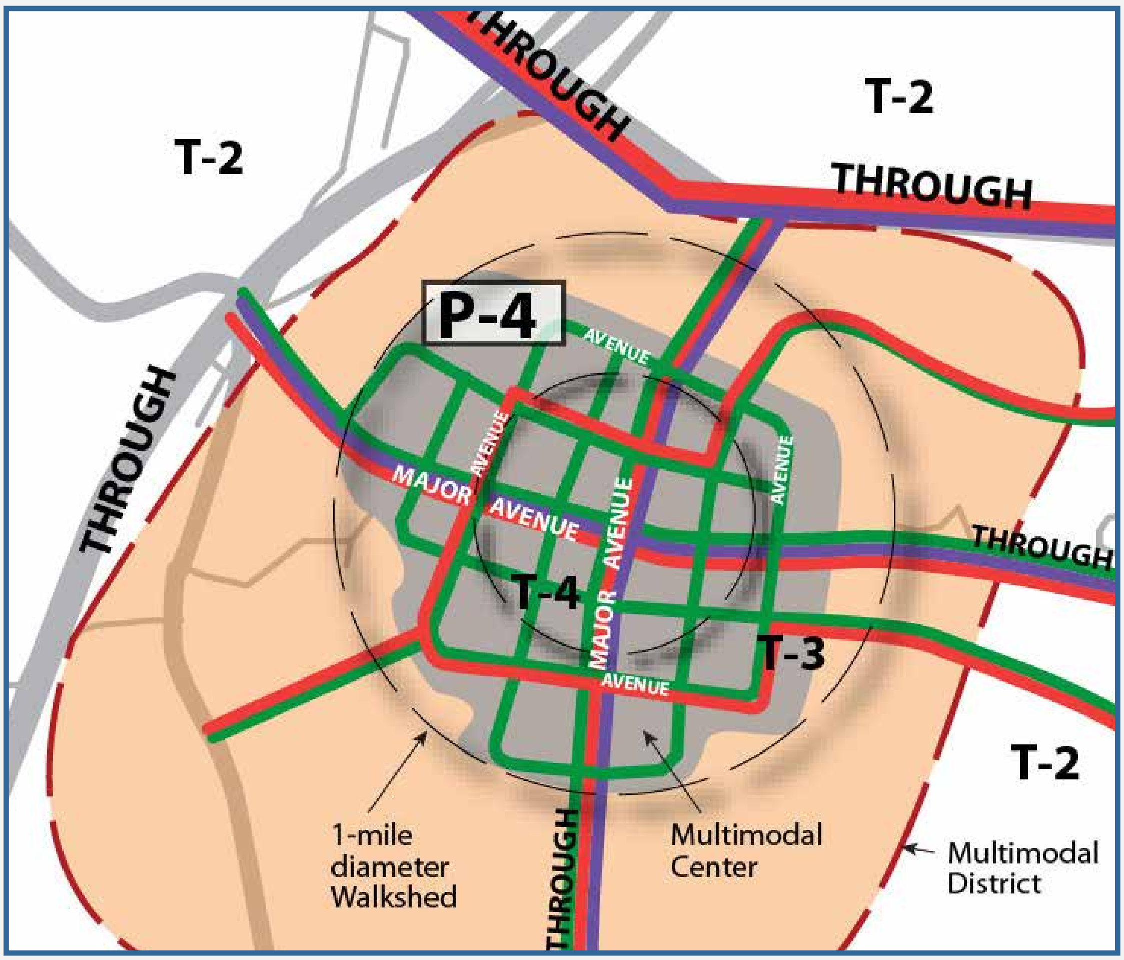


Figure 28: Detail of a Final Multimodal System Plan. This map shows how a Multimodal Center and Multimodal Corridors are designated according to the Multimodal Center types and Multimodal Corridor types described in Chapters 3 and 5 of these Guidelines.

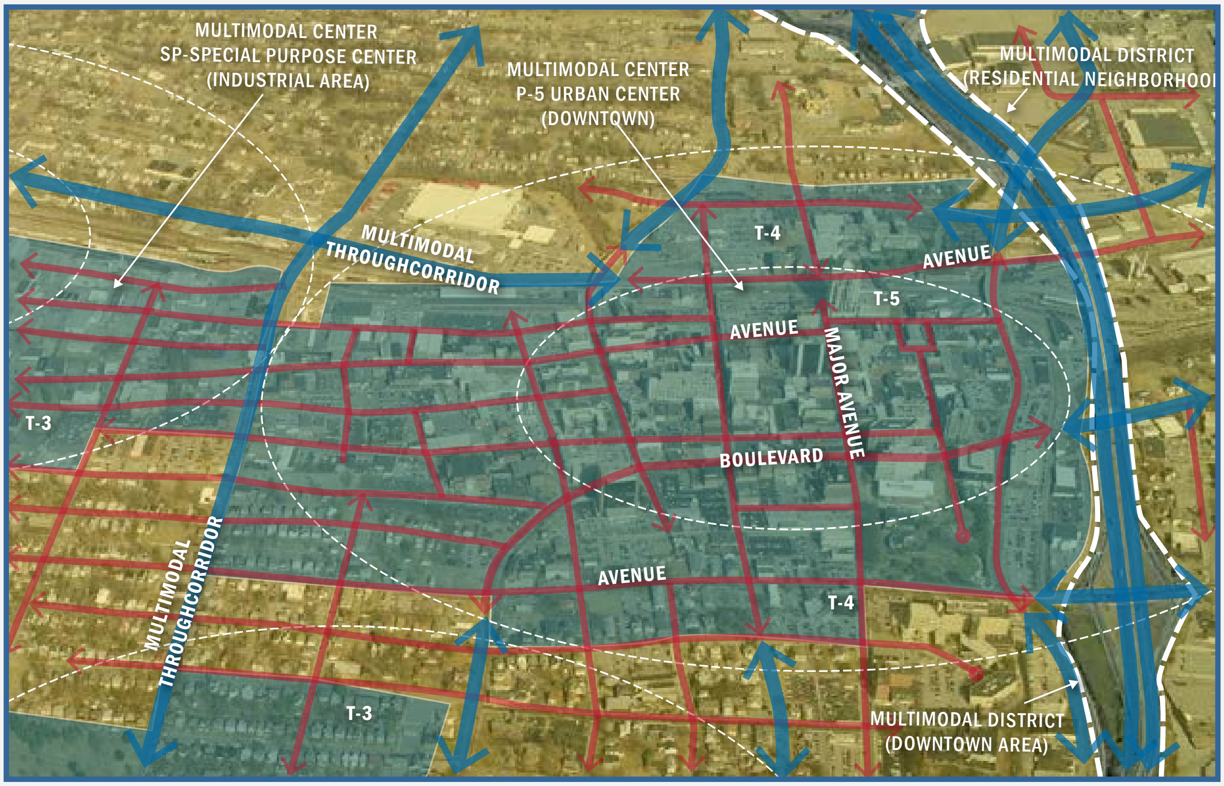


Figure 29: Downtown Roanoke, VA. The superimposed Multimodal Districts, Multimodal Centers and Multimodal Corridors show how a Multimodal System Plan could be applied to this downtown area.

Summary

This process describes the foundations of multimodal planning in these Guidelines – the development of a Multimodal System Plan. Although there are many possible variations of this basic planning process, the core methodology of identifying destinations and multimodal transportation networks and their interplay is fundamental to multimodal planning at any scale.

The next chapters will delve deeper into the typologies for Multimodal Centers and Multimodal Corridors and how they can be designed to make the most of public investments that enhance travel choices and quality of life.

CHAPTER 3

Multimodal Districts and Multimodal Centers

What are Multimodal Districts and Multimodal Centers?

As described in the previous chapter, **Multimodal Districts** are any portion of a city, town, or county that has (or is envisioned to have) good multimodal characteristics such as:

- Moderate to high density development, quite often with mixed uses
- Good connectivity of roads and a compact, connected system of blocks
- Generally slow-speed roads and thoroughfares that have dense transit, motorized, and non-motorized transportation networks or where such networks are planned.

Multimodal Districts can vary in size and may even be as large as a whole town or section of a city. A Multimodal District could be an area that a locality has designated with a defined identity, like a downtown, an arts district, or an economic development district. These Guidelines purposefully refrain from providing specific criteria for what a Multimodal District is. Multimodal Districts are simply areas where it is envisioned that walking, bicycling, and taking transit are safe and viable either now or in the future.

An area can be designated as a Multimodal District even if it does not yet have good multimodal characteristics. The point of designating a Multimodal District is to show intentionality for this area to evolve into a multimodal place. Multimodal Districts (and Multimodal Centers, as described further in this chapter) can occur in rural and suburban places, in addition to in dense urban areas where walking and taking transit are relatively more commonplace.

Multimodal Centers are much more compact nodes defined by a specific walkable travel-shed, generally with a one-mile diameter. Multimodal Centers have the following characteristics:

- Based on a comfortable walk-shed, generally defined as a one-mile diameter circle (modified as needed for barriers and natural or man-made features)
- Consist of localized centers of activity and density, whether population, employment or activities (retail, civic or other activity-generating uses)
- Served by existing or future transit (although in low-intensity centers this may not be possible)
- Have a well-connected (current or planned) network of walkable and bikeable streets with low vehicular speeds and accommodations for bicycles, pedestrians, and buses.

One of the most important benefits of identifying potential Multimodal Centers within a region is that doing so gives a focus for prioritizing multimodal improvements to ensure that they serve the greatest number of people and leverage the most private investment and job growth. Identifying Multimodal Centers in a region helps to focus key locations for investing in multimodal improvements and helps ensure that these investments are located where they will create the most public benefit.

Multimodal Districts are usually bigger than a Multimodal Center and typically include one or more Multimodal Centers within them. A locality may designate a Multimodal District around a Multimodal Center to acknowledge the transitional area between a Multimodal Center and further-out areas that have markedly different characteristics.

Places do not need to be urban or even moderately dense to have Multimodal Centers. The closeness of destinations, not the number of destinations, is what creates a Multimodal Center. Thus even in very low density rural places, Multimodal Centers can be identified. Walkability and bikability within these low density Multimodal Centers is still possible. The Corridor Matrix includes standards for Multimodal Corridors within a broad spectrum of Transect Zones, which are applicable to all Multimodal Centers, from Urban Cores to Rural Centers.

The Importance of Short Block Lengths and Multimodal Connectivity

One of the key characteristics of Multimodal Centers is a connected network of walkable and bikeable streets. ***Short block lengths****, generally less than 300 feet long[5], provide frequent opportunities for pedestrians to cross the street. A gridded pattern of short blocks is also critical for achieving a system of parallel streets that work together to emphasize different modes.*

ITE recommends a desirable block size/intersection spacing of 400 feet, and no more than 660 feet, for areas planned for walkability[6]. ITE's Implementing Context Sensitive Design on Multimodal Thoroughfares provides several metrics for measuring connectivity as well as policies and strategies for improving street connectivity. Further guidance on analyzing multimodal connectivity can be found in FHWA's Measuring Multimodal Network Connectivity guidebook, published in 2018.

[5] American Planning Association, 2006. Planning and Urban Design Standards. Pg. 479.

[6] Institute of Transportation Engineers, 2017. Implementing Context Sensitive Design on Multimodal Thoroughfares: A Practitioner's Handbook. Sections 3.2.1 and 3.2.2.

Multimodal Centers and Transit-Oriented Development

It is important to distinguish Multimodal Centers from Transit-Oriented Development (TOD). Many excellent studies have been done on planning for TOD within the context of a region or a corridor.[7]

However, there are many places in Virginia with no or only limited transit that nevertheless have good multimodal characteristics, such as density, walkability, and compact development patterns. Therefore the focus of Multimodal Centers in these Guidelines is much broader than just TOD and includes all centers with good multimodal characteristics as described above, not just those with transit-focused development. In the context of these Guidelines, TOD is an overlay on top of higher-intensity Multimodal Centers. TODs and their connection with Multimodal Centers will be discussed in greater detail in the next chapter.

Figure 30: Multimodal Centers with and without Transit Oriented Development. In higher intensity areas, Multimodal Centers may be focused on a high-capacity transit station, like the Tide light rail in downtown Norfolk (photo on the left). However, Multimodal Centers also occur in lower intensity areas without TOD, such as in Staunton (photo on the right).

Multimodal Centers and TOD

The focus of Multimodal Centers in these Guidelines is much broader than just TOD and includes all centers with good multimodal characteristics, not just those with transit-focused development.

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[7]One of the most comprehensive of these is the Center for Transit Oriented Development's "Planning for TOD at the Regional Scale," 2011.

The Range of Multimodal Centers in Virginia

Analyzing Potential Multimodal Centers for Virginia

Multimodal Centers can be found in a wide range of contexts in Virginia, from dense urban downtowns such as Richmond and Norfolk, to historic town and village centers such as Lexington and Staunton, to relatively new walkable suburban hubs such as Reston Town Center or New Town in James City County. Multimodal Centers can also be found in rural contexts, like the small town of Eastville in Northampton County. In order to define a typology of Multimodal Centers with a range of scales and characters as diverse as these, the typology was based on a careful analysis of real places in Virginia.

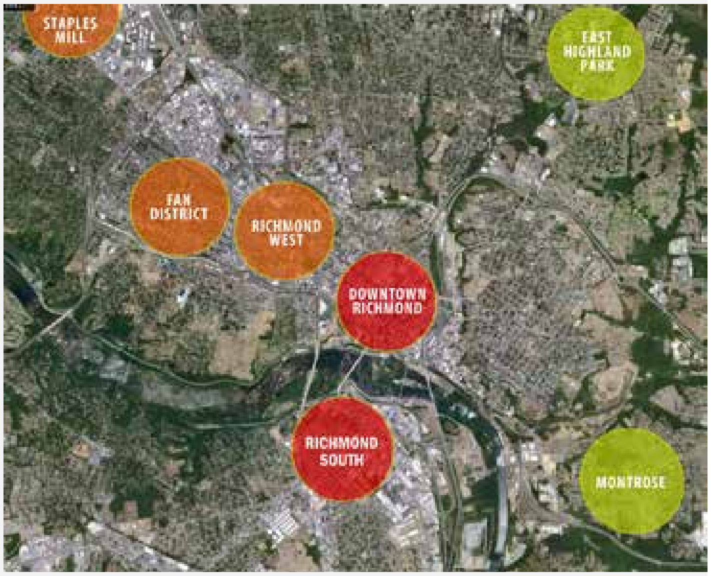


Figure 31: One-Mile Circles Identified as Potential Multimodal Centers throughout Virginia. This image shows some of the potential Multimodal Centers analyzed in the Richmond area. The colors indicate different levels of Activity Density.

In this analysis, one-mile diameter circles representing potential Multimodal Centers were placed over more than 300 rural, suburban, and urban centers throughout Virginia. The population and employment densities were analyzed in each potential Multimodal Center using 2010 Census block-level data and compared amongst each other. The analysis methodology, including sources of data and the summary of results are in Appendix E of these Guidelines. A standardized way of comparing these densities was adopted called "Activity Density." Activity Density is a measure of population and employment density and is expressed in terms of jobs plus population per acre.[8]

One characteristic that is present in many of these potential Multimodal Centers in Virginia is a marked gradation of density from high to low from the center to the edge of the one-mile circle. This gradation in density was systematized in the Multimodal Center typology by the use of density transects, and is described in the following sections.

Measuring Multimodal Centers in Virginia

One-mile diameter circles were placed over more than 300 rural, suburban, and urban centers throughout Virginia. The population and employment densities were analyzed in each potential Multimodal Center and compared amongst each other. A standardized way of comparing these densities was adopted called Activity Density. Activity Density is a measure of population and employment density and is expressed in terms of jobs plus population per acre.

[8]Although there are a variety of other factors that affect the intensity and trip-making characteristics of a region (e.g. tourism and hotel rooms), population and employment densities are a simple, consistent, and effective way of measuring the activity of an area at many different scales and in various regions throughout the Commonwealth. References to Activity Density throughout these Guidelines refer to gross activity density, the sum of population and employment divided by the gross acreage.

Using the Transect to Define Density

The Transect as used in the planning profession has been a relatively common way of describing density and intensity for more than a decade. It has been used as the basis for numerous zoning codes, for the Smart Code system of standardized development codes nationwide, and as the basis for ITE/CNU's Guidebook on Designing Walkable Urban Thoroughfares, also used as a primary source for these Guidelines. The Transect was first defined by the CNU to describe the range of natural and built environments from the countryside to the center of the city. The diagram for the Transect, shown in Figure 17 in Chapter 2, shows these as Transect ("T") zones: each T-Zone defines a consistent scale of density and intensity of development and the whole complement of streets, buildings, and open space that goes along with that level of intensity.

As used in these Guidelines, T-Zones help to clearly identify a level of intensity of development, from a T-6, which is generally a dense urban core area, to a T-4, which is the type of smaller-scale urban environment that might be found toward the edges of a large city or at the very core of a small town, to a T-1, which is a generally rural area. Thus, Transect Zones are the basic building blocks to define the intensity of development whether within a Multimodal Center or along a Multimodal Corridor. Transect Zones can also be applied in areas outside of Multimodal Districts and Centers.

Transect Zones have been used throughout these Guidelines, both to define density and intensity in Multimodal Centers, and to define levels of intensity along Multimodal Corridors. Within each Multimodal Center type, there is a spectrum of intensity levels described by T-Zones. The basic metrics for density and intensity for each of these T-Zones are described in Table 1, along with typical gross and net Floor Area Ratios (FARs) associated with each Transect Zone. The ranges of Activity Density for each T-Zone were derived through the analysis of over 300 potential Multimodal Centers in Virginia, as previously described, and the Activity Density ranges in Table 1 were based on this density spectrum across Virginia.

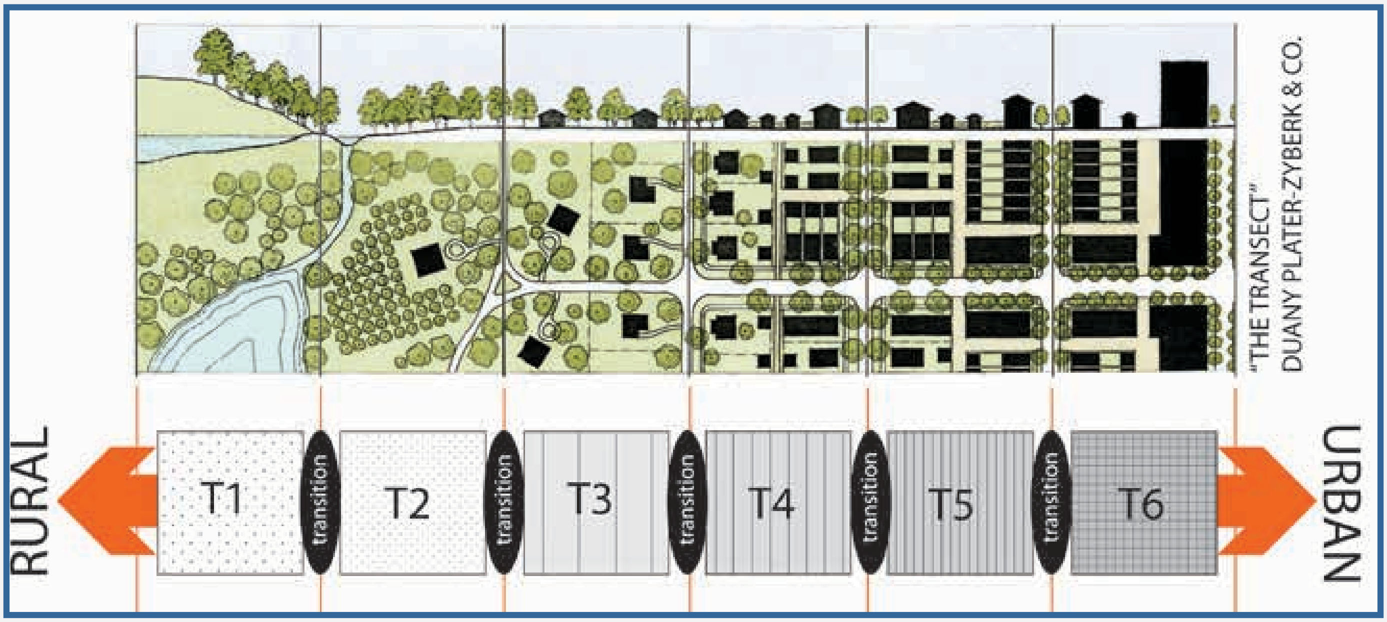


Figure 17: The Transect Diagram. The Transect describes the range of natural and built environments across a spectrum of density. Places can be classified into one of the six different Transect Zones or "T-Zones" depending on the density or intensity of the land uses in an area.

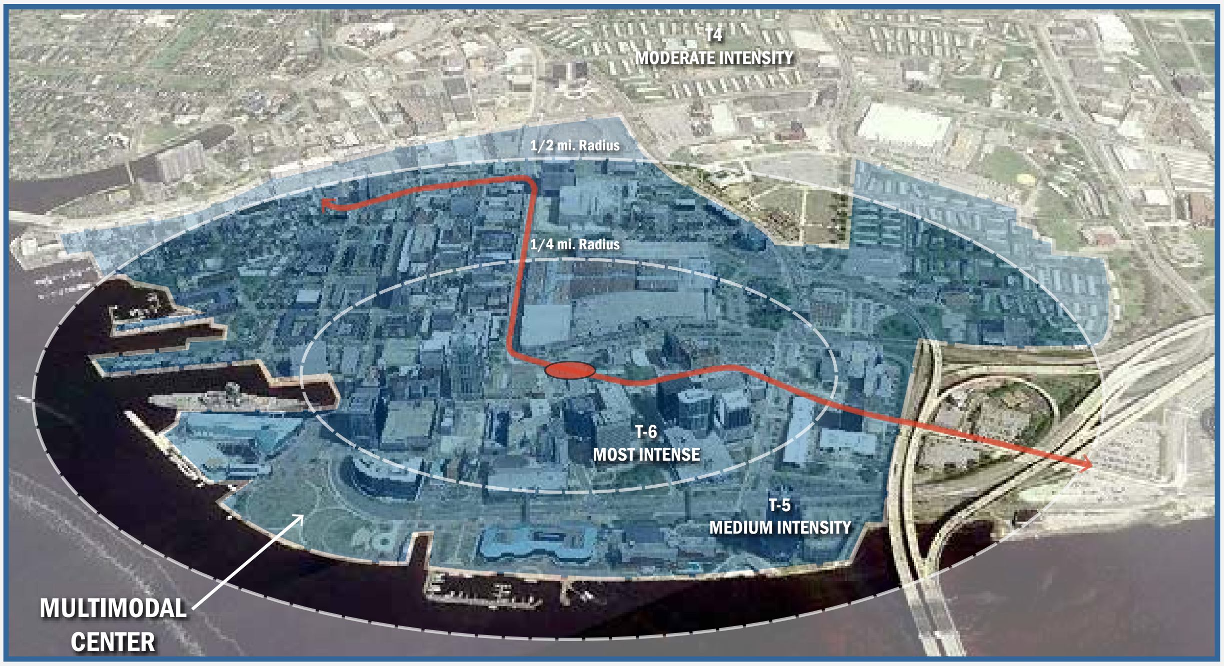


Figure 32: T-Zones in a Multimodal Center in Downtown Norfolk. The red line is the alignment of the light rail line and the station in the center is MacArthur Square.

However, density does not occur in a uniform pattern in real places. When we average the density over an area of several city blocks, for example, it will usually include a range of densities and building heights, with some parcels having multi-story buildings adjacent to surface parking lots or vacant sites. The three-dimensional illustrations in Figure 33 show the built form of a typical block and give a more realistic picture of the density in each Transect Zone. These typical blocks show the variety and range of building heights and parking layouts commensurate with each T-Zone and help to visualize the density of each T-Zone with some basic metrics of development scale. The supported transit technology indicated for each T-Zone describes the most advanced type of transit technology that these densities are able to support. The concept of supported transit technology and how they were determined is explained in greater detail in Chapter 4.

TRANSECT ZONE INTENSITY

Transect Zone	Activity Density (Jobs + people/acre)	Gross Development FAR (residential + non-residential)	Net Development FAR (residential + non-residential)
T-1	1 or less	0.01 or less	0.02 or less
T-2	1 to 10	0.01 to 0.15	0.02 to 0.23
T-3	10 to 25	0.15 to 0.37	0.23 to 0.57
T-4	25 to 60	0.37 to 0.9	0.57 to 1.38
T-5	60 to 100	0.9 to 1.49	1.38 to 2.3
T-6	100 or more	1.49 or more	2.3 or more

Table 1: Transect Zone Intensities. These metrics were calibrated based on analyzing the existing Activity Density in potential Multimodal Centers in Virginia.

Typical Blocks for each T-Zone

Density does not occur in a uniform pattern in real places. In order to give a more realistic picture of the density in each Transect Zone, a series of three-dimensional illustrations have been developed for these Guidelines that show the built form of a typical block for each Transect Zone.

T6

MIXED USE INTENSITY	High
ACTIVITY DENSITY (jobs + people/ac)	100+/ac
AVG. BLDG. HEIGHT	8+ Stories
TYPICAL MAX BLDG. HEIGHT	20+ Stories
TYPICAL NET FAR	2.30+
SUPPORTED TRANSIT TECHNOLOGY	LRT/Rail

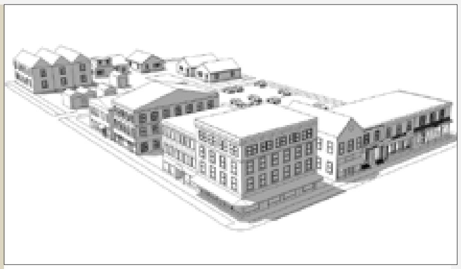
T5

MIXED USE INTENSITY	High
ACTIVITY DENSITY (jobs + people/ac)	60-100/ac
AVG. BLDG. HEIGHT	6 Stories
TYPICAL MAX BLDG. HEIGHT	12 Stories
TYPICAL NET FAR	1.38-2.30
SUPPORTED TRANSIT TECHNOLOGY	BRT/LRT

T4

MIXED USE INTENSITY	Moderate
ACTIVITY DENSITY (jobs + people/ac)	25-60/ac
AVG. BLDG. HEIGHT	4 Stories
TYPICAL MAX BLDG. HEIGHT	8 Stories
TYPICAL NET FAR	0.57-1.38
SUPPORTED TRANSIT TECHNOLOGY	Express Bus

T3

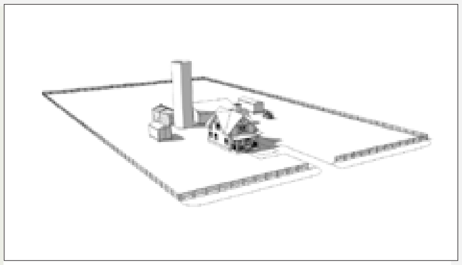


MIXED USE INTENSITY	Moderate
ACTIVITY DENSITY (jobs + people/ac)	10-25/ac
AVG. BLDG. HEIGHT	3 Stories
TYPICAL MAX BLDG. HEIGHT	5 Stories
TYPICAL NET FAR	0.23-0.57
SUPPORTED TRANSIT TECHNOLOGY	Fixed Route Bus

T2

MIXED USE INTENSITY	Low
ACTIVITY DENSITY (jobs + people/ac)	1-10/ac
AVG. BLDG. HEIGHT	1.5 Stories
TYPICAL MAX BLDG. HEIGHT	3 Stories
TYPICAL NET FAR	0.02-0.23
SUPPORTED TRANSIT TECHNOLOGY	Demand Response

T1



MIXED USE INTENSITY	Very Low
ACTIVITY DENSITY (jobs + people/ac)	0-1/ac
AVG. BLDG. HEIGHT	1 Stories
TYPICAL MAX BLDG. HEIGHT	2 Stories
TYPICAL NET FAR	0-0.02
SUPPORTED TRANSIT TECHNOLOGY	Demand Response

Figure 33: Illustrations of Typical Block Types by Transect Zone.

The Basic Typology of Multimodal Centers

As described previously, the one-mile diameter circle walksheds representing Multimodal Centers – although based on real places in Virginia – are somewhat idealized representations of a real place. They are represented as two concentric circles of uniform density – the first quarter-mile radius with higher density and the second quarter-mile radius with a step lower density. Although few places exhibit this exact kind of regular decrease in density in quarter-mile bands, it is nevertheless a general diagrammatic representation of the way that real Multimodal Centers are composed. The 10-minute walkshed that is the basis for Multimodal Centers forms the nucleus for activities and destinations within easy walking distance. The one-mile-diameter circles approximate the locations of potential Multimodal Centers within each Multimodal District. However, these one-mile circles are typically morphed into more organic-looking shapes as they are modified by natural or man-made barriers, or by parcel-level designation on local governments' future land use maps and zoning codes. Despite these modifications, the organic-looking shapes of Multimodal Centers should roughly retain the general scale of the one-mile walkshed. This translation is discussed in more detail in Chapter 7.

Activity Density

Figure 34 shows the Activity Density of downtown Lynchburg, represented by a range of colors from T-1 (dark green) to T-6 (dark red). The data is at the Census block level and shows the sum of jobs and population in each Census block. Overlaid on the map is a one-mile circle representing the basis for a potential Multimodal Center. The pattern of densities in the map highlights the real world variability of densities on a block-by-block basis. In this case, however, Lynchburg's downtown generally corresponds to a T-4 inner ring and T-3 outer ring of densities, which would be classified as a "P-4 Large Town or Suburban Center" Multimodal Center type (discussed below) according to these Guidelines.

Figure 34: Activity Densities in Downtown Lynchburg with a One-Mile Circle Superimposed.

Based on the analysis of a wide variety of potential Multimodal Centers in Virginia according to these basic metrics of Activity Density, the following six Multimodal Center types and corresponding densities have been defined for these Guidelines to establish a basic palette of place types for planning purposes.

MULTIMODAL CENTER INTENSITY			
Center Type	**Activity Density (Jobs + people/acre)**	**Gross Development FAR (residential + non-residential)**	**Net Development FAR (residential + non-residential)**
P-6 Urban Core	70.0 or more	1.0 or more	1.6 or more
P-5 Urban Center	33.75 to 70.0	0.5 to 1.0	0.8 to 1.6
P-4 Large Town or Suburban Center	13.75 to 33.75	0.21 to 0.5	0.3 to 0.8
P-3 Medium Town or Suburban Center	6.63 to 13.75	0.10 to 0.21	0.15 to 0.3
P-2 Small Town or Suburban Center	2.13 to 6.63	0.03 to 0.10	0.05 to 0.15
P-1 Rural or Village Center	2.13 or less	0.03 or less	0.05 or less
SP Special Purpose Center	Varies	Varies	Varies

Table 2: Multimodal Center Types and Activity Density Ranges.

Figure 35 shows these seven Multimodal Center types graphically as a spectrum of place types from dense urban to low density rural centers:

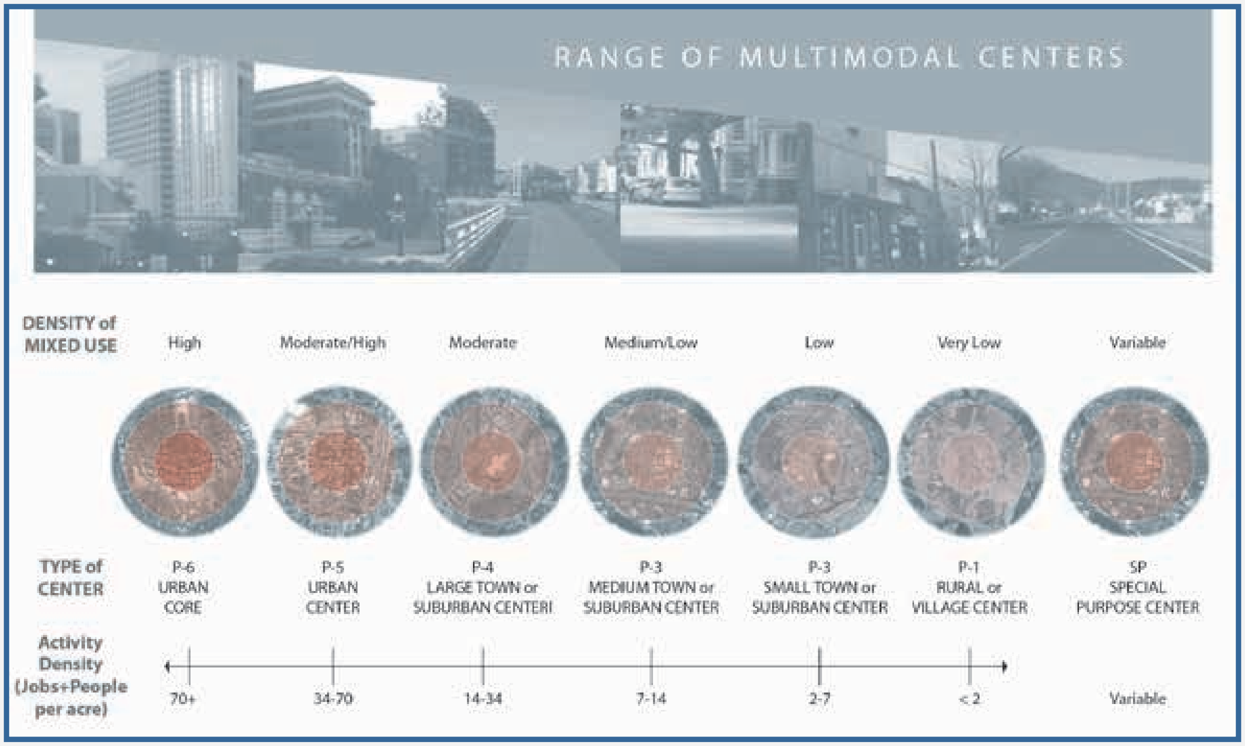


Figure 35: Range of Multimodal Center Types. Urban to rural defined by Activity Density (number of jobs + people) in each Multimodal Center.

Land Use Mix

One of the primary characteristics of a Multimodal Center is a mixture of land uses. For the purposes of these Guidelines, all Multimodal Centers are assumed to have a mixture of uses and a general balance of housing and employment. However, as noted in the next section, a spreadsheet-based tool was developed to allow the creation of customized Multimodal Center types with other proportions of housing and employment.

Creating Special Purpose Multimodal Centers

Although there are six Multimodal Center types that are intended to represent a comprehensive set of place types for planning purposes throughout Virginia, there may be a need to define a customized Special Purpose Multimodal Center. For example, an employment-rich center such as Innsbrook in Henrico County can be an important destination and regional activity center while not having a diverse mixture of uses or a pattern of density that matches a typical Multimodal Center. For this reason, these Guidelines include a spreadsheet tool for creating customized Special Purpose Multimodal Centers, illustrated in Appendix C.

The Multimodal Centers Calculator tool allows a user to select various factors such as density and land use mix. A full list of the values that can be adjusted for Multimodal Centers is listed in Table 3:

Customizable Data for Multimodal Centers
Percent of Activity Units that are jobs
Percent of Activity Units that are population
Square feet per job
Square feet per dwelling unit
Persons per dwelling unit
Gross-to-Net Ratio (Ratio of gross site density to net site density)
Percent of inner quarter-mile residential density concentrated to 1/8 mile TOD node
Percent of inner quarter-mile residential density located outside of 1/8 mile TOD node
Percent of inner quarter-mile employment density concentrated to 1/8 mile TOD node
Percent of inner quarter-mile employment density located outside of 1/8 mile TOD node

Table 3: Data for Special Purpose Multimodal Centers. Special Purpose Multimodal Centers can be customized using the Multimodal Centers Calculator Tool in Appendix C.

Special Purpose Multimodal Centers

Although there are six Multimodal Center types that are intended to represent a comprehensive set of place types for planning purposes throughout Virginia, there may be a need to define a customized Special Purpose Multimodal Center. For this reason, these Guidelines include a spreadsheet tool for creating customized Special Purpose Multimodal Centers, illustrated in Appendix C.

Comparing Multimodal Centers in Virginia

During the original development of the Multimodal System Design Guidelines, the population and employment densities of over 300 potential Multimodal Centers in Virginia were calculated to assess how they would fit into this basic typology. Table 4 shows a sample of the potential Multimodal Centers, classified into the Multimodal Center types according to their Activity Density, which is based on 2010 Census data. A full listing of all potential Multimodal Centers that were analyzed is in Appendix E.

This analysis does not incorporate future growth. It is simply a snapshot of where these potential Multimodal Centers fall in relation to each other and to the Multimodal Center types based on the 2008 employment and 2010 population data. Population data in Table 4 is from the SF1 Summary data for population from the 2010 decennial census at the census block level. Employment data in Table 4 is from the US Census LED On The Map tool for the census block level for 2008.

Potential Multimodal Center (1 mile diameter)	Employment (2008)	Population (2010)	Population/ Employment Ratio	Total Activity Units (Jobs + People)	Activity Units/Acre	Multimodal Center Type
Tysons Corner	50,491	419	0.01	50,910	101	P6 Urban Core
Ballston	27,902	14,202	0.51	42,104	84	
Rosslyn	24,385	16,688	0.68	41,073	82	
Crystal City	24,704	12,377	0.50	37,081	74	
Norfolk	30,917	4,582	0.15	35,499	71	
Alexandria	15,587	9,489	0.61	25,076	50	P5 Urban Center
Clarendon	13,231	10,598	0.80	23,829	47	
Richmond	14,513	8,989	0.62	23,502	47	
Charlottesville	12,496	4,046	0.32	16,542	33	P4 Large Town or Suburban Center
Roanoke	12,956	2,295	0.18	15,251	30	
Fairfax	10,088	4,488	0.44	14,576	29	
Blacksburg	10,360	3,709	0.36	14,069	28	
Winchester	4,581	4,933	1.08	9,514	19	
Reston	2,406	6,134	2.55	8,540	17	
Fredericksburg	4,918	3,143	0.64	8,061	16	
Manassas	2,371	3,965	1.67	6,336	13	P3 Medium Town or Suburban Center
Salem	2,910	3,205	1.10	6,115	12	
Petersburg	4,038	2,035	0.50	6,073	12	
Staunton	2,536	3,300	1.30	5,836	12	
Front Royal	2,525	3,211	1.27	5,736	11	
Newport News	3,555	2,027	0.57	5,582	11	
Bristol	4,033	1,245	0.31	5,278	11	
Virginia Beach	2,509	2,034	0.81	4,543	9	
Galax	2,581	1,326	0.51	3,907	8	
Dunn Loring	854	2,382	2.79	3,236	6	
South Boston	871	1,185	1.36	2,056	4	P2 Small Town or Suburban Center
Crozet	284	1,697	5.98	1,981	4	
Chester	704	883	1.25	1,587	3	
Lake Monticello	6	1,187	197.83	1,193	2	
Bluefield	388	768	2	1,156	2	
Timberlake	409	717	2	1,126	2	
Aquia Harbour	1	742	742	743	1	P1 Rural or Village Center
Forest	484	115	0	599	1	
Poquoson	6	577	96	583	1	
Great Falls	1	455	455	456	1	

Table 4: Activity Densities of Potential Multimodal Centers throughout Virginia. These activity densities do not incorporate anticipated future growth. Several of these potential Multimodal Centers are anticipated to add enough population and employment to transition to more intense Multimodal Center types in the future. Data Source: 2010 Decennial Census SF1 Summary (population); 2008 US Census LED On The Map tool (employment).

From Table 4, it is clear that there is a very wide range of Activity Densities in Virginia places, as well as some interesting similarities among the densities of very different places. For example, the downtown areas of Norfolk and Richmond are similar in density to the urban Metrorail station areas along the Rosslyn-Ballston corridor. However, other stops on the same Metrorail line, such as Dunn Loring, have much lower Activity Densities that correspond to those of smaller towns such as Galax and Staunton. Remember though, these densities do not reflect future growth. Some localities' comprehensive plans articulate a very different vision for some of these potential Multimodal Centers. Fairfax County's Comprehensive Plan, for example, anticipates Dunn Loring to add population and employment to move from a P-3 Medium Town or Suburban Center to a P-5 Urban Center in the next 25 years, some of which has already occurred since the 2010 Census.

Although this analysis used 2010 Census data, local and regional planners should incorporate long-range future land use and intensity projections into their population and employment calculations when designating Multimodal Districts and Multimodal Centers in the Multimodal System planning process, as described in Step 2 of Chapter 2.

In Figure 36, the one-mile circles for the Richmond area are shown overlaid onto a color-coded map of Activity Density. This map shows the variability of density in a large region and how potential Multimodal Center locations identified for analysis purposes were chosen as representative of the diverse densities of areas throughout the region. The selection of potential Multimodal Centers shown here is simply illustrative. Local and regional planners should use their comprehensive plans and other planning documents to select their Multimodal Districts and Multimodal Centers to best reflect the future visions articulated in their local and regional plans.

Many more observations can be made by comparing the Activity Densities among these potential Multimodal Centers in Virginia. However, the prime value of this analysis is to have a standard frame of comparison and common language to begin comparing the density of different Multimodal Centers throughout Virginia.

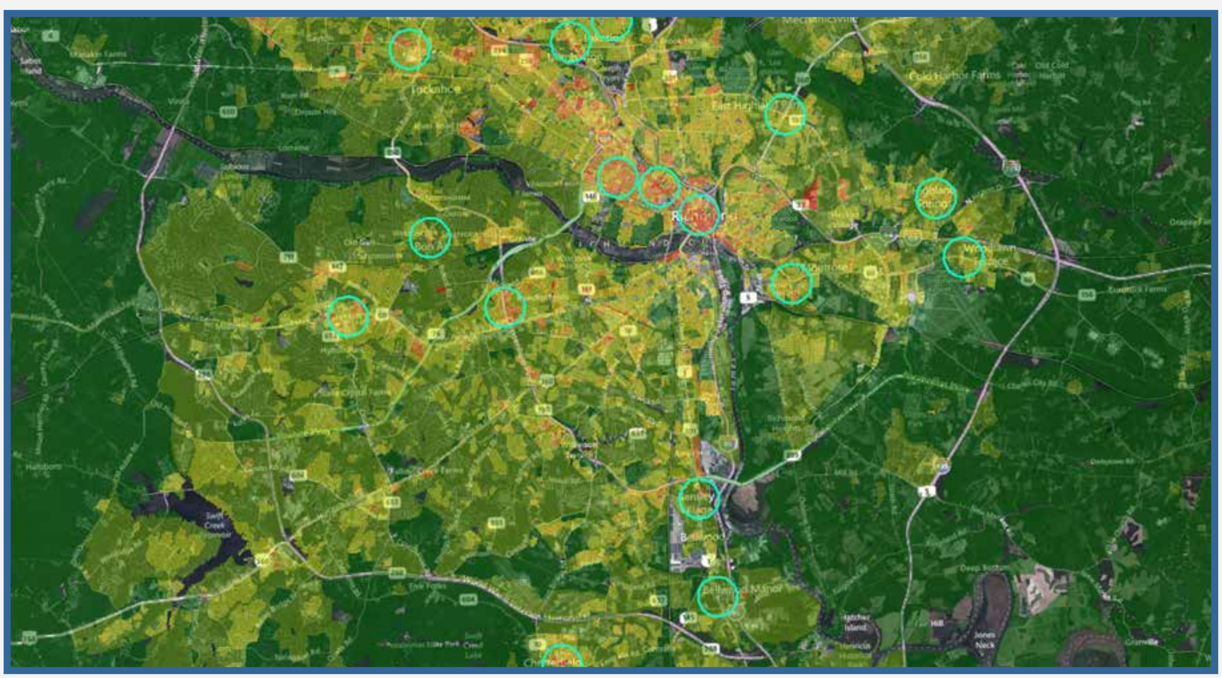


Figure 36: Map of Activity Density in the Richmond Region. One-mile circles used for analysis purposes as potential Multimodal Centers for illustrative purposes only.

Detailed Descriptions of the Multimodal Center Types

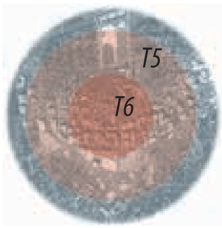
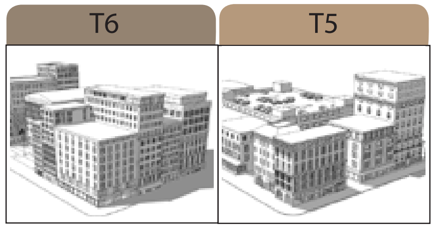
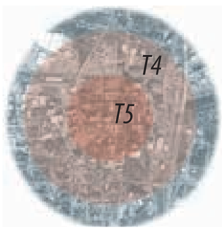
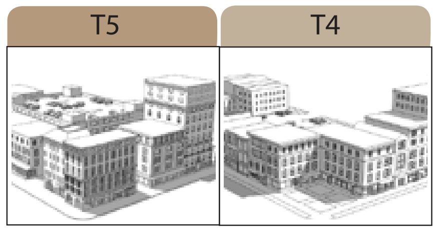
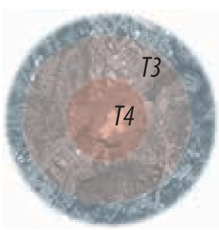
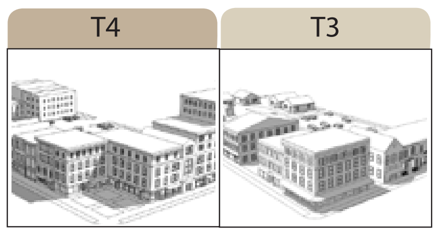
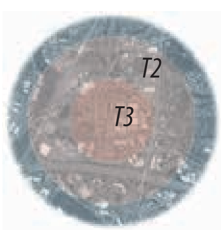
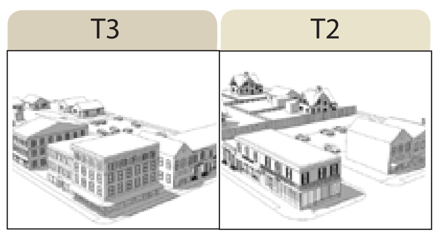
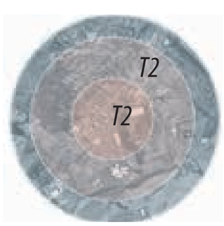
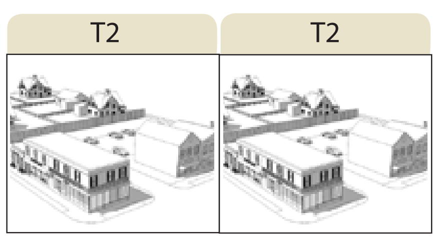
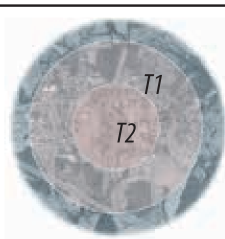
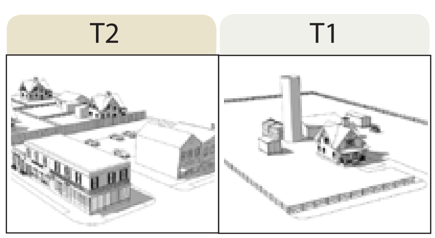
The arrangement and spacing of corridors in these diagrams is based generally on rules for roadway spacing and hierarchy of road types. However, just as road networks in real places don't look like the diagrams in engineering manuals, it is not expected that real Multimodal Centers will look exactly like these diagrammatic representations.

As described in Chapter 2, Multimodal Centers are the primary destinations and hubs of activity within a region. The purpose of designating Multimodal Centers in a Multimodal System Plan is twofold – first, to be able to provide a focus of destinations with the highest levels of multimodal connectivity; and second, to be able to identify the types of Multimodal Corridors recommended for each Multimodal Center. This last point – that the type of Multimodal Center suggests the selection of a Multimodal Corridor – is an important point for these Guidelines. In other words, answering the question of the larger context of a corridor (i.e., in which Multimodal Center type is the corridor located?) will help us answer the question of which Multimodal Corridor type we should use for a particular roadway.

The following summary pages contain a series of diagrams and tables that describe each Multimodal Center type. Each summary page also has a diagram that shows the "prototypical" arrangement of Multimodal Corridors within the Multimodal Center. These are idealized diagrams and are not intended to represent any particular real place. The purpose of these diagrams, instead, is to give a basic design framework for a prototypical arrangement of Multimodal Corridors for each Multimodal Center type. The arrangement and spacing of Multimodal Corridors in these diagrams is based generally on rules of thumb for roadway spacing and hierarchy of road types. However, just as road networks in real places do not look like the diagrams in engineering manuals, it is not expected that real Multimodal Centers will look exactly like these diagrammatic representations.

A summary page of all the Multimodal Center types is provided in Firgure 37 on the next page, followed by more detailed diagrams and metrics of each of the Multimodal Center types. The Summary Tables for each Multimodal Center type in Figures 38 through 43 provide the typical characteristics (Activity Density, FAR, supported transit technology, and building height) that would generally be found in the places that would fall into each type. Planners can use the Activity Density ranges in the Multimodal System Planning Process to determine which types of Multimodal Centers they have identified in their regions. The FARs and typical building heights are provided simply to suggest typical development patterns associated with each of the Multimodal Center types. The supported transit technology indicates the highest or most advanced type of transit service that might be supported given the land use intensities. The concept of supported transit technology is explained in greater detail in Chapter 4.

MULTIMODAL CENTERS

TYPE OF MULTIMODAL CENTER	ACTIVITY DENSITY*	TRANSECT ZONES	MULTIMODAL CORRIDOR TYPES BY TRANSECT
CENTER TYPE P6 Urban Core 	HIGH 70+		T6 T5: BOULEVARD, MAJOR AVE., AVENUE, LOCAL ST.
CENTER TYPE P5 Urban Center 	MODERATE/ HIGH 34-70		T5 T4: BOULEVARD, MAJOR AVE., AVENUE, LOCAL ST.
PLACE TYPE P4 Large Town or Suburban Center 	MODERATE 14-34		T4 T3: BOULEVARD, MAJOR AVE., AVENUE, LOCAL ST.
CENTER TYPE P3 Medium Town or Suburban Center 	MEDIUM/ LOW 7-14		T3 T2: BOULEVARD, MAJOR AVE., AVENUE, LOCAL ST.
CENTER TYPE P2 Small Town or Suburban Center 	LOW 2-7		T2 T2: TRANSIT BLVD., BOULEVARD, MAJOR AVE., AVENUE, LOCAL ST.
CENTER TYPE P1 Rural or Village Center 	VERY LOW <2		T2 T1: BOULEVARD, MAJOR AVE., AVENUE, LOCAL ST.

* sum of jobs + population

Figure 37: Multimodal Center Types Summary Page.

P6 URBAN CORE

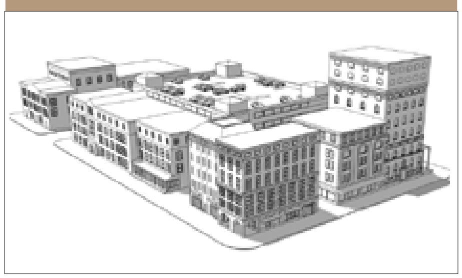
Typical P6 Center (Ballston, Virginia)

Typical Street view (Ballston, Virginia)

T6

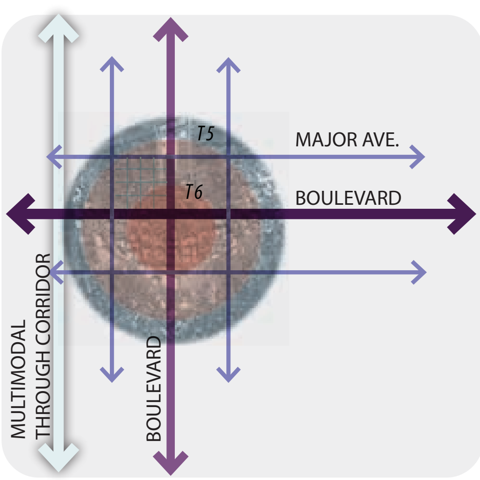
MIXED USE INTENSITY	High
ACTIVITY DENSITY (jobs + people/ac)	100+/ac
AVG. BLDG. HEIGHT	8+ Stories
TYPICAL MAX BLDG. HEIGHT	20+ Stories
TYPICAL NET FAR	2.30+
SUPPORTED TRANSIT TECHNOLOGY	LRT/Rail

T5



MIXED USE INTENSITY	High
ACTIVITY DENSITY (jobs + people/ac)	60 - 100/ac
AVG. BLDG. HEIGHT	6 Stories
TYPICAL MAX BLDG. HEIGHT	12 Stories
TYPICAL NET FAR	1.38 - 2.30
SUPPORTED TRANSIT TECHNOLOGY	BRT/LRT

Prototypical Arrangement of Multimodal Corridors (P6 Urban Core)

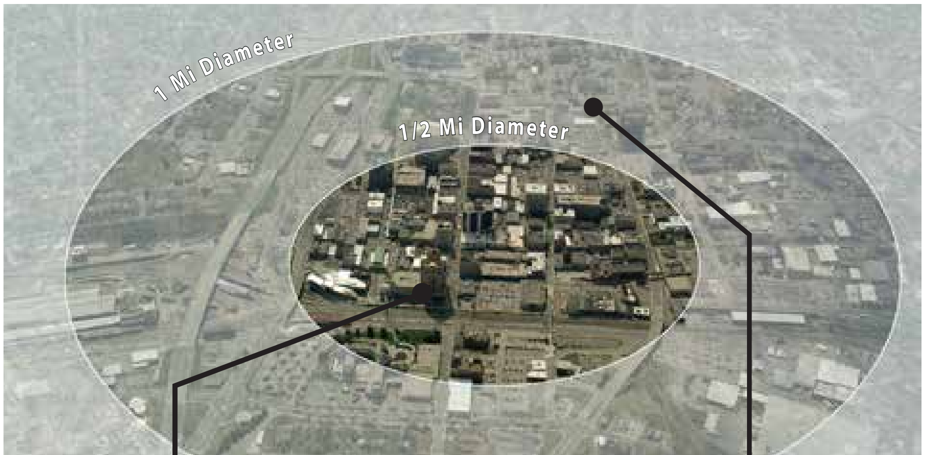


P6 URBAN CORE SUMMARY TABLE	
ACTIVITY DENSITY (jobs + people/acre)	70 or more
GROSS DEVELOPMENT FAR (residential + non-residential)	1.0 or more
NET DEVELOPMENT FAR (residential + non-residential)	1.6 or more
SUPPORTED TRANSIT TECHNOLOGY	LRT/Rail
Height of Buildings	7 story average 14 story typical maximum

Figure 38: P-6 Urban Core Multimodal Center Diagrams & Metrics.

P5 URBAN CENTER

Typical P5 Center (Roanoke, Virginia)



Typical Street view (Roanoke, Virginia)

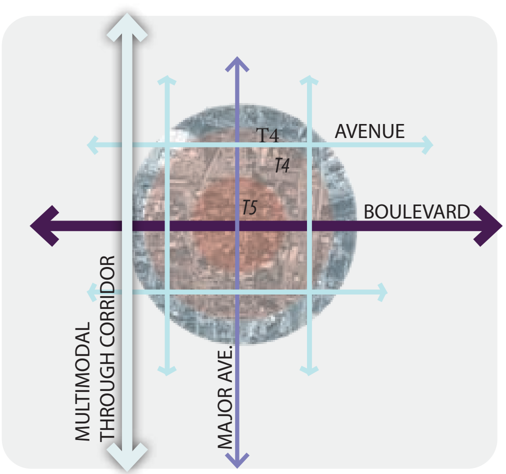
T5

MIXED USE INTENSITY	High
ACTIVITY DENSITY (jobs + people/ac)	60-100/ac
AVG. BLDG. HEIGHT	6 Stories
TYPICAL MAX BLDG. HEIGHT	12 Stories
TYPICAL NET FAR	1.38-2.30
SUPPORTED TRANSIT TECHNOLOGY	BRT/LRT

T4

MIXED USE INTENSITY	Moderate
ACTIVITY DENSITY (jobs + people/ac)	25-60/ac
AVG. BLDG. HEIGHT	4 Stories
TYPICAL MAX BLDG. HEIGHT	8 Stories
TYPICAL NET FAR	0.57-1.38
SUPPORTED TRANSIT TECHNOLOGY	Express Bus

Prototypical Arrangement of Multimodal Corridors (P5 Urban Center)

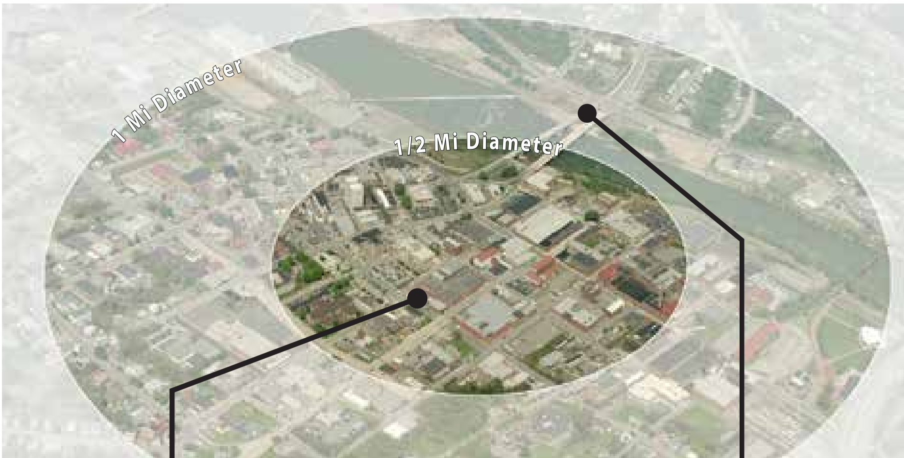


P5 URBAN CENTER SUMMARY TABLE	
ACTIVITY DENSITY (jobs + people/acre)	34 to 70
GROSS DEVELOPMENT FAR (residential + non-residential)	0.5 to 1.0
NET DEVELOPMENT FAR (residential + non-residential)	0.8 to 1.6
SUPPORTED TRANSIT TECHNOLOGY	BRT/LRT
Height of Buildings	5 story average 9 story typical maximum

Figure 39: P-5 Urban Center Multimodal Center Diagrams & Metrics.

P4 LARGE TOWN/SUBURBAN CENTER

Typical P4 Center (Danville, Virginia)

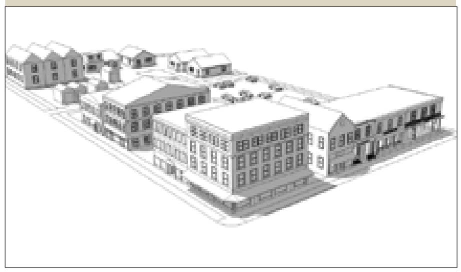


Typical Street view (Danville, Virginia)

T4

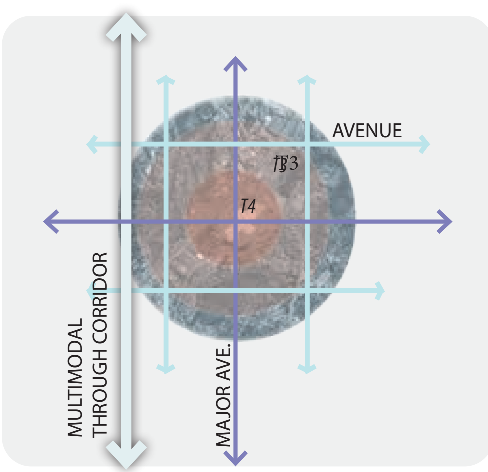
MIXED USE INTENSITY	Moderate
ACTIVITY DENSITY (jobs + people/ac)	25-60/ac
AVG. BLDG. HEIGHT	4 Stories
TYPICAL MAX BLDG. HEIGHT	8 Stories
TYPICAL NET FAR	0.57-1.38
SUPPORTED TRANSIT TECHNOLOGY	Express Bus

T3



MIXED USE INTENSITY	Moderate
ACTIVITY DENSITY (jobs + people/ac)	10-25/ac
AVG. BLDG. HEIGHT	3 Stories
TYPICAL MAX BLDG. HEIGHT	5 Stories
TYPICAL NET FAR	0.23-0.57
SUPPORTED TRANSIT TECHNOLOGY	Fixed Route Bus

Prototypical Arrangement of Multimodal Corridors (P4 Large Town/Suburban Center)



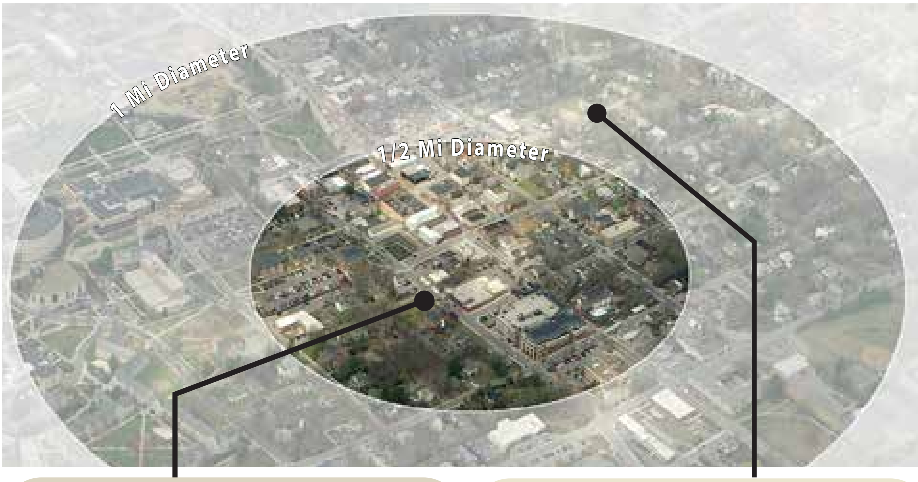
P4 LARGE TOWN/SUBURBAN CENTER SUMMARY TABLE	
ACTIVITY DENSITY (jobs + people/acre)	14 to 34
GROSS DEVELOPMENT FAR (residential + non-residential)	0.2 to 0.5
NET DEVELOPMENT FAR (residential + non-residential)	0.3 to 0.8
SUPPORTED TRANSIT TECHNOLOGY	Express Bus
Height of Buildings	3 story average 6 story typical maximum

Figure 40: P-4 Large Town/Suburban Center Multimodal Center Diagrams & Metrics.

P3 MEDIUM TOWN/SUBURBAN CENTER

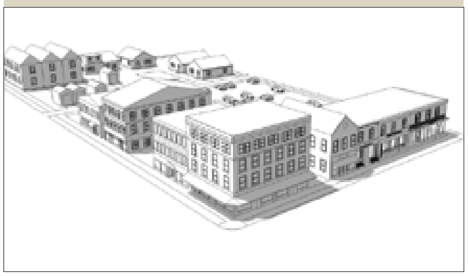
CENTER TYPE P3

Typical P3 Center (Blacksburg, Virginia)



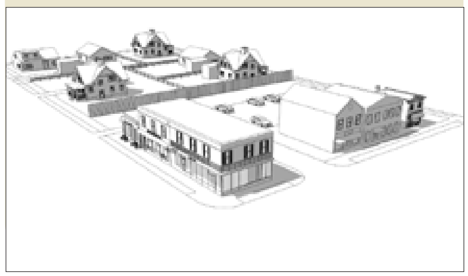
Typical Street view (Blacksburg, Virginia)

T3



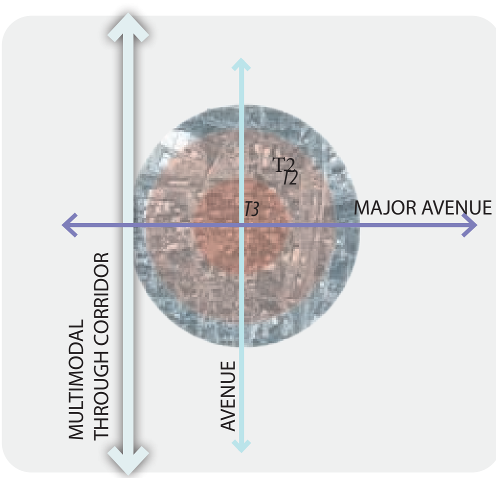
MIXED USE INTENSITY	Medium/Low
ACTIVITY DENSITY (jobs + people/ac)	10-25/ac
AVG. BLDG. HEIGHT	3 Stories
TYPICAL MAX BLDG. HEIGHT	5 Stories
TYPICAL NET FAR	0.23-0.57
SUPPORTED TRANSIT TECHNOLOGY	Fixed Route Bus

T2



MIXED USE INTENSITY	Medium/Low
ACTIVITY DENSITY (jobs + people/ac)	1-10/ac
AVG. BLDG. HEIGHT	1.5 Stories
TYPICAL MAX BLDG. HEIGHT	3 Stories
TYPICAL NET FAR	0.02-0.23
SUPPORTED TRANSIT TECHNOLOGY	Demand Response

Prototypical Arrangement of Multimodal Corridors (P3 Medium Town/Suburban Center)



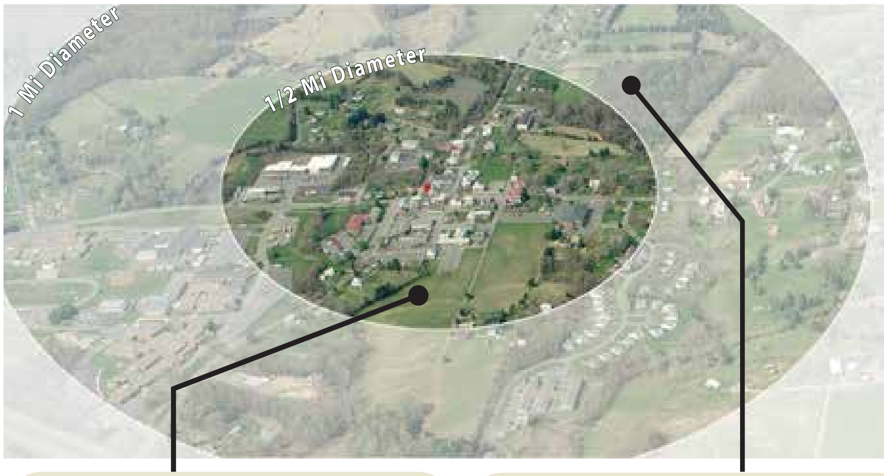
P3 MEDIUM TOWN/SUBURBAN CENTER SUMMARY TABLE	
ACTIVITY DENSITY (jobs + people/acre)	7 to 14
GROSS DEVELOPMENT FAR (residential + non-residential)	0.1 to 0.2
NET DEVELOPMENT FAR (residential + non-residential)	0.15 to 0.3
SUPPORTED TRANSIT TECHNOLOGY	Fixed Route Bus
Height of Buildings	2 story average 4 story typical maximum

Figure 41: P-3 Medium Town/Suburban Center Multimodal Center Diagrams & Metrics.

P2 SMALL TOWN/SUBURBAN CENTER

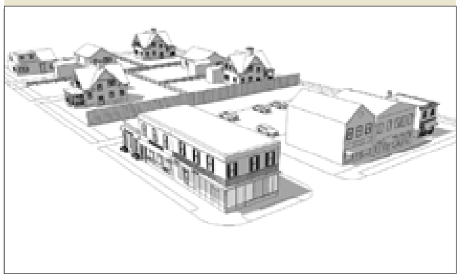
CENTER TYPE

Typical P2 Center (Stanardsville, Virginia)



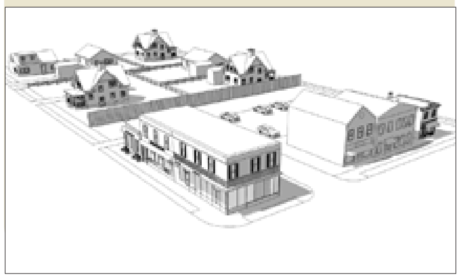
Typical Street view (Stanardsville, Virginia)

T2



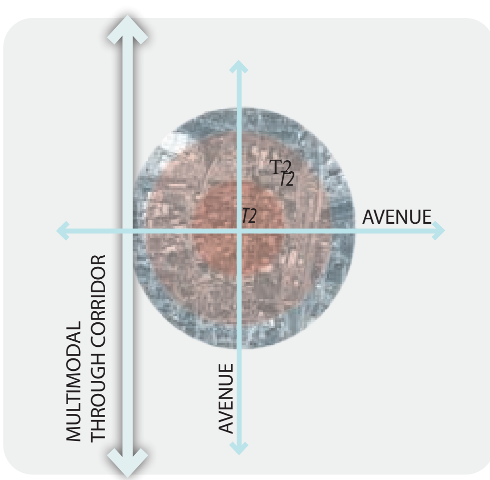
MIXED USE INTENSITY	Low
ACTIVITY DENSITY (jobs + people/ac)	1-10/ac
AVG. BLDG. HEIGHT	1.5 Stories
TYPICAL MAX BLDG. HEIGHT	3 Stories
TYPICAL NET FAR	0.02-0.23
SUPPORTED TRANSIT TECHNOLOGY	Demand Response

T2



MIXED USE INTENSITY	Low
ACTIVITY DENSITY (jobs + people/ac)	1-10/ac
AVG. BLDG. HEIGHT	1.5 Stories
TYPICAL MAX BLDG. HEIGHT	3 Stories
TYPICAL NET FAR	0.02-0.23
SUPPORTED TRANSIT TECHNOLOGY	Demand Response

Prototypical Arrangement of Multimodal Corridors (P2 Small Town/Suburban Center)



P2 SMALL TOWN/SUBURBAN CENTER SUMMARY TABLE	
ACTIVITY DENSITY (jobs + people/acre)	2 to 7
GROSS DEVELOPMENT FAR (residential + non-residential)	0.03-0.10
NET DEVELOPMENT FAR (residential + non-residential)	0.05-0.15
SUPPORTED TRANSIT TECHNOLOGY	Demand Response
Height of Buildings	1.5 story average 3 story typical maximum

Figure 42: P-2 Small Town/Suburban Center Multimodal Center Diagrams & Metrics.

P1 RURAL/VILLAGE CENTER

CENTER TYPE P1

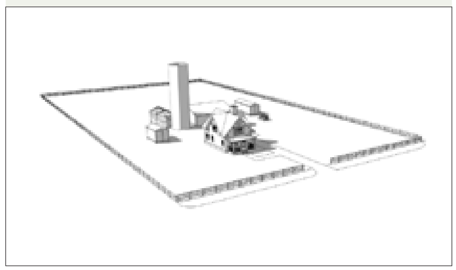
Typical P1 Center (Eastville, Virginia)

Typical Street view (Eastville, Virginia)

T2

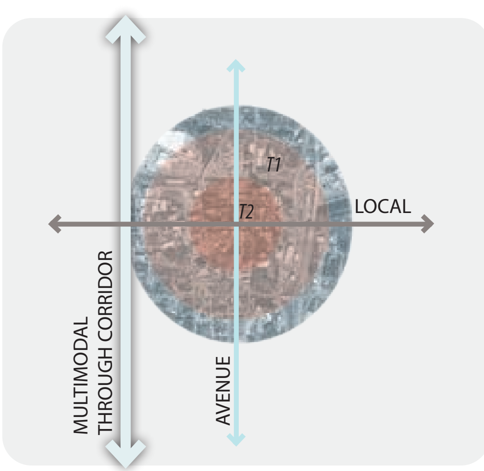
MIXED USE INTENSITY	Low
ACTIVITY DENSITY (jobs + people/ac)	1-10/ac
AVG. BLDG. HEIGHT	1.5 Stories
TYPICAL MAX BLDG. HEIGHT	3 Stories
TYPICAL NET FAR	0.02-0.23
SUPPORTED TRANSIT TECHNOLOGY	Demand Response

T1



MIXED USE INTENSITY	Very Low
ACTIVITY DENSITY (jobs + people/ac)	0-1/ac
AVG. BLDG. HEIGHT	1 Stories
TYPICAL MAX BLDG. HEIGHT	2 Stories
TYPICAL NET FAR	0-0.02
SUPPORTED TRANSIT TECHNOLOGY	Demand Response

Prototypical Arrangement of Multimodal Corridors (P1 Rural/Village Center)



P1 RURAL/VILLAGE CENTER SUMMARY TABLE

ACTIVITY DENSITY (jobs + people/acre)	0 to 2
GROSS DEVELOPMENT FAR (residential + non-residential)	0-0.03
NET DEVELOPMENT FAR (residential + non-residential)	0-0.05
SUPPORTED TRANSIT TECHNOLOGY	Demand Response
Height of Buildings	1 story average 2 story typical maximum

Figure 43: P-1 Rural/Village Center Multimodal Center Diagrams & Metrics.

Other Typologies of Multimodal Centers and Land Use Contexts

A variety of relatively new guidance documents and research papers outline several different ways of describing the variations between land use and density patterns, that are similar to and more nuanced than Transect Zones.

ITE published the *Implementing Context Sensitive Design on Multimodal Thoroughfares* handbook in 2017 as a follow-up to the 2010 *Designing Walkable Urban Thoroughfares* guidebook. The 2017 handbook shows four typical land use context types – Residential, Industrial, Mixed Use Retail, and Office Park/Commercial. The land use context type combined with the mobility function (i.e., roadway functional class) determines the street type, which influences the selection of design elements. This combination of land use context and mobility function is similar to the Corridor Matrix as described in Chapter 5.

AASHTO's 7th edition of *A Policy on Geometric Design of Highways and Streets* (i.e., the "Green Book"), published in 2018, introduces five context classes for roadway design, providing more nuance than the simple binary urban or rural contexts previously in place. AAHSTO defines the five contexts – Rural, Rural Town, Suburban, Urban, and Urban Core – based on development density, land uses, and building setbacks. The values in the Corridor Matrix are consistent with these five context classes, as described further in Chapter 5 and Appendix B.

Reid Ewing, professor of city and metropolitan planning at the University of Utah, conducted research on centers in 28 metropolitan regions of the U.S. to measure variations in density as well as the other "D" variables of land use diversity, design, destination accessibility, and distance to transit. Ewing's research provides recommendations for built environment characteristics of multimodal centers.[9]

Although these other typologies of Multimodal Centers and Land Use Contexts vary in complexity and sophistication, the method of using Transect Zones to define the Multimodal Center Types provided in these Multimodal System Design Guidelines is tailored to the Virginia context, representing a full range of center types for all contexts in Virginia.

Overlapping Multimodal Centers

Sometimes the one-mile diameter circles of Multimodal Centers may overlap significantly, especially within downtown areas of larger metropolitan regions.

An example of this overlap appeared during development of the Multimodal System Plan component of the City of Norfolk's Downtown Plan. The center point of the Multimodal Center for the Downtown area was placed on the MacArthur Square light rail station, and many of the highest-density blocks in the downtown area were included within its inner quarter-mile-radius circle. The center point for the Multimodal Center for the St. Paul's neighborhood was located only 0.65 miles away from the MacArthur Square light rail station. Much of the outer half-mile radius rings overlapped between the two Multimodal Centers. Similarly, the Multimodal Center for the NEON Arts District overlapped with the other two Multimodal Centers.

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[9] "Polycentric Development," a Lightning Talk by Reid Ewing, at the 2019 Transportation and Communities Summit (September 19-20, 2019 at Portland State University). Presentation downloaded from https://drive.google.com/drive/folders/10nfuSDYBW59KvR4uzxZtViB-WacUqEYP on 07 Jan 2020.

In cases like these, the question arises whether to keep the overlapping Multimodal Centers separate as their own distinct Centers, or combine them into one larger Multimodal Center. Items to consider in these situations include:

- How often do people make short walking, bicycling, or scootering trips from one Multimodal Center to the next?
- How cohesive are the areas that are being considered as separate Multimodal Centers in terms of place identity?
- Does one area have a unique character distinct from the other?
- How different is the variation in land use intensity from one Multimodal Center to the next?
- Is there a Multimodal Through Corridor with infrequent pedestrian crossings that separates the Multimodal Centers and dissuades people from crossing the street?

On this last point, and as explained further in Chapter 5, Multimodal Through Corridors with relatively higher speeds and infrequent pedestrian crossings become Placemaking Corridors with lower speeds within Multimodal Centers. A road between two separate Multimodal Centers can remain a Multimodal Through Corridor, but once it enters a Multimodal Center, it must transition to a Placemaking Corridor.

A Multimodal Center with drastically different densities from another Multimodal Center might need to be considered a separate Center so that the Multimodal Center types (P-6 vs. P-4 for example) accurately reflect the true context of each.

Combining multiple Multimodal Centers into one larger Multimodal Center shows an intentionality to knit together areas into a cohesive unit. The City of Norfolk ultimately decided to combine the three Multimodal Centers into one larger Downtown Multimodal Center including the St. Paul's neighborhood and the NEON Arts District for several reasons. The City is implementing a transformative vision to revitalize the St. Paul's neighborhood into a mixed-income, mixed-use neighborhood and improve the physical, educational, recreational, commercial, and social attributes of the area. Part of this revitalization hinges on making sure the employment, educational, and community assets of downtown are easily accessible to St. Paul's residents. St. Paul's Boulevard, which separates the St. Paul's neighborhood from the rest of downtown, is currently a 45-mph principal arterial carrying over 40,000 vehicles per day[10] with 800 feet between pedestrian crossings. Through a process of committee and stakeholder input, the City determined that St. Paul's Boulevard should be a Placemaking Corridor that provides more frequent pedestrian crossings and is thus less of a barrier between the St. Paul's area and the downtown area to the west. Similarly, the City decided to include the NEON Arts District as part of the same Multimodal Center to purposefully blur the boundaries between this area and the downtown and encourage pedestrian activity between the areas.

Figure 44: Overlapping Multimodal Centers in Downtown Norfolk, VA. Three Multimodal Centers originally identified for the Downtown area, St. Paul's Neighborhood, and NEON Arts District were combined into one larger Multimodal Center.

[10] VDOT 2018 Traffic Data

CHAPTER 4

Multimodal Centers and Transit-Oriented Development

The previous chapter described Multimodal Centers as local concentrations of activities with good multimodal connectivity. This chapter describes more specifically how Transit-Oriented Development (TOD) works with Multimodal Centers and how the basic metrics of Multimodal Centers change when the centers are served by high-capacity transit.

Traditionally, TOD has been defined as compact walkable areas of moderate to high density and mixed uses that surround the area within walking distance of a high-frequency/capacity transit stop or station. Typically, TOD areas have been scaled as a quarter-mile to a half-mile radius around the transit station. As noted previously, the concept of Multimodal Centers is much broader than the concept of TODs, although it includes many of the same characteristics of density, walkablility, and general scale.

Transit-Oriented Development within Multimodal Centers

What happens to a Multimodal Center when it contains a transit stop? From analyzing a wide variety of Multimodal Centers, it is apparent that the answer to this question depends to a large part on the type of transit that is serving the Multimodal Center.

For Multimodal Centers that are served by lower-capacity transit service such as demand-response and fixed-route bus service, there is generally no additional increase in density in the core of the Multimodal Center resulting from its being served by a bus stop. However, with higher-capacity transit service such as bus rapid transit (BRT), light rail transit (LRT), or heavy rail transit, Multimodal Centers tend to have a noticeable jump in density at the very core of the Multimodal Center around the transit stop. This is reflected in these Guidelines by a refinement of Multimodal Centers that are served by high-capacity transit through the addition of an eighth-mile radius **TOD Node** overlaid on top of those Multimodal Centers. Figure 45 shows how a TOD Node is overlaid onto the basic geometry of a Multimodal Center.

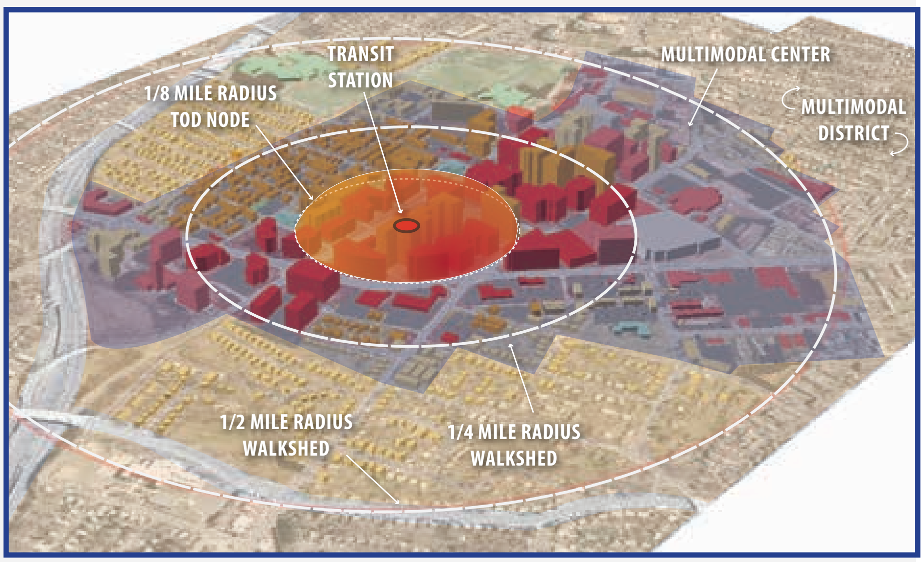

Figure 45: TOD Node Walksheds. Multimodal Centers served by high capacity transit have a TOD Node within the first eighth-mile radius core with a noticeable jump in density that corresponds to a 2.5 to 3 minute walk to the transit station.

As shown in Figure 45, the inner eighth-mile-radius core of a Multimodal Center with high-capacity transit forms a TOD Node with correspondingly higher densities than the surrounding quarter-mile-radius ring. Appendix C contains summary tables that show the basic metrics for densities within the TOD Nodes within Multimodal Centers. Although the overall density of the Multimodal Center does not change, there is a reallocation of density within the inner eighth-mile-radius core of the Multimodal Center when there is a TOD Node. It should be noted that TOD Nodes are assumed only for the higher-intensity Multimodal Centers: P-3 through P-6. Tables 5 and 6 show how these densities are allocated in Multimodal Centers P-3 through P-6:

TRANSIT-ORIENTED DEVELOPMENT NODE DENSITIES (Multimodal Centers P3 and Above)

	INSIDE TOD NODE (1/8 mile radius circle)							
	ACTIVITY DENSITY		TOTAL FLOOR-AREA-RATIO based on Activity Density (combined residential and commercial)				BUILDING HEIGHT based on visual inspection (No. of stories)	
Multimodal Center Types	Activity Density = (Jobs + HH)/acre		Gross Building FAR (includes res + com)		Net Building FAR (includes res + com)		Average Building Height	Typical Maximum Bldg Height
	Low	High	Low	High	Low	High		
P-3 Medium Town or Suburban Center	13.3	27.5	0.20	0.41	0.30	0.63	4	7
P-4 Large Town or Suburban Center	27.5	67.5	0.41	1.01	0.63	1.55	7	12
P-5 Urban Center	67.5	140.0	1.01	2.09	1.55	3.21	9	18
P-6 Urban Core	140.0	-	2.09	-	3.21	-	13	28

Table 5: Densities and Intensities within the Eighth-Mile Radius TOD Node.

TRANSIT-ORIENTED DEVELOPMENT NODE DENSITIES (Multimodal Centers P3 and Above)

	OUTSIDE TOD NODE (1/8 mile to 1/4 radius ring)							
	ACTIVITY DENSITY		TOTAL FLOOR-AREA-RATIO based on Activity Density (combined residential and commercial)				BUILDING HEIGHT based on visual inspection (No. of stories)	
Multimodal Center Types	Activity Density = (Jobs + HH)/acre		Gross Building FAR (includes res + com)		Net Building FAR (includes res + com)		Average Building Height	Typical Maximum Bldg Height
	Low	High	Low	High	Low	High		
P-3 Medium Town or Suburban Center	4.4	9.2	0.07	0.14	0.10	0.21	3	5
P-4 Large Town or Suburban Center	9.2	22.5	0.14	0.34	0.21	0.52	4	8
P-5 Urban Center	22.5	46.7	0.34	0.70	0.52	1.07	6	12
P-6 Urban Core	46.7	-	0.70	-	1.07	-	9	19

Table 6: Densities and Intensities outside the Eighth-Mile Radius TOD Node.

The above metrics are important benchmarks for those who are planning for transit and TOD in the context of Multimodal Centers according to these Guidelines. By defining optimal Activity Densities for each type of TOD Node and Multimodal Center, an overall framework can be established for station-area intensities around high-capacity transit stops.

The eighth-mile radius TOD node is a useful planning tool, but it is important to note that the service area of a transit stop or station varies in size depending on the transit mode and service provided at the stop. For example, commuters are more likely to walk a greater distance to a heavy rail station than to a local bus stop. Commuter rail stations have even larger service areas and are typically served by feeder buses and park-and-ride lots. For more discussion of station service area, see the Federal Transit Administration (FTA) publication Planning for Transit-Supportive Development: A Practitioner's Guide.[11]

[11]Federal Transit Administration, Planning for Transit-Supportive Development: A Practitioner's Guide, Section 4: Corridor Planning and Transit-Supportive Development. https://www.transit.dot.gov/sites/fta.dot.gov/files/FTA_Report_No._0056.pdf

The Relationship Between Density and Transit

When considering transit investments, it is important that local communities develop clear goals for transit so that transit agencies can provide service that meets local needs. There is no single measure of success for transit service that applies to all regions and service types. In recent years, transit planners have emphasized the distinction between coverage-oriented service and ridership-focused service and highlighted the importance of finding the right balance between the two.

- A coverage approach spreads out transit service so that many households are near a transit stop
- A ridership approach focuses transit service in the areas that will achieve the highest total ridership.

Most transit agencies provide a combination of the two types of service, and it is important for local communities to choose the balance that best meets their needs.

As mentioned above, not all Multimodal Centers have transit within them. In fact, many of the lower-intensity Multimodal Centers (P-1 to P-3) have no transit service when they are located away from larger metropolitan areas. However, in higher-intensity Multimodal Centers, transit is typically a key feature in making the Multimodal Centers denser, more multimodal, and more vibrant.

TRANSECT ZONE INTENSITY		
Transect Zone	Activity Density (Jobs + people/acre)	Supported Transit Technology
T-1	1 or less	Demand Response
T-2	1 to 10	Demand Response
T-3	10 to 25	Fixed Route Bus
T-4	25 to 60	Express Bus
T-5	60 to 100	BRT/LRT
T-6	100 or more	LRT/Rail

Table 7: Supported Transit Technologies by Transect Zone.

MULTIMODAL CENTER INTENSITY		
Center Type	Activity Density (Jobs + people/acre)	Supported Transit Technology
P-6 Urban Core	70.0 or more	LRT/Rail
P-5 Urban Center	33.75 to 70.0	BRT/LRT
P-4 Large Town or Suburban Center	13.75 to 33.75	Express Bus
P-3 Medium Town or Suburban Center	6.63 to 13.75	Fixed Route Bus
P-2 Small Town or Suburban Center	2.13 to 6.63	Demand Response
P-1 Rural or Village Center	2.13 or less	Demand Response
SP Special Purpose Center	Varies	Varies

Table 8: Supported Transit Technologies by Multimodal Center Type.

What kinds of densities are needed to support transit? This is a frequent industry question and a complex issue that has been studied extensively. Density and demand for transit are closely linked together in a symbiotic relationship. As the intensity of activity in an area increases, so too does demand for travel to and from that area. If driving to and from the area is unattractive because of congestion or market-rate parking pricing, demand for transit service will increase. Conversely, the provision of high-capacity transit makes an area more accessible to the broader region, which increases land values and encourages a greater intensity of land use. Providing high-quality transit allows higher activity densities to occur, which then increases demand for transit.

Transit frequency and transit ridership are also closely linked. Decreasing the time a rider must wait for the bus or train to arrive makes a trip more reliable and improves a rider's experience. Although transit frequency is more a function of available funding and local priorities, density can be a proxy for determining the propensity for frequency, which can affect the density of development in the long term.

These Guidelines cannot address the full array of issues associated with transit and land use markets. However, these Guidelines have used a standardized approach to defining transit-supportive densities in Multimodal Centers correlated to different types of transit technologies, shown in Table 7. The supported transit technology simply means that the density levels for each Transect Zone or Multimodal Center type are generally high enough to generate adequate ridership to justify the investment in that particular type of transit service. However, it should be noted that in order to understand transit-supportiveness in a region, the densities for much broader areas than just a single Multimodal Center must be considered.

The transit-supportive density metrics in this chapter are based on the best-available guidance from the FTA and DRPT at the time of publication of the first edition of the Multimodal System Design Guidelines (2013):

- The FTA guidelines for transit supportiveness, and
- the DRPT Transit Service Design Guidelines

Both of these sources give typical residential and commercial density/intensity standards for transit-supportiveness. The FTA guidelines describe densities supportive of rail transit and the DRPT Transit Service Design Guidelines give densities supportive of bus transit. Using these existing standards as benchmarks, the densities needed for BRT and LRT were interpolated between these standards and checked against the densities of places in Virginia that had heavy rail transit (i.e. Metrorail stops) and LRT (Norfolk's Tide stations). The resulting transit-supportive Activity Densities for the T-1 through T-6 Transect Zones and the P-1 through P-6 Multimodal Center types are listed in Tables 7 and 8. It should be noted that the transit technologies are cumulative, i.e. that a Multimodal Center supporting a higher technology also supports the lower technologies.

Research on transit-supportive density has advanced in recent years, and the FTA has published additional guidance in Planning for Transit-Supportive Development: A Practitioner's Guide. These and other transit-supportive density metrics provide general guidance for aligning transit technology with land use.

Connections within Multimodal Centers

Density within TOD nodes is a substantial contributor to successful transit, but it is important to note that high-capacity transit stops serve an area that is larger than the eighth-mile radius TOD node. Connecting services such as feeder buses, shuttles, and shared scooters and bikes extend the reach of high-capacity transit and provide important last-mile connections. The FHWA's *Achieving Multimodal Networks* publication provides some guidance for designing multimodal access to transit stations. General design principles include safety, comfort, coherence, and predictability. Refer to this guide for detailed design strategies for multimodal connections[12].

Intercity rail and bus stations are often located within multi-modal centers near downtowns and other dense urban areas where multimodal connections are available. Station proximity to many potential trip destinations is one advantage of intercity rail and bus services compared to other modes. Although intercity stations have many things in common with other types of transit stations, they serve different kinds of trips. Travelers passing through these stations are typically taking longer trips and may have more luggage than the average commuter. Long-distance travelers may also be more likely to take a taxi to and from the station than daily commuters. It is important to consider these needs when designing multimodal connections to intercity stations. The streets adjacent to intercity stations should provide sufficient curb access for the modes likely to be used by intercity travelers connecting to and from their destinations, including taxis, buses, shuttles, and private vehicles. It is also important to note that generally, intercity passenger and commuter rail stations with only directional or rush hour service are not conducive to TOD because of the limited frequencies and large gaps in service (typically mid-day.) These stations, however, can support the development of dense multimodal centers when combined with a mixture of local high-frequency transit options, such as bus or BRT/LRT, serving local trips while also connecting passengers to longer intercity or commuter rail travel at certain times. For more information, see DRPT's Intercity Passenger Rail Station Policy[13] and Amtrak's Station Program and Planning Guidelines[14].

[12]Federal Highway Administration, Achieving Multimodal Networks, 2016, Page 71

[13]DRPT Intercity Passenger Rail Station Policy, 2017, http://www.drpt.virginia.gov/media/2372/station-stop-policy-final-010817.pdf

[14]Amtrak Station Program and Planning Guidelines, https://www.greatamericanstations.com/planning-development/station-planning-guidelines/

Transit Corridor Planning: Using the Multimodal Center Types, TOD Nodes and Multimodal Corridor Types

The Multimodal Center types and TOD Nodes are intended to work in concert with the Multimodal Corridor typology in these Guidelines to give a complete framework for planning for TODs and supportive land uses around station areas as part of an overall transit system plan. The steps involved in planning for TOD in the context of a transit corridor or system plan will vary from project to project. However, a basic six-step process for using the Multimodal Center and TOD typology is outlined below:

Step 1. Identify the destinations (Multimodal Centers) to be served by transit and the Multimodal Corridors that will serve each Multimodal Center.

Step 2. Identify the transit technology and type of service for the near and long terms, based on a thorough analysis of the potential market for transit and ridership projections.

Step 3. Identify the potential station areas based on the existing or proposed Multimodal Centers, spacing requirements of the transit technology, and overall future transit network.

Step 4. For each station area, identify the Multimodal Center type (P-3 to P-6) best suited to each station area based on the anticipated future build-out of the area.

Step 5. Develop a TOD plan for each station area based on the metrics for the type of Multimodal Center and TOD Node from the Guidelines.

Step 6. Develop Multimodal Corridor plans for each of the corridors within the TOD based on the Multimodal Corridor types in these Guidelines.

It is important to keep in mind that not all stations along a transit corridor will support dense TOD. Even a very successful transit line, such as the Metrorail Orange Line, can have relatively low-density land uses around some stations – particularly in more suburban areas at the end of the line.

It is important to keep in mind that not all stations along a transit corridor will support dense TOD. Even a very successful transit line, such as the Metrorail Orange Line, can have relatively low-density land uses around some stations – particularly in more suburban areas at the end of the line. Figure 46 shows the existing Activity Density of jobs plus population (called 24-hour population in the chart) within the Orange Line Metrorail corridor in Northern Virginia. It shows that well-developed Multimodal Centers, such as those in the Rosslyn to Ballston corridor exhibit this same typical pattern of higher density in the inner quarter-mile ring, while more dispersed Multimodal Centers such as those west of Ballston, tend to have relatively low densities in both the first and second quarter-mile rings. Note that this analysis is based on existing data and does not reflect the anticipated future growth in many of these station areas as articulated in Fairfax County's Comprehensive Plan.

In addition, as noted in the Orange Line example, it is important to note that the uniform "rings" of density shown in these Guidelines are idealized representations of the pattern of densities found in real-world Multimodal Centers and TODs. As shown in the map view of the same area in Figure 47, the highest densities (shown in dark red) do not always conform to a pattern of equal rings around the station areas, but can be "stretched" in the direction of the transit corridor and can overlap with adjacent Multimodal Centers when the station spacing is less than one mile.

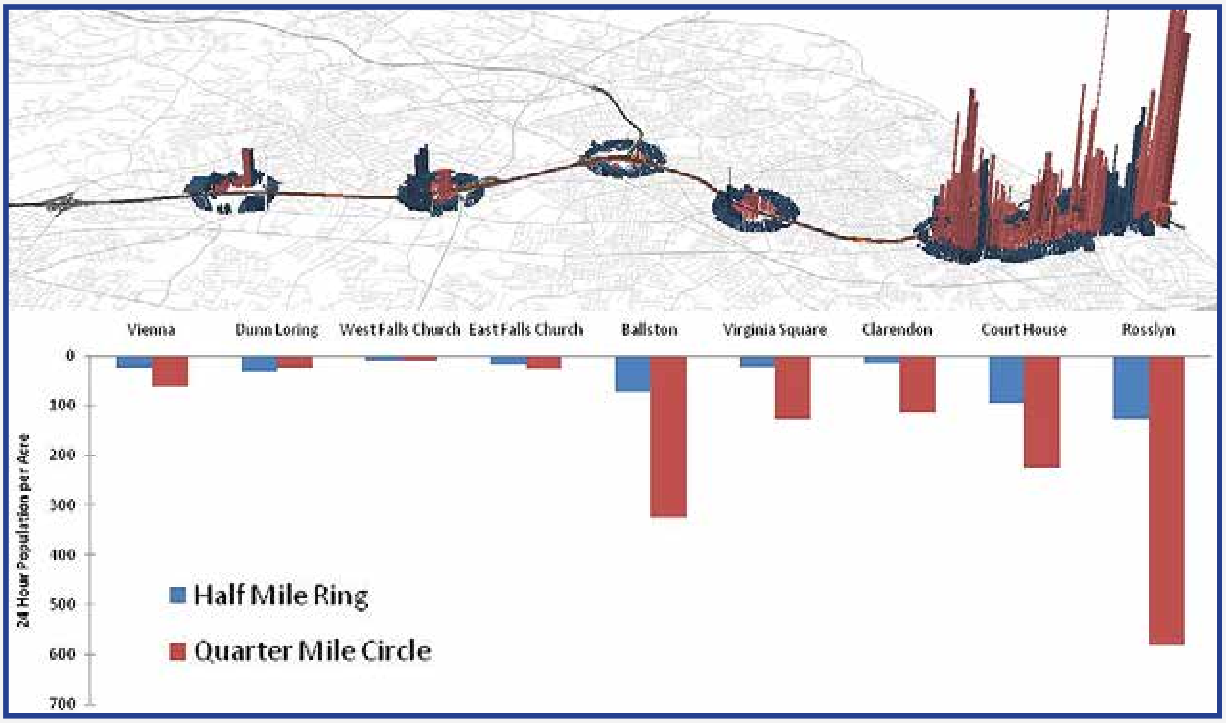

Figure 46: Analysis of Orange Line Metrorail Station Area Densities in Virginia. Stations in the Rosslyn to Ballston corridor show significant density differentials between the first and second quarter-mile rings.

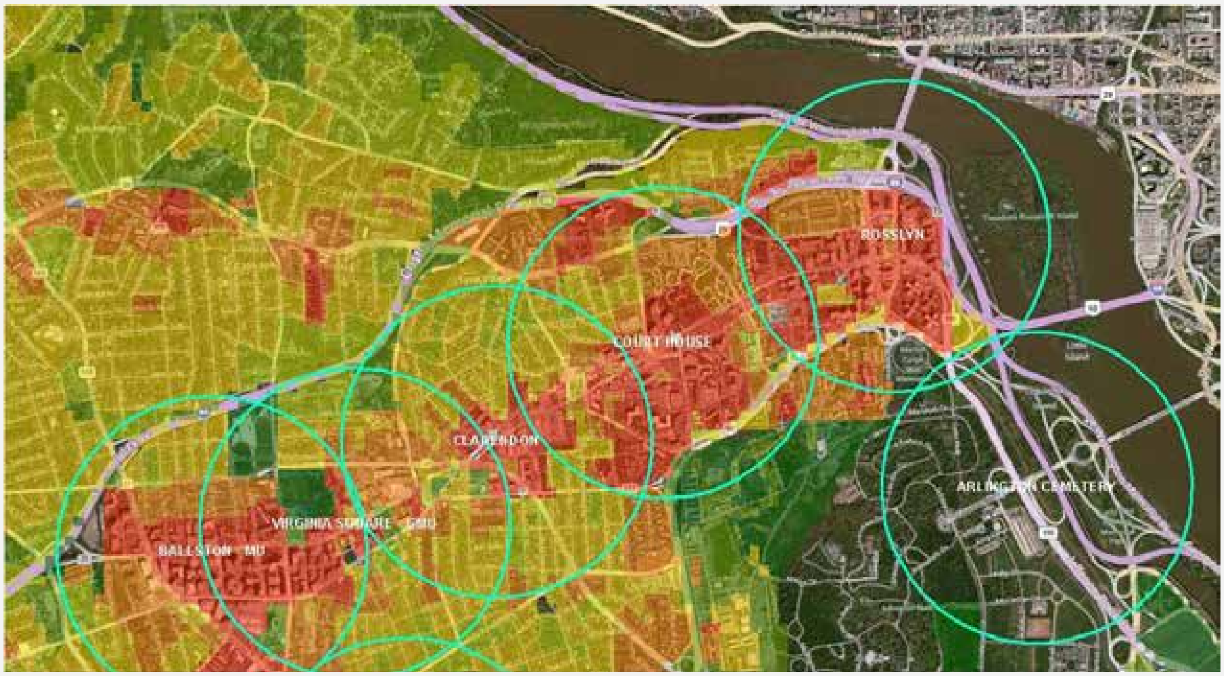

Figure 47: Map of Densities around Metrorail Stations in the Rosslyn/Ballston Corridor.

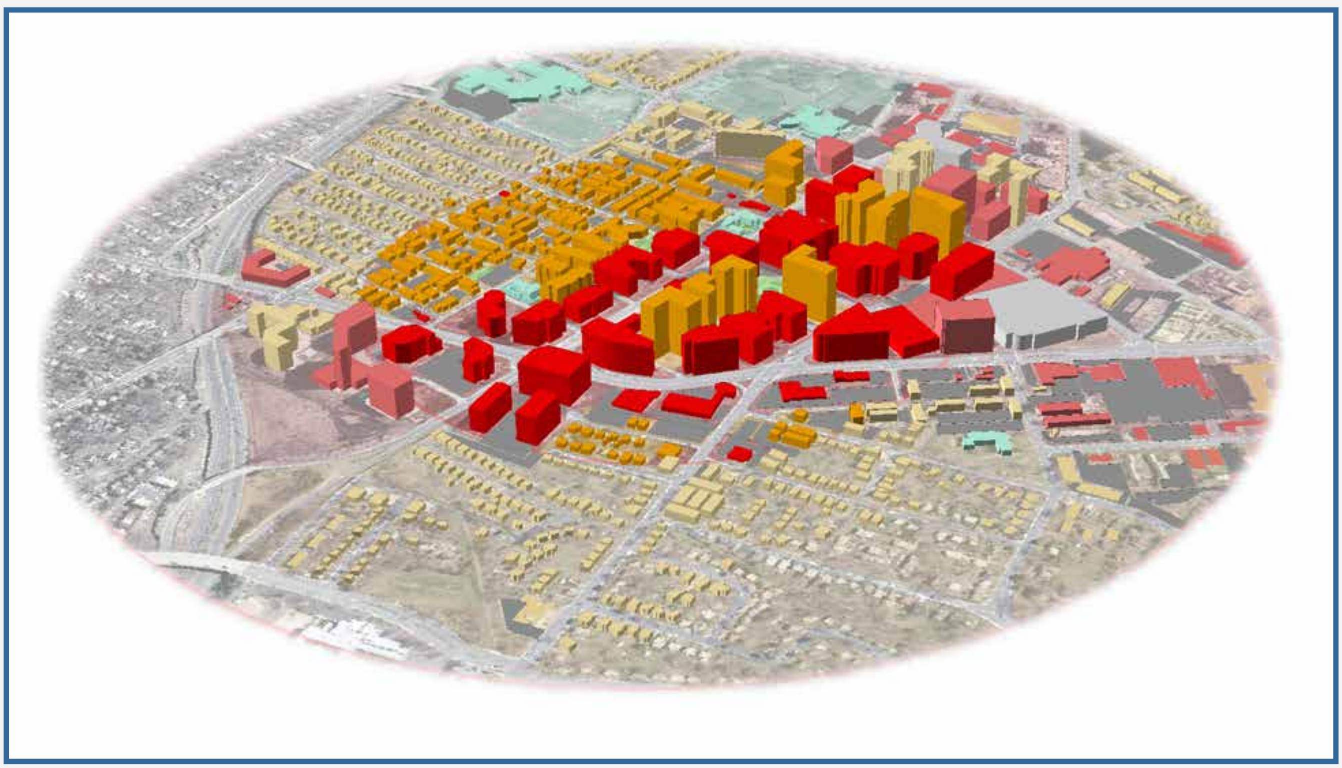

Figure 48: Ballston, VA. A stop on the Metrorail Orange Line shows many of the typical characteristics of a TOD Node within a P-6 Urban Core. Colors represent varying land uses.

Transit Service Design Principles

TOD nodes should be served by high-quality transit service that is designed to best meet the needs of its service area. These guidelines do not provide comprehensive advice for planning and implementing high-quality transit service, but there are a few key transit service design principles to consider when developing a multimodal system plan:

1. Transit routes should connect major activity centers in a direct manner, avoiding circuitous detours that increase travel time between destinations.
2. Transit stops should be spaced to balance passenger access and route speed. In most cases, bus stops should be located on the far side of intersections to avoid conflicts with right-turning vehicles and to minimize delay at intersections. Bus bulbs and boarding islands save time by allowing buses to drop off and pick up passengers without exiting and re-entering the flow of traffic.
3. Transit Modal Emphasis street treatments should be used to allow transit vehicles to bypass traffic congestion, improving the speed and reliability of transit. Bus-only lanes are a relatively cheap way to improve bus speeds and provide some of the benefits of higher-capacity transit. Queue jumps and transit signal priority are lower-impact tools for improving transit performance in constrained environments.

Figure 49: Broad Street Queue Jump at 9th Street, Richmond. Buses are given signal priority to get out in front of traffic. While the general traffic lanes have a red light, the vertical white bar indicates buses can proceed through the intersection. (Image Credits: VDOT (top), Google Earth (bottom))

CHAPTER 5

Multimodal Corridors

The prime goal of multimodal planning is to define a multimodal transportation network for an entire region or metropolitan area. Multimodal Corridors are the building blocks for such a system that move people and goods between and within Multimodal Districts and Multimodal Centers.

The previous chapters described how multimodal planning transitions from the regional scale to the scale of Multimodal Districts and Multimodal Centers. They described a series of Multimodal Center types based on the Activity Density (jobs + people per acre) in each. As shown in Chapter 3, a series of prototype diagrams for each Multimodal Center described the ideal or "prototypical" arrangement of Multimodal Corridors in each Multimodal Center. This chapter describes the Multimodal Corridor types that are the building blocks of each Multimodal Center. A Multimodal Corridor, as used in these Guidelines, is generally a roadway that accommodates multiple modes (or in special cases a trail or rail right-of-way) and that includes all the area within the public right-of-way, as well as the adjacent building context zone.

The prime goal of multimodal planning is to define a multimodal transportation network for an entire region or metropolitan area. Multimodal Corridors are the basic elements for such a system that move people and goods between and within Multimodal Districts and Multimodal Centers. As explained in Chapter 2, a true multimodal transportation system is one where travelers of every mode have a connected network of corridors to move within and between Multimodal Districts and Multimodal Centers. Without first understanding the context or identifying connected networks for each travel mode, designing individual corridors may lead to disconnected or underused facilities that fail to provide safe and convenient connections for people on foot and bike, and transit riders.

This chapter introduces a typology of Multimodal Corridors that is sensitive to the surrounding Activity Density and context and customized to the needs of the travel modes that are emphasized. This chapter explains how to design and retrofit corridors to best fulfill their multimodal functions within the larger regional multimodal transportation system. The flowchart in Figure 50 describes the design process for developing a typical cross-section for a Multimodal Corridor. Each step will be further described in this chapter.

Several sections of this chapter refer to the Corridor Matrix, provided in Appendix A. The Corridor Matrix provides customized design elements for each Multimodal Corridor type, as explained in this chapter. Appendix B is the Corridor Matrix Annotation Document, which thoroughly documents the engineering resources used to define the dimensions for each corridor design element.

This chapter explains how to design and retrofit corridors to best fulfill their multimodal functions within the larger regional multimodal transportation system. The flowchart describes the design process for developing a typical cross-section for a Multimodal Corridor. Each step will be further described in this chapter.

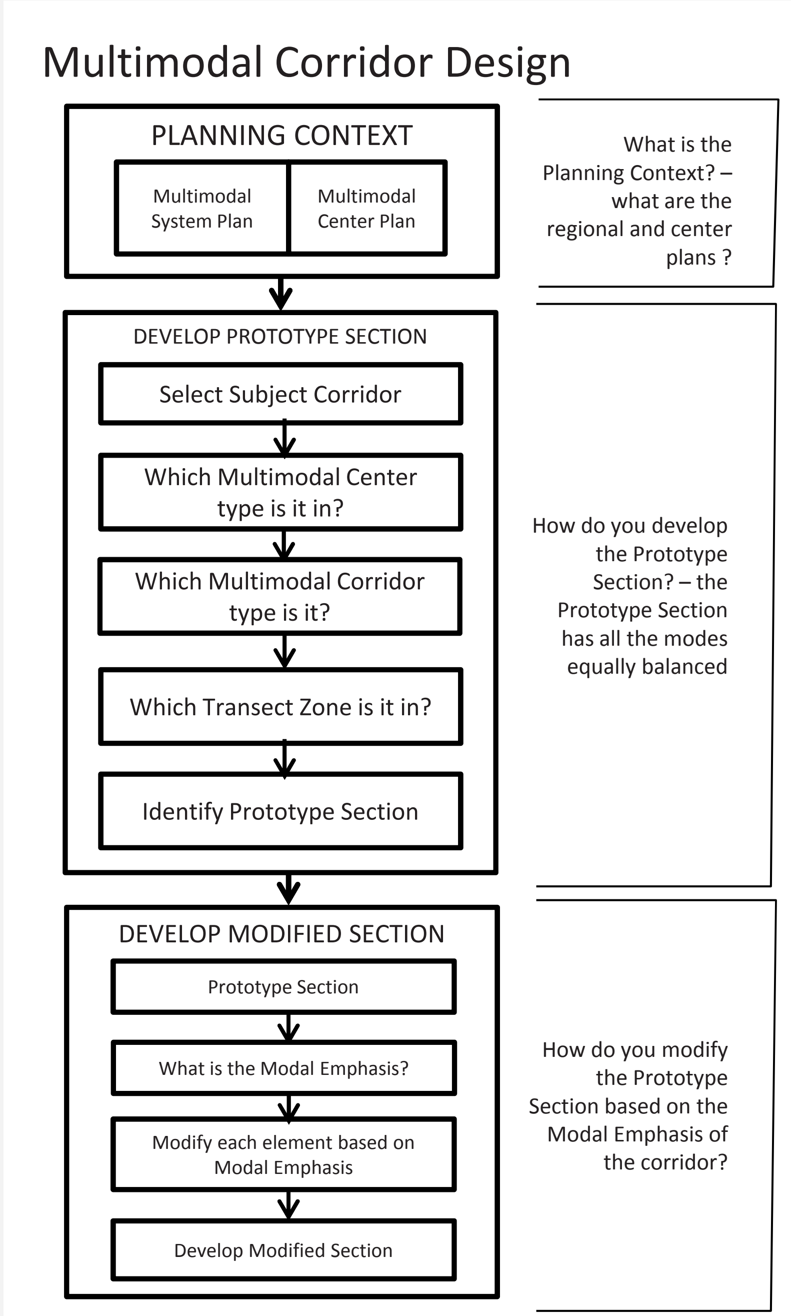

Figure 50: The Process for Designing Multimodal Corridors.

Multimodal Corridors and Complete Streets

Complete Streets are streets that are designed and operated to enable safe access for all travelers regardless of travel mode, age, and ability.

Localities across the Commonwealth and across the nation have undertaken the task of designing and redesigning streets to accommodate all travel modes safely and changing their land development and transportation infrastructure policies to make it easier to do so. At the state level, the Commonwealth Transportation Board adopted a Complete Streets Policy in 2004 that directs VDOT to initiate all highway construction projects with the principle that bicycling and walking modes shall be accommodated and to promote the inclusion of bicycle and pedestrian accommodations in transportation planning activities at local, regional, and statewide levels.

The overriding purpose of these Guidelines is the same as that of Complete Streets – to rethink the design of transportation infrastructure to make sure all people on foot, bicycle, and transit have equal access to all destinations. However, the approach of these Guidelines goes beyond simply accommodating all travel modes. Through the concept of Modal Emphasis, facilities for specified modes can go beyond minimum accommodation and be optimized according to the Multimodal System Plan for the region or locality.

As explained in Chapter 2, when a locality develops a Multimodal System Plan, it identifies and designates connected networks for each travel mode using Modal Emphasis to ensure that pedestrians, bicyclists, and transit riders can move between and within the Multimodal Districts and Multimodal Centers. The concept of Modal Emphasis is further explained later in this chapter. This process of designating connected networks for each mode looks beyond the individual street and ensures the entire transportation system is complete and safely accessible for all travelers.

The ideal Complete Street has designated space for each travel mode, including sidewalks, bike lanes, and transit service. However, many streets have limited rights-of-way, making it impossible to provide an optimal facility for each travel mode. The methodology for Multimodal Corridor design presented in these Guidelines allows additional flexibility to address constrained rights of way. It allows all modes to be accommodated at least using minimum acceptable dimensions according to industry standards. For those modes that are most important – according to the Multimodal System Plan – it also shows where to allocate any additional space within the right-of-way. This concept of Multimodal Corridor design is more fully described at the end of this chapter.

Many localities have implemented road diets, which repurpose travel lanes, and lane diets, which narrow the width of travel lanes, to reallocate right-of-way to facilities for non-vehicular modes such as bike lanes, wider sidewalks, and planting areas between the sidewalk and the road. In some instances, taking away travel lanes is the only way to make space for bike lanes. However, road diets need to be carefully considered in the context of available capacity and other operational issues. For this reason, these Guidelines do not address road diets that take away travel lanes. The methodology of corridor design assumes that the number of travel lanes for an existing corridor will remain the same. Localities may find that a road diet would be appropriate for a specific corridor, but road diets may require more in-depth study than outlined in these Guidelines.

FHWA provides resources for localities interested in pursuing road diets, including a Road Diet Informational Guide.[15] At the time of this writing, the Virginia Transportation Research Council is inventorying road diets completed in Virginia since 2010 and synthesizing studies on these and related projects. Concurrently, VDOT's Transportation and Mobility Planning Division has developed a Roadway Reconfiguration Guidance document. Both that guidance and the research report (The Report - *How's that Diet Working: Performance of Virginia Road Diets*) are anticipated to be completed by spring 2020. Regardless of whether the number of travel lanes is to change or remain the same, the process for multimodal corridor design within this chapter will be helpful in understanding the optimal and minimum corridor elements for each travel mode.

All Multimodal Corridors safely accommodate all travel modes regardless of Modal Emphasis. This is the basis for the "minimum" corridor design.

[15] FHWA's Office of Safety Programs provides resources on road diets at https://safety.fhwa.dot.gov/road_diets.

Guiding Principles for Multimodal Corridor Design

Multimodal corridor design is complicated and often requires professional engineering judgment. Several of NACTO's recent street design guides outline overarching guiding principles before outlining the technical design guidance as a way of recognizing that design decisions involve tradeoffs. The process for designing multimodal corridor cross-sections provided in this chapter is intended to result in safe, human-scaled streets. It is not intended to be overly prescriptive, but rather to allow designers to identify a variety of options for accommodating all modes. Design decisions inevitably involve tradeoffs, and a designer may decide one way in one circumstance and a different way in another similar circumstance. The following Guiding Principles are adapted from recent NACTO street design guides[16] and briefly summarized below. By keeping these principles in mind, designers can ensure that the decisions they make are in line with the overall principles for these Guidelines as articulated in Chapter 1.

Design for Safety

Streets should be designed to be safe and comfortable for all users. Recognize the needs of the most vulnerable users including children, seniors, and people with disabilities. Slower speeds and fewer conflicts make streets safer.

Move People, Not Cars

Designing for a range of mobility choices including transit, pedestrians, and bicyclists, and prioritizing efficient modes can both reduce demand for longer trips and increase the person-carrying capacity of the street.

Ensure Universal Accessibility

Streets should be safe and comfortable regardless of the physical ability, income, gender, culture, and language of their users.

Streets Can Change

Temporary demonstration projects using low-cost materials are quick to both implement and deconstruct. They allow communities to test out new concepts with low risk to help inform public decision-making.

[16] Including the Global Street Design Guide, Urban Street Design Guide, and Transit Street Design Guide

Multimodal Through Corridors and Placemaking Corridors

Corridors have different functions in a region. Some corridors are used to get smoothly and rapidly through a region or to get quickly to major destinations in the region. For the purpose of these Guidelines, these kinds of corridors are called Multimodal Through Corridors. Other corridors have slower speeds and are used to access local businesses, residences, and activities within a destination. Usually these types of corridors are found in Multimodal Districts and Multimodal Centers, and they are called Placemaking Corridors in these Guidelines.

This fundamental distinction between Multimodal Through Corridors and Placemaking Corridors is a key concept in these Guidelines. All Multimodal Corridors within a Multimodal Center, and often many of the corridors in a Multimodal District, are considered to be Placemaking Corridors.

Placemaking corridors do more than facilitate movement to destinations within a Multimodal Center or District; they are designed for pedestrians, are an integral part of public space, and offer opportunities for social interaction, place identity, and neighborhood pride. The higher-speed Multimodal Corridors that travel between and connect Multimodal Centers within a Multimodal District, or connect between Districts, are considered to be Multimodal Through Corridors. Multimodal Through Corridors and Placemaking Corridors work together in a region by getting people quickly from one Multimodal District or Multimodal Center to another and ultimately to activities within a Multimodal District or Multimodal Center. Multimodal Through Corridors will typically transition to Placemaking Corridors as they enter a Multimodal Center. Ideally, though, they are located at the edge of Multimodal Centers, remaining as higher-speed facilities to which Placemaking Corridors provide access from the core of the Multimodal Center.

Placemaking Corridors are usually located within Multimodal Centers but can extend outward beyond the Multimodal Center boundaries into a Multimodal District. Any street that communities desire to make into a lively, pedestrian-oriented street may be designated as a Placemaking Corridor, regardless of location. Because of the concentration and diversity of land uses within Multimodal Centers, the streets within Multimodal Centers should be designated as Placemaking Corridors.

Multimodal Through Corridors are located exclusively outside of Multimodal Centers, but may traverse Multimodal Districts. If possible, Multimodal Centers should be located such that Multimodal Through Corridors skirt the edges of a Multimodal Center. Alternatively, Multimodal Through Corridors should transition to Placemaking Corridors if they go through a Multimodal Center. Once they have passed through the Multimodal Center, they may transition back to Multimodal Through Corridors.

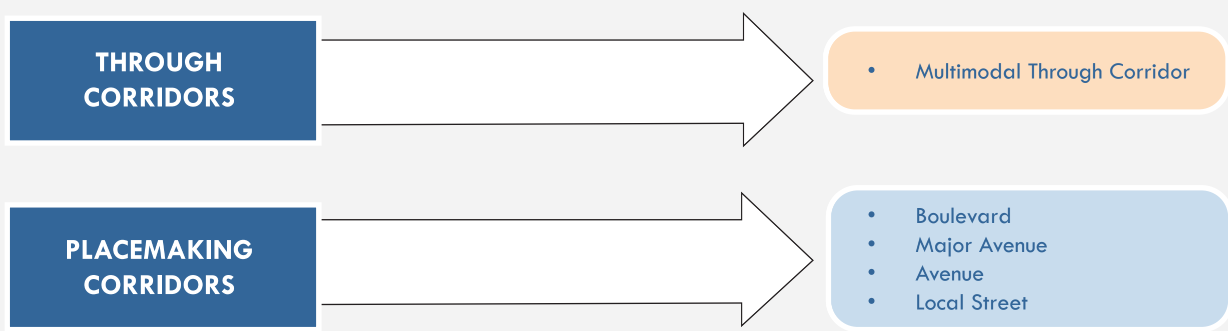

Figure 51: List of Multimodal Corridor Types.

The basic relationship between Multimodal Through and Placemaking Corridors is described in Figure 52.

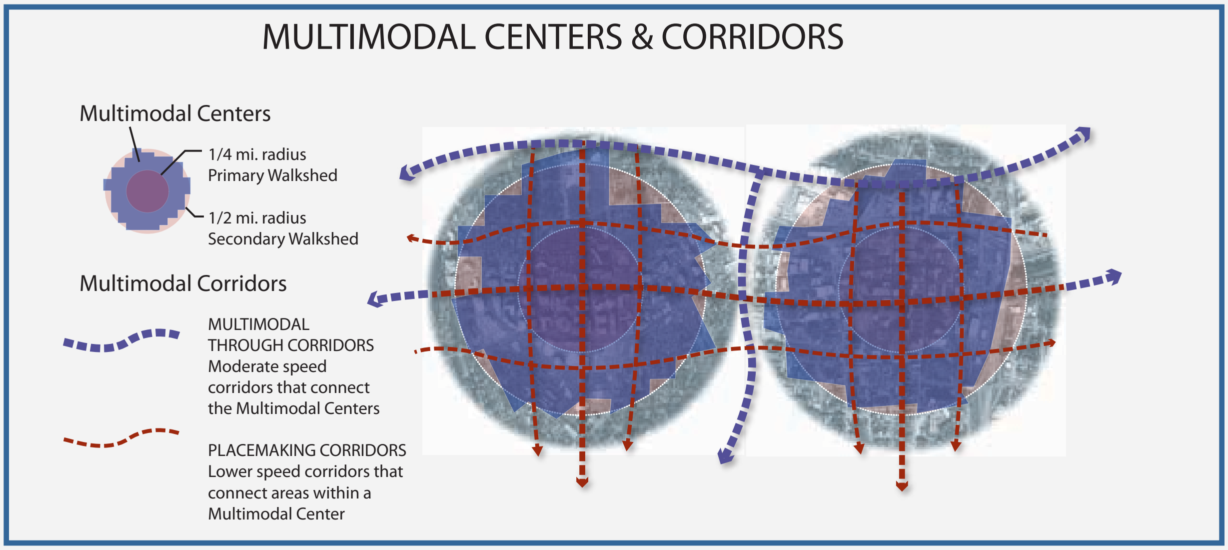

Figure 52: Multimodal Through and Placemaking Corridors. The diagram distinguishes Placemaking Corridors from Multimodal Through Corridors – the two general categories of Multimodal Corridors that together comprise a true multimodal transportation system in a region.

Multimodal Through Corridors

The Multimodal Through Corridor is a moderate-speed corridor that connects multiple activity centers. It is intended for longer-distance, higher-speed automobile, bus, or rail travel and ideally has limited at-grade intersections with other roads. Multimodal Through Corridors are good candidates for high-speed commuter transit, having few impediments to traffic flow. High speeds limit pedestrian and bicycle modes and hence the corridor design should provide separated facilities for these modes. The design of the adjacent buildings should be oriented away from Multimodal Through Corridors and towards Placemaking Corridors on the other side of the buildings, providing more desirable pedestrian facilities and pedestrian-oriented land uses on the Placemaking Corridors, while still accommodating pedestrian travel along the Multimodal Through Corridors. Design speeds for Multimodal Through Corridors range from 35 to 55 mph.

Figure 53: Fairfax County Parkway. An example of a Multimodal Through Corridor.

Placemaking Corridors

Within Multimodal Centers, the street network consists of different types of corridors with different functions relative to access, mobility, and multimodal features. Placemaking corridors are thus further divided into five types, each of which has a unique function and interface with the surrounding land uses. The following five Placemaking Corridor types were derived from the basic typology of Boulevard, Avenue and Street used in the ITE/CNU Guidebook, but with two additional Multimodal Corridor types added. The Major Avenue provides additional flexibility between the Avenue and Boulevard corridor types. The Slow Street was added in the 2020 Update to reflect the latest design guidance for bicycle boulevards, shared streets, and other streets with slower design speeds.[17] The five Placemaking Corridor types used in these Guidelines are described below:

Boulevard

A Boulevard is the corridor type of highest multimodal capacity that accommodates multiple motorized and non-motorized modes. Boulevards allow for higher traffic volumes and greater efficiency of vehicular movements than Major Avenues, Avenues, and Local Streets. They typically have four to six lanes of traffic but may grow to eight in particularly dense centers such as Tysons. Boulevards provide safe and convenient pedestrian and bicycle access to adjacent land uses. Boulevards feature a median, landscaped amenity elements, street trees, and wider sidewalks. Design speeds for Boulevards range from 25 to 35 mph.

Figure 54: Fairfax Drive in Arlington County. An example of a Boulevard. (Image Credit: Google Earth)

Major Avenue

Major Avenues contain the highest density of destinations, intensity of activity, and mix of modes. Because of the close proximity of destinations, pedestrians and street activity are common on Major Avenues. Major Avenues have wide sidewalks to accommodate high numbers of pedestrians and a variety of outdoor activities, including sidewalk cafes, kiosks, vendors, and other street activities. Major Avenues can be areas of high transit ridership for local bus routes. Traffic is low-speed and localized. Due to the intensity of destinations, longer regional trips do not use Major Avenues; rather they would typically be on Boulevards or Multimodal Through Corridors. Cars and buses on Major Avenues travel at slow speeds, because pedestrian crossings and on-road bicyclists are frequent. Major Avenues typically have four or fewer lanes for motor vehicle travel while providing adequate facilities for bicycling and typically providing roadway space dedicated to curbside activity. Design speeds for Major Avenues range from 25 to 35 mph.

Figure 55: Bank Street in Richmond. An example of a Major Avenue. (Image Credit: VDOT)

[17] The original 2013 Guidelines included a Transit Boulevard placemaking corridor type – a boulevard with a dedicated right-of-way for transit. The 2020 Update eliminated this as a separate corridor type and added a Transit Element to the Corridor Matrix that is applicable for all multimodal corridor types, not just the Boulevard.

Avenue

Avenues provide a balance between access to the businesses and residences that front upon them and the collection of vehicular and pedestrian traffic. While having fewer destinations than Major Avenues. Avenues serve as critical links in the non-motorized network. Avenues are low-speed roadways that facilitate shorter trips but still contain a fair amount of destinations. Avenues typically have three travel lanes or fewer and do not exceed four lanes. Avenues may have roadway space dedicated for curbside activity and provide adequate bicycle facilities. Avenues have a 25-30 mph design speed.

Figure 56: Market Street in Charlottesville. An example of an Avenue. (Image Credit: EPR, P.C.)

Local Street

Local Streets see a low amount of activity and have slow speeds and high access. Bicyclists typically can share the road with autos, because speeds are slow and auto traffic is sparse, although separate sidewalks or trails accommodate pedestrians. Local Streets are primarily in residential areas and are intended to serve only trips that originate or end along them. They connect to Avenues, Boulevards or Major Avenues, funneling longer trips to these higher-capacity corridor types. Local Streets are characterized by slow design speeds and wider setbacks; they may not have lane striping, and they emphasize on-street parking. Local Streets have a 25 mph design speed.

Figure 57: Colonial Street in Williamsburg. An example of a Local Street. (Image Credit: Google Earth)

Slow Street

Slow Streets are a special kind of Local Street designed for extremely low vehicle speeds – with maximum speeds of 20 to 25 mph and the majority of motorists going slower. Slow Streets would typically be found in residential neighborhoods. Slow Streets may be used as Bicycle Boulevards – where signage, pavement markings, and speed and volume management measures discourage motor vehicles from using streets as cut-throughs while giving bicycle travel priority. Slow Streets may use traffic -calming devices like gateway treatments, neighborhood traffic circles, and speed tables to make high speeds difficult to achieve. This reduces the speed differential between motorized vehicles and non-motorized users. Neighborhood greenways and shared streets are special types of Slow Streets.

Slow Streets are an option for Local Streets on non-VDOT maintained roadways. Posted speeds are typically 20 mph or less. The Slow Street corridor type is not included in the Corridor Matrix in these Guidelines. Practitioners interested in Slow Streets can refer to the Slow Streets section of FHWA's Achieving Multimodal Networks 2016 publication, which provides design guidance, considerations, case studies, and further references. The NACTO Urban Street Design Guide also provides information on several types of streets that could be considered Slow Streets, including Yield Streets and Residential Shared Streets.

Figure 58: Old Town Alexandria. The cobblestone streets in Old Town Alexandria require vehicles to operate at very low speeds.

Transitions Between Through Corridors and Placemaking Corridors

When Multimodal Through Corridors enter a Multimodal Center, the surrounding context signals a change in corridor character and function, and they transition to Placemaking Corridors. This transition is marked by slower traffic speeds, more frequent pedestrian crossings, and pedestrian-oriented buildings. Multimodal Through Corridors that transition to Placemaking Corridors can maintain vehicular throughput by access management (consolidating driveways and unsignalized intersections to minimize the number of entrances onto a road) and traffic signal coordination and optimization. These techniques are particularly relevant for Corridors of Statewide Significance, National Highway System Routes, and emergency evacuation routes.

Relationship to Functional Class

The Multimodal Corridor typology within these Guidelines is related, but not identical, to the functional classification of roads. Functional classification is a concept within roadway design and engineering circles that recognizes that roads have different functions for motorized vehicles. Streets that provide direct access to destinations for cars via driveways, curb cuts, and frequent intersections often cannot retain high speeds and serve high volumes of traffic. Conversely, high-capacity roads with heavy volumes and higher speeds have less frequent access points to keep traffic moving.

Roads are designated into functional classes mainly for federal and state funding purposes. FHWA provides guidelines on how to classify roads, based on having a certain percentage of total road miles for each classification. For example, urban principal arterials should only account for 5 to 10 percent of an area's total road centerline miles but should carry 40 to 65 percent of the area's total vehicle-miles traveled.

Functional classification is also a relevant concept for Multimodal Corridor design, but must be broadened to include other travel modes. The five types of Placemaking Corridors are different in nomenclature from the functional classification systems used by VDOT and FHWA. However, the concept of functional classification is similar. The Corridor Matrix Annotation Document in Appendix B has a more detailed discussion of VDOT functional classification. Table 9 shows the general translation of Multimodal Corridor types to the functional classes of roadways.

<table>
<tr><th rowspan="2"></th><th colspan="5">VDOT Functional Classification (Design Speed)</th></tr>
<tr><th>Interstate, Freeway, or Expressway (50 – 70 mph)</th><th>Urban Other Principal Arterial (25 – 60 mph)</th><th>Urban Minor Arterial (25 – 60 mph)</th><th>Urban Collector (25 – 50 mph)</th><th>Local Street (20 – 30 mph)</th></tr>
<tr><th rowspan="5">Multimodal Corridor Types (Design Speed)</th><td colspan="2">Multimodal Through Corridor (35-55 mph)</td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="2">Boulevard (25-35 mph)</td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="2">Major Avenue (25-35 mph)</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Avenue (25-30 mph)</td></tr>
<tr><td></td><td></td><td></td><td></td><td>Local Street (25 mph)</td></tr>
</table>

Table 9: Comparison of VDOT Functional Classes to Multimodal Corridor Types.

The Multimodal Corridor types do not have a one-to-one correlation to the VDOT functional classes. The Multimodal Corridor types are purposely elastic to allow localities flexibility in designating roads into Multimodal Corridor types. A road may be classified into one particular functional class to meet the FHWA percentage criteria but may serve a very different function for non-motorized modes. For example, Water Street in Charlottesville is designated as an Urban Collector, but with multi-story buildings on either side of the street and ground-floor pedestrian-oriented retail, it serves a higher function for pedestrians and transit, and would likely be classified as a Major Avenue.

Planners should consider the functional classification of a road as one factor when designating roads into the various Placemaking Corridor types. Other factors to consider would be the amount of pedestrian-generating land uses that line the street, the number of transit routes that serve the corridor, and the length and frequency of connections to other roads.

Figure 59: Water Street in Charlottesville. Although classified as an Urban Collector in VDOT's Functional Classification system, Water Street functions more like a Major Avenue for pedestrians, bicyclists, and transit. (Image Credit: Google 2020)

Design and Posted Speeds

Although the concepts of design, target, and posted speeds are explained in more length in Appendix B: Corridor Matrix Annotation Document, it is important to note that speed is a critical factor in roadway safety, especially for pedestrians and bicyclists. If a vehicle hits a pedestrian at a speed of 25 mph, the likelihood of the crash resulting in the pedestrian's death is 12 percent, on average. At 30 mph, the likelihood of death increases to 20 percent, and at 40 mph, the likelihood of death is 45 percent. The risk of severe injury is 30 percent at 25 miles per hour and 79 percent at 45 miles per hour.[18]

Cities like Richmond, Alexandria, and Norfolk are joining other communities across the U.S. in publicly setting a clear goal of eliminating traffic fatalities by adopting Vision Zero policies. One of the key strategies in Vision Zero plans and policies is setting and managing travel speeds by lowering posted speed limits, reducing the number and/or width of travel lanes, and implementing traffic calming infrastructure changes, among other tactics.[19]

Each of the Multimodal Corridor types in these Guidelines has a range of design speeds, shown in Table 9. The 2020 Update to these Multimodal System Design Guidelines lowers the minimum design speed for Boulevards and Major Avenues from 30 mph to 25 mph to reflect the trend of reducing vehicle speeds to improve safety for pedestrians, bicyclists, and other vulnerable road users.

Designating Multimodal Corridor Types in thwe Multimodal System Plan

As described in Chapter 2, preparing a Multimodal System Plan involves identifying the Multimodal Districts and Multimodal Centers and designating the streets within the Multimodal Districts and Centers as different Multimodal Corridor Types. It is important to identify the Multimodal Through Corridors and Placemaking Corridors in combination with the Multimodal Districts and Multimodal Centers.

For example, the activity density mapping may indicate a hot spot of activity along a high-capacity, higher-speed road. If a Multimodal Center is designated at this spot with the areas on both sides of the road included in the Multimodal Center, then within the Multimodal Center the road should be designated as a Placemaking Corridor with lower speeds. Alternatively, if the road needs to be maintained as a higher-speed facility, the road could be designated as a Multimodal Through Corridor, and the Multimodal Center may be designated on one side of the road only, or two separate Multimodal Centers could be designated on either sides of the road. If the road is designated as a Multimodal Through Corridor with two separate Multimodal Centers on either side, pedestrian connections across the Multimodal Through Corridor should be provided, either grade-separated connections if the Through Corridor remains higher-speed, or at-grade connections with reduced corridor speed.

Dedicated Transit Facilities

The original 2013 Multimodal System Design Guidelines had one additional Placemaking Corridor Type – the Transit Boulevard, which was a Boulevard with a dedicated lane or right-of-way for transit. However, dedicated transit lanes can occur on any corridor type, not just Boulevards. The 2020 Update to the Guidelines eliminates the Transit Boulevard as its own corridor type and adds a Transit Element to the Corridor Matrix for all corridor types. The Transit Element values in the Corridor Matrix are from the NACTO Transit Street Design Guide. Readers should reference the NACTO Transit Street Design Guide for more information on planning and designing dedicated transit facilities on multimodal corridors.

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[18] Teft, B. 2011. Impact Speed and a Pedestrian's Risk of Severe Injury or Death. AAA Foundation for Traffic Safety. Retrieved from https://aaafoundation.org/wp-content/uploads/2018/02/2011PedestrianRiskVsSpeedReport.pdf on 08 Jan 2020.
[19] The Vision Zero Network provides information and resources at www.visionzeronetwork.org

Corridor Intensity Zones

Just as the Transect Zones were used to define intensity zones in the Multimodal Centers, they are also used to define intensity levels among Multimodal Corridors. Within each Multimodal Corridor type, there is a spectrum of land use contexts ranging from T-1 to T-6. The intensity levels directly correspond to the Transect Zones. The purpose of applying Transect Zones to the Multimodal Corridor types is to describe the context surrounding a particular corridor. For example, a Local Street in a T-1 context zone is vastly different from a Local Street in a T-6 context zone. Both corridors may function similarly, i.e. to carry purely local traffic within a neighborhood. However, the Local Street in a T-1 rural context may have very low density development, wide setbacks and correspondingly rural design details in the corridor, while the Local Street in a T-6 urban context may have high density development, narrow setbacks and more urban design details. Therefore, each of the six Multimodal Corridor types is modified by its Transect Zone.

Not all intensity levels exist in all Multimodal Corridor types. For example, the intensity levels for a Boulevard range from T-6 to T-2, since a very low-intensity Boulevard is not practical. In the least dense Multimodal Center (P-1), roads that provide a high level of mobility will not correspond with the description and function of a Boulevard. In these cases, a Major Avenue or Avenue will serve as the primary Multimodal Corridor within the Multimodal Center and will provide the facilities for multimodal transportation scaled to their less dense context.

The purpose of applying Transect Zones to the Multimodal Corridor types is to better describe the context surrounding a particular corridor. For example, a Local Street in a (P-1) Rural Center is vastly different from a Local Street in a (P-5) Urban Center.

The Multimodal System Design Guidelines are designed to address urban and rural areas of many scales and intensities. A Rural or Village Center may be a village crossroads through which two regional routes (or a regional route and a smaller road) intersect. For example, in the small town of Palmyra in Fluvanna County, US 15 intersects with Courthouse Road. Outside of this local center, US 15 has a posted speed limit of 55 mph with no sidewalks and is used for high speed regional auto travel. But within the primary walkshed of the center, the road serves a different function. It becomes more like a Major Avenue as described above, although it is located within what could be described as a P-2 (Small Town or Suburban Center) context.

In this example, the Transect Zones differentiate the intensity levels of similar Multimodal Corridor types. For example, a Major Avenue in downtown Richmond looks and feels different from the Major Avenue just described in Palmyra, but the functions of the two roads are similar: They both serve more localized traffic, contain destinations for pedestrians, have slower speeds to allow safe pedestrian crossings, and focus on destinations and access than mobility. The T-Zones, however, help differentiate the intensities and characteristic features of the two examples of Major Avenue corridors – one rural and one urban.

Table 10 specifies which Multimodal Corridor types are appropriate for each Transect Zone.

Multimodal Corridor Types	Transect Zone (Intensity Zone)					
	T-6 High Intensity	T-5 Medium High Intensity	T-4 Medium Intensity	T-3 Medium Low Intensity	T-2 Low Intensity	T-1 Very Low Intensity
Boulevard	Boulevard	Boulevard	Boulevard	Boulevard	Boulevard	
Major Avenue	Major Avenue	Major Avenue	Major Avenue	Major Avenue	Major Avenue	Major Avenue
Avenue	Avenue	Avenue	Avenue	Avenue	Avenue	Avenue
Local Street	Local Street	Local Street	Local Street	Local Street	Local Street	Local Street
Multimodal Through Corridor	Multimodal Through Corridor	Multimodal Through Corridor	Multimodal Through Corridor	Multimodal Through Corridor	Multimodal Through Corridor	Multimodal Through Corridor

Table 10: Relation of Transect Zones to Multimodal Corridor Types.

Other Typologies of Multimodal Corridors

The corridor typology in original 2013 Multimodal System Design Guidelines was primarily based on the Boulevard, Avenue, and Local Street typology in the ITE/CNU Designing Walkable Urban Thoroughfares Guidebook, which was published in 2010. Since 2013, NACTO has published several street design guidebooks which each contain a unique street typology.

- The NACTO Urban Street Design Guide outlines 13 different street types including Downtown Thoroughfares, Neighborhood Main Streets, Residential Shared Streets, and Green Alleys.
- The NACTO Transit Street Design Guide provides a typology of streets with different types of transit facilities in a variety of contexts including Downtown Shared Transitways, Offset Bus Lane Streets, Edgefront Transit Streets, Contraflow Transit Streets, and Parallel Paired Transitways, among others.
- The NACTO Global Street Design Guide encourages practitioners to identify a range of street typologies. It presents a list of 21 different street types ranging from Pedestrian-Only Streets to Grand Streets to Streets in Informal Areas.
- Sidewalk Labs, Alphabet Inc.'s urban innovation organization, outlines four street types – Laneways, Accessways, Transitways, and Boulevards – in Street Design Principles. These street types prioritize different modes, separate streets by speed, and take advantage of technological advancements to make streets narrower and safer while still getting people where they need to go.

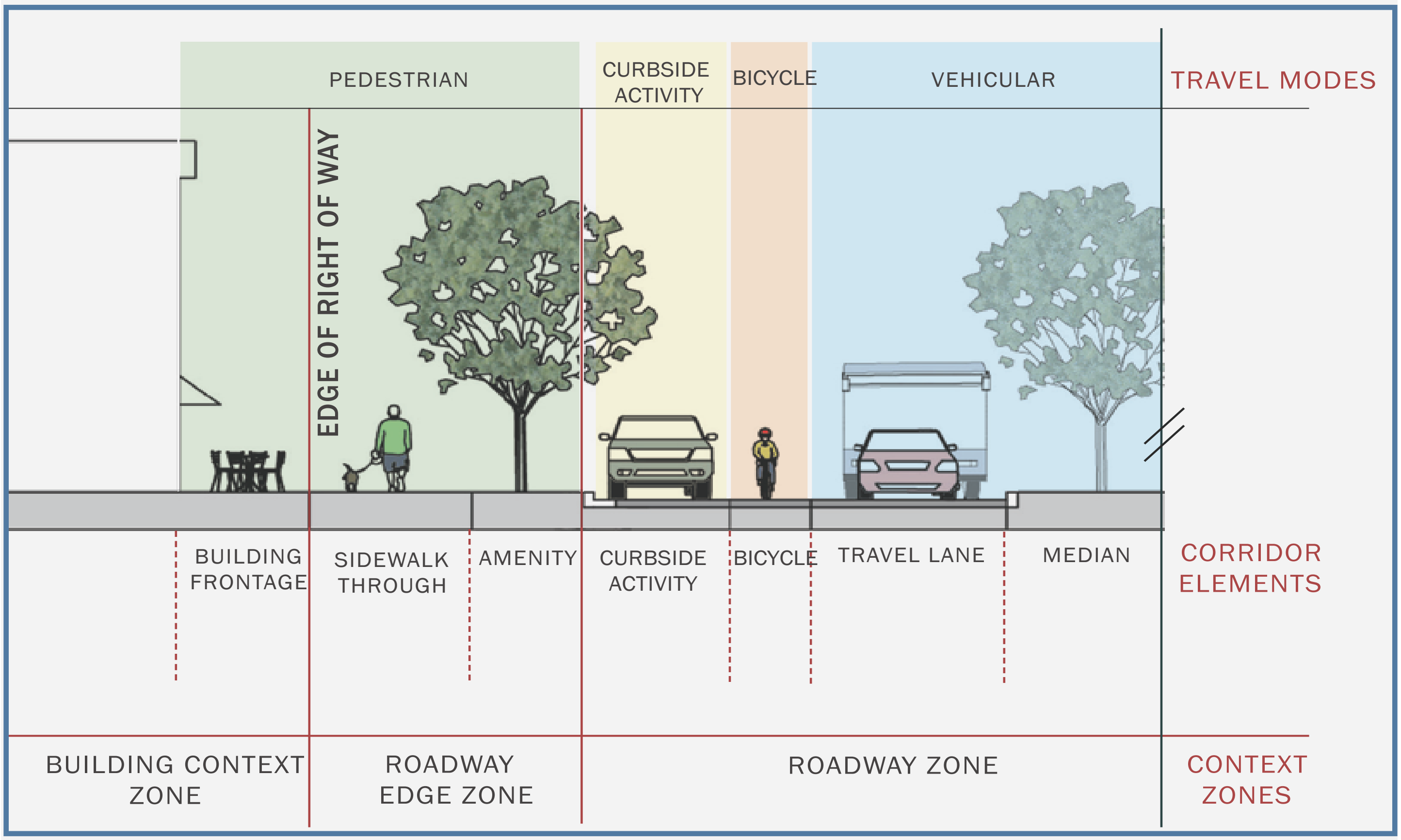
These new street typologies are more nuanced than the corridor types presented in these Multimodal System Design Guidelines, and they generally apply only in urban areas. The corridor types in these Guidelines span a full spectrum of context types, including suburban areas and small rural towns. The purpose of these Guidelines is to provide an overarching framework for multimodal corridor design that applies to the full range of contexts in Virginia. Practitioners working in urban contexts may find the additional street types in the NACTO guidebooks useful for a variety of different functions and contexts that only apply in urban areas.

Using Corridor Elements

The most important step in designing Multimodal Corridors is to understand the typical Corridor Elements that make up a Multimodal Corridor. Figure 60 is a diagram of a cross-section that is broken down into Context Zones, which are broad segments of a corridor that contain different contexts such as the Building Context, Roadway, and Roadway Edge Zone. Each Context Zone is further broken down into Corridor Elements, which are the individual "pieces" of the corridor, such as the Travel Lane element, Median element, Curbside Activity element, etc.

For ease of identification in these Guidelines, each Corridor Element is assigned a letter and is referenced in the master Corridor Matrix in Appendix A. The Corridor Matrix lists the recommendations for the design and the size of each Corridor Element according to the type of Multimodal Corridor and T-Zone. Also shown in Figure 60 are the typical travel modes associated with each Corridor Element.

Figures 61 and 62 illustrate the pedestrian and vehicular corridor elements on street in Roanoke and Portsmouth.



Note: Not all modes are shown in this diagram. Some modes such as Green, that overlaps with other modes, are not precisely depicted. Refer to Corridor Matrix for recommended dimensions for each Corridor Element by Corridor Type and Transect Zone. In some instances, the Bicycle element may be located between the curb and an on-street parking lane, or behind the curb. Possible configurations and treatments for the Bicycle element are discussed in more detail in Appendix B: Corridor Matrix Annotation Document.

Figure 60: Diagram of Context Zones, Corridor Elements, and Travel Modes.

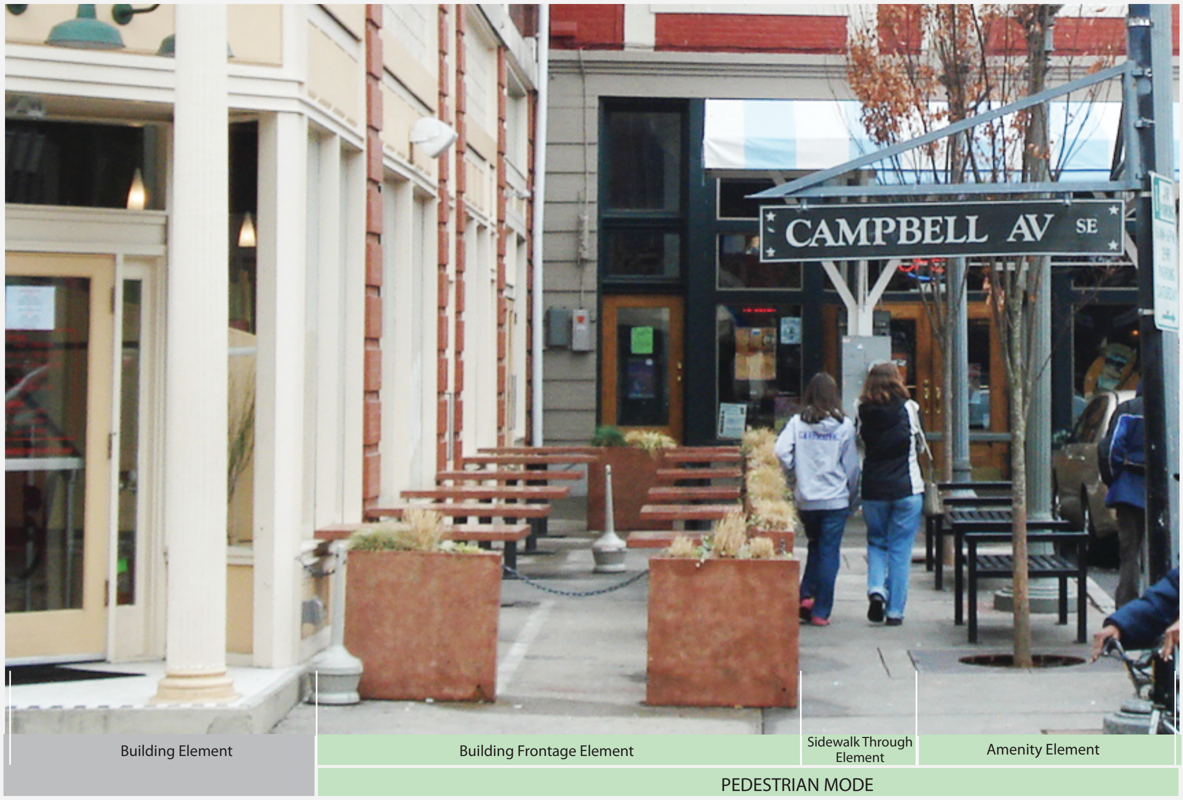


Figure 61: Pedestrian Corridor Elements Illustrated on a Street in Roanoke.

Figure 62: Vehicular Corridor Elements Illustrated on a Street in Portsmouth.

This understanding of how Corridor Elements serve different travel modes is essential to understanding how to plan Multimodal Corridors using Modal Emphasis, described in the following sections.

Planning For Modal Emphasis

One of the most important features of these Guidelines is the process for designing corridors around Modal Emphasis. Modal Emphasis is defined in these Guidelines as giving greater weight, or emphasis, to those elements of the street that serve a particular travel mode. It is important to note, however, that Modal Emphasis does not mean that other travel modes are excluded – other modes are still accommodated in a Multimodal Corridor - Modal Emphasis means the primary but not the sole travel mode that is emphasized on a corridor. This is a realistic way of looking at travel mode accommodation within a Multimodal Corridor planning context.

While there may occasionally be cases where some modes are excluded (as in a pedestrian-only street, for example), the basic principle followed in these Guidelines is to accommodate as many modes as possible within a Multimodal Corridor. All Multimodal Corridors provide at minimum safe accommodations for all travel modes. Modal Emphasis simply prioritizes which Corridor Elements (e.g. sidewalks, bicycle lanes, travel lanes, etc.) will receive additional space, according to the travel modes that are emphasized (pedestrian, transit, bicycle, or a combination thereof). The Modal Emphasis for each corridor is determined through the Multimodal System Plan, which is explained in Chapter 2.

In addition to non-auto travel modes, there are other considerations that affect which Corridor Elements are emphasized in cross-section design. These additional considerations include curbside activity in bustling commercial areas, and special landscaping features along entrance corridors or other "Green Streets." Although, "Curbside Activity" and "Green" are not travel modes, they are considerations for emphasis in corridor cross-section design and are incorporated in the Multimodal Corridor design methodology in these Guidelines. Curbside Activity and Green considerations are not identified in a Multimodal System Plan, but rather are designated during corridor design.

For the purposes of these Guidelines, the modes and other considerations that are used to define Modal Emphasis on a corridor are:

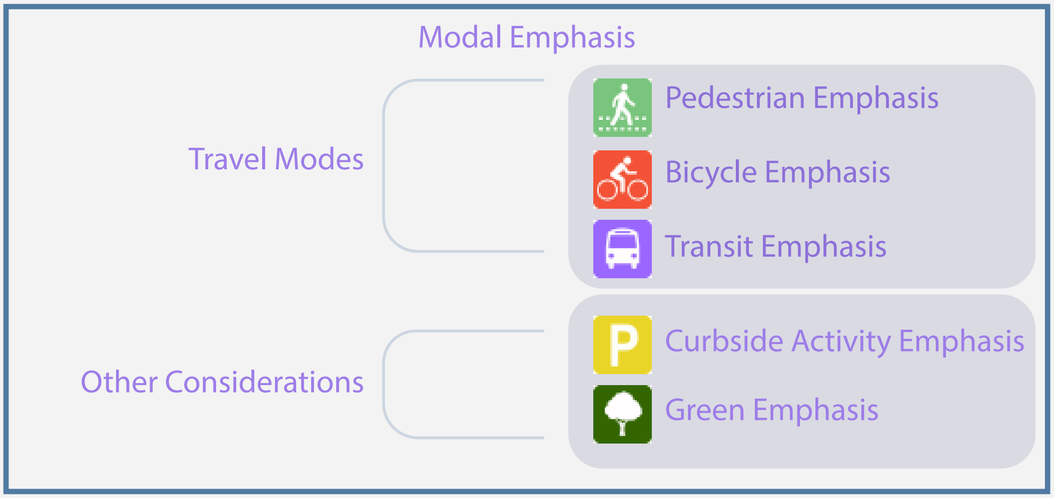


Figure 63: Travel Modes and Other Considerations for Modal Emphasis in Corridor Cross-Section Design.

"Move people, not cars" is an increasingly recurring theme in corridor design guidebooks (e.g., NACTO's Global Street Design Guide), policy publications (e.g., Sidewalk Labs' Street Design Principles), and metropolitan transportation plans (e.g., Vancouver, Canada's 2040 Transportation Plan, see Figure 64). This concept represents a policy shift to emphasize safety and efficient mobility in corridor design. Although traditional corridor design has focused on reducing vehicle delay, often at the expense of the comfort and practicality of other modes, this shift in policy turns the traditional corridor design approach on its head.

Instead of emphasizing vehicle level of service, which serves to minimize delays for motorized vehicles (usually private automobiles), this new paradigm places the priority with pedestrians, then other vulnerable road users such as bicyclists and people riding scooters, then high-capacity transit. Lower on the priority list are taxis and shared vehicles, and the private automobile is lowest.

The concept of Modal Emphasis is consistent with this "move people, not cars" approach. Through the Multimodal System Plan, planners designate connected networks for all modes, ensuring that each mode has a safe and connected network for accessing Multimodal Centers and moving around within them. When preparing a Multimodal System Plan, the concept of Modal Emphasis allows practitioners to designate corridors where each mode is emphasized. For example, in the Multimodal System Plan for its Downtown, the City of Norfolk is designating pedestrian modal emphasis on every street in the downtown.

Corridors may have more than one modal emphasis. Where existing rights of way are constrained, it may not be possible to accommodate the optimal standards for the corridor elements ofunder each modal emphasis. In this case, there may be a distinction among the modal emphases, where one is more important than another in a given context. Practitioners should use the Corridor Matrix and Corridor Elements as a kit of parts for designing the corridor and select the treatments that fit within the corridor in accordance with the modes of emphasis, in some cases choosing less-than-optimal standards for the modal emphasis that is of secondary importance. In all cases, however, no standards should be less than the minimum called for in the Corridor Matrix.

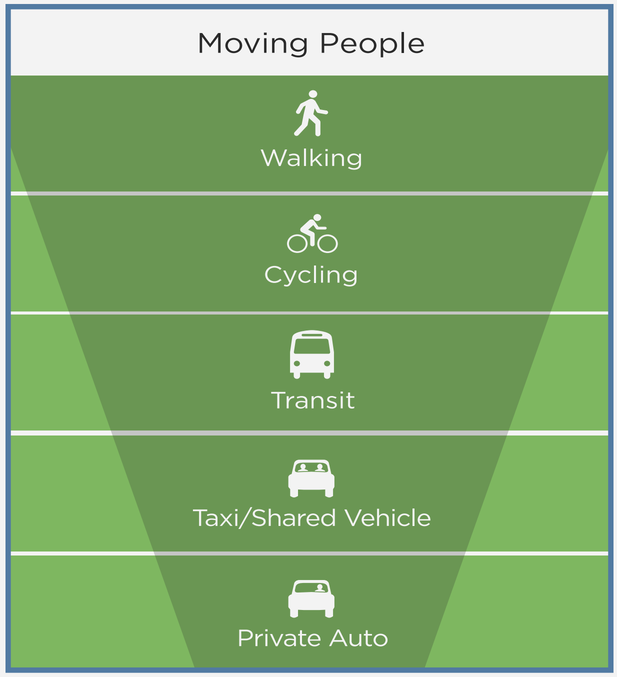


Figure 64: Modal Priorities from Vancouver, Canada's 2040 Transportation Plan.

Curbside Activity and Curbside Management

One of the biggest changes since the original Guidelines were developed in 2013 is the dramatic increase in the types of activities occurring at the curbside. Ride-hailing pick-ups and drop-offs, e-commerce deliveries, scooters, and bikeshare stations are now more commonplace curbside activities, joining transit stops, on-street parking, food trucks, parklets, and other uses to intensify demand for curb access.

The original 2013 Guidelines included a Parking modal emphasis. The 2020 Update has replaced it with a Curbside Activity emphasis to acknowledge the full range of activities competing for curb space. Allocating curb space to meet and manage these competing demands is important to improve mobility and safety for all modes. Prioritizing curb space is complex and takes into account considerations of transportation, land use, and economic development. Curb space is also inherently flexible. The allowable uses can be changed quickly, and different uses can be allowed at different times of day.

ITE's Curbside Management Practitioners Guide[20] provides guidance and best practices for curb space allocation policy and implementation, with a framework and toolbox for analyzing and optimizing curb space that promotes safety and reflects community values. Flex zones, demand-based parking pricing, and bicycle and shared mobility device storage are a few of the many treatments discussed in this resource. The ITE Curbside Management Practitioners Guide also cites the NACTO Curb Appeal: Curbside Management Strategies for Improving Transit Reliability resource paper[21] and the International Transport Forum's The Shared-Use City: Managing the Curb[22] as additional resources.

How Corridor Elements are used in Modal Emphasis

Table 11 shows how a Multimodal Corridor cross-section can be designed using Modal Emphasis. It shows how to select and size Corridor Elements according to the Modal Emphasis of the corridor. Corridor Elements are allocated according to whether they are Primary, Secondary, Contributing or Non-Contributing Elements. This allows the designer of a Multimodal Corridor cross-section to select an appropriate balance among Corridor Elements and their relative size, according to their importance in achieving the intended Modal Emphasis of the corridor.

For example, to achieve Pedestrian Modal Emphasis, the road designer would first look up the Primary Corridor Element for Pedestrian Modal Emphasis from this table, and select the optimal standards for that Corridor Element from the Corridor Matrix in Appendix A. Then, as space within the right-of-way permits, the designer would maximize the Secondary and Contributing Corridor Elements. If a corridor has more than one Modal Emphasis, the designer would balance the Primary Elements for both emphases first, then allocate any remaining space within the right-of-way to the Secondary and Contributing Elements.

HOW CORRIDOR ELEMENTS ARE USED IN MODAL EMPHASIS				
MODAL EMPHASIS	PRIMARY ELEMENTS	SECONDARY ELEMENTS	CONTRIBUTING ELEMENTS	NON-CONTRIBUTING ELEMENTS
Pedestrian	Sidewalk Through Element	Building Frontage Element Amenity Element	Curbside Activity Element	Bicycle Element Transit Element Travel Lane Element Median Element
Bicycle	Bicycle Element	N/A	Amenity Element	Building Frontage Element Sidewalk Through Element Curbside Activity Element Transit Element Travel Lane Element Median Element
Transit	Transit Element Travel Lane Element	Sidewalk Through Element	Building Frontage Element Amenity Element Bicycle Element	Curbside Activity Element Median Element
Green	Amenity Element	Median Element	Building Frontage Element	Sidewalk Through Element Curbside Activity Element Bicycle Element Transit Element Travel Lane Element
Curbside Activity	Curbside Activity Element	N/A	Bicycle Element	Building Frontage Element Sidewalk Through Element Amenity Element Transit Element Travel Lane Element Median Element

Table 11: Using Corridor Elements in Corridor Design According to Modal Emphasis.

[20] Institute of Transportation Engineers, 2018. Curbside Management Practitioners Guide. Retrieved 14 Jan 2020 from https://www.ite.org/pub/?id=C75A6B8B-E210-5EB3-F4A6-A2FDDA8AE4AA.

[21] National Association of City Transportation Officials, 2017. Curb Appeal: Curbside Management Strategies for Improving Transit Reliability. Retrieved on 14 Jan 2020 from https://nacto.org/wp-content/uploads/2017/11/NACTO-Curb-Appeal-Curbside-Management.pdf

[22] International Transport Forum, 2018. The Shared-Use City: Managing the Curb. Retrieved on 14 Jan 2020 from https://www.itf-oecd.org/shared-use-city-managing-curb-0.

Choosing Design Standards

Table 12 shows specifically how to choose a design standard from the Corridor Matrix. It describes which standard to choose – optimal, minimum, or somewhere in between, based on whether a Corridor Element is Primary, Secondary, Contributing or Non-Contributing. Although this process has several steps, the purpose is to have a very flexible framework for Multimodal Corridor design. It allows for trade-offs to be made among Corridor Element sizes in a constrained right-of-way situation, while still optimizing those Corridor Elements that are most important for the key travel modes in the corridor.

HOW TO CHOOSE DESIGN STANDARDS BASED ON TYPE OF ELEMENT					
	TYPE OF ELEMENT	PRIMARY ELEMENTS	SECONDARY ELEMENTS	CONTRIBUTING ELEMENTS	NON-CONTRIBUTING ELEMENTS
	Which Standard to Choose	Use Optimal Standard in all cases	Use Optimal Standard whenever ROW width allows	Use Optimal if ROW allows - May use Minimum if ROW is constrained	May use Minimum Standard

Table 12: Using Modal Emphasis to Choose Design Standards.

With Table 12, the designer of a Multimodal Corridor can choose the specific standard to use for each Corridor Element based on the emphasized travel modes for the corridor and other considerations for cross-section design. Figure 65 shows an example of how to choose the Primary, Secondary, Contributing and Non-Contributing Elements in a Multimodal Corridor based on Pedestrian Modal Emphasis.

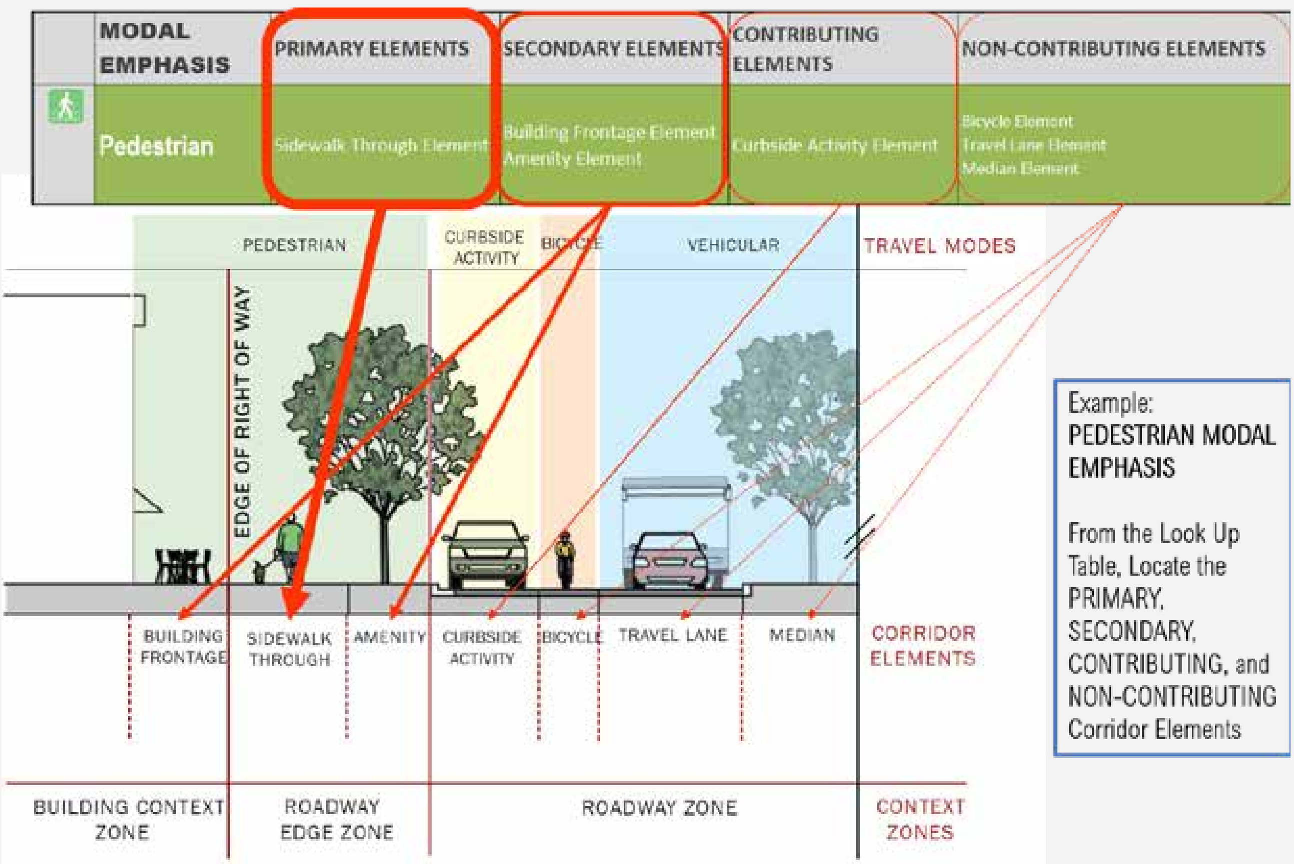


Figure 65: Example of Choosing Corridor Elements for a Pedestrian Modal Emphasis.

The Corridor Matrix

The previous sections describe how Corridor Elements form the basic building blocks of a Multimodal Corridor – as well as how these Corridor Elements are selected. This section describes the basic design standards for each Corridor Element as organized in the Corridor Matrix.

The Corridor Matrix organizes the cross-section of each Multimodal Corridor into defines a series of Corridor Elements, each with optimal and minimum standards. The standards for each Corridor Element were originally developed in 2013 based on two primary sources:

1. "*Designing Walkable Urban Thoroughfares: A Context Sensitive Approach*," published by ITE and CNU. The ITE/CNU Guidebook defines thoroughfare types that correspond to the Transect Zones from CNU's SmartCode and to traditional functional classifications for roadways.
2. The Road Design Manual, published by VDOT. The VDOT Road Design Manual is the informational and procedural guide for engineers, designers, and technicians involved in the development of plans for Virginia's highways. It provides the standards and specifications for road design and is used in conjunction with AASHTO publications. The Road Design Manual is adapted from the 2011 AASHTO Green Book[23] for the Virginia context.

Since 2013, a wealth of new corridor design guidebooks and manuals have been published. The Corridor Matrix has been revised as part of the 2020 Update to these Guidelines to reflect the new guidance. The following resources played a major role in the update to the Corridor Matrix.

- *A Policy on Geometric Design of Highways and Streets, 7th Edition,* published by AASHTO in 2018
- *Urban Street Design Guide,* published by NACTO in 2013
- *Bikeway Selection Guide*, published by FHWA in 2019
- *Separated Bike Lane Planning and Design Guide*, published by FHWA in 2015
- *Transit Street Design Guide*, published by NACTO in 2016
- *Urban Bikeway Design Guide*, published by NACTO in 2012[24]

A full list and summary of the new guidance documents that were reviewed and incorporated into this update is available in Appendix G.

Optimal and Minimum Standards

The design standards in the Corridor Matrix are shown as a range of two values – optimal and minimum. The reason for this range is to allow flexibility in applying the Modal Emphasis for each Corridor Element as described in the previous section. This range allows the designer to select a design standard within the range depending on whether that Corridor Element needs to be optimized, minimized or somewhere in between.

The optimal and minimum values in the Corridor Matrix come from the guidebooks and manuals listed in the previous section. These values are consistent with the VDOT Road Design Manual.

[23] A Policy on Geometric Design of Highways and Streets (or the Green Book) is a reference manual published by the American Association of State Highway and Transportation Officials (AASHTO). It is the baseline manual for roadway designers and provides a range of acceptable values for various elements of cross-section design. State road design manuals are often based on the AASHTO Green Book.

[24] Although the NACTO Urban Bikeway Design Guide was published during the development of the original 2013 Multimodal System Design Guidelines, this 2020 Update to the Guidelines more fully incorporates the different bicycle facility treatments into the Corridor Matrix.

The Corridor Matrix and Corridor Matrix Annotation Document

The Corridor Matrix is given in its full version in Appendix A. In addition, there is an accompanying document in Appendix B, the Corridor Matrix Annotation Document, that serves as the detailed reference for the Corridor Matrix, and provides sources and further discussion for each of the standards in the Corridor Matrix. It is important to note that all of the detailed recommendations for these Guidelines are located in the Corridor Matrix in Appendix A, and explained in the Corridor Matrix Annotation Document in Appendix B. They were not included within the text of this chapter due to their length but are given in full in those Appendices. Figure 66 is an excerpt from the Corridor Matrix to show its organization and structure.

Optimal and Minimum Standards

The design standards in the Corridor Matrix are shown as a range of two values – optimal and minimum. The reason for this range is to allow flexibility in applying the Modal Emphasis for each Corridor Element. This range allows the designer to select a design standard within the range depending on whether that Corridor Element needs to be optimized, minimized or somewhere in between.

Corridor Element Key											
		CORRIDOR MATRIX Multimodal System Design Guidelines - 2020 Update									
	Corridor Type ⇨	**Boulevard**									
	Intensity ⇨	**T-6**		**T-5**		**T-4**		**T-3**		**T-2**	
⇩	**Context Zones & Corridor Elements** ⇩	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM
	Building Context Zone										
A	BUILDING FRONTAGE ELEMENT	5 ft	3 ft	5 ft	3 ft	5 ft	2.5 ft	7 ft	1.5 ft	12 ft	1.5 ft
	Location of off street parking	rear	rear	rear	rear	rear	rear	rear	rear	rear	rear
	Typical building entry locations	front	front	front	front	front	front	front	front	front	front
	Roadway Edge Zone										
B	SIDEWALK THROUGH ELEMENT	10 ft	6 ft	10 ft	6 ft	8 ft	6 ft	6 ft	6 ft	6 ft	6 ft
C	AMENITY ELEMENT	8 ft	6 ft	8 ft	6 ft	8 ft	6 ft	8 ft	6 ft	9 ft	6 ft
	Surface Treatment for Amenity Element	Paved with tree wells		Paved with tree wells		Paved with tree wells		Paved with tree wells		Grassy strip with trees	
	Roadway Zone										
D	CURBSIDE ACTIVITY ELEMENT										
	PARALLEL PARKING ONLY	8 ft both sides	None	8 ft both sides	None	8 ft both sides	None	8 ft both sides	None	8 ft both sides	None
	FLEX ZONE: variable parallel parking, pick-up + drop-off, light delivery	10 ft [1]	8 ft	10 ft [1]	8 ft	10 ft [1]	8 ft	10 ft [1]	8 ft	10 ft [1]	8 ft
E	BICYCLE ELEMENT*										
	Non-Separated Conventional Bike Lane	5 - 8 ft [2]	4 - 5 ft [2]	5 - 8 ft [2]	4 - 5 ft [2]	5 - 8 ft [2]	4 - 5 ft [2]	5 - 8 ft [2]	4 - 5 ft [2]	5 - 8 ft [2]	4 - 5 ft [2]
	Non-Separated Buffered Bike Lane	9 - 10 ft [2]	6 - 8 ft [2]	9 - 10 ft [2]	6 - 8 ft [2]	9 - 10 ft [2]	6 - 8 ft [2]	9 - 10 ft [2]	6 - 8 ft [2]	9 - 10 ft [2]	6 - 8 ft [2]
	Further Guidance for Non-Separated Facilities	NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide	
	Separated Bike Lane (one-way)	10 ft [2]	6.5 - 8 ft [2]	10 ft [2]	6.5 - 8 ft [2]	10 ft [2]	6.5 - 8 ft [2]	10 ft [2]	6.5 - 8 ft [2]	10 ft [2]	6.5 - 8 ft [2]
	Separated Bike Lane (two-way)	15 ft [2]	9.5 - 11 ft [2]	15 ft [2]	9.5 - 11 ft [2]	15 ft [2]	9.5 - 11 ft [2]	15 ft [2]	9.5 - 11 ft [2]	15 ft [2]	9.5 - 11 ft [2]
	Further Guidance for Separated Facilities	FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide	
F	TRANSIT ELEMENT										
	Shared Transit Lane	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft
	Considerations	Low congestion		Low congestion		Low congestion		Low congestion		Low congestion	
	Dedicated Transit Lane	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft
	Considerations	High congestion		High congestion		High congestion		High congestion		High congestion	
	Further Guidance	NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide	
G	TRAVEL LANE ELEMENT	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]
	Design Speed	25 - 35 mph		25 - 35 mph		25 - 35 mph		25 - 35 mph		25 - 35 mph	
	Number of Through Lanes	4 to 6		4 to 6		4 to 6		4 to 6		2 to 6	
	Typical Traffic Volume Range (vehicles per day)	15,000 to 40,000		15,000 to 40,000		10,000 to 50,000		8,000 to 40,000		5,000 to 30,000	
		The following rows provide guidance on design speeds, lane widths, and number of though lanes from other guidebooks. This guidance was considered and incorporated in the values above, and is provided here for additional reference.									
	*2020 VDOT Road Design Manual***										
	Lane Widths	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]
	Design Speeds	30 - 40 mph		30 - 40 mph		30 - 40 mph		40 - 60 mph		40 - 60 mph	
	2018 AASHTO Green Book										
	Lane Widths	11 ft [5]	10 ft	11 ft [5]	10 ft	11 ft [5]	10 ft	11 ft [5]	10 ft	11 ft [5]	10 ft
	Design Speeds	30 mph OR LESS		30 mph OR LESS		25 - 45 mph		25 - 45 mph		20 - 45 mph	
	Number of Through Lanes	4 to 6		4 to 6		4 to 6		4 to 6		2 to 6	
	2013 NACTO Urban Street Design Guide							NACTO Urban Street Design Guidance is not applicable.		NACTO Urban Street Design Guidance is not applicable.	
	Lane Widths	11 ft [6]	10 ft	11 ft [6]	10 ft	11 ft [6]	10 ft				
	Design Speeds	35 mph or less		35 mph or less		35 mph or less					
H	MEDIAN ELEMENT	18 ft [4]	6 ft [4]	18 ft [4]	6 ft [4]	18 ft [4]	6 ft [4]	18 ft [4]	6 ft [4]	18 ft [4]	6 ft [4]

*The bicycle element treatments listed here are discussed in more detail in **Appendix B: Corridor Matrix Annotation Document**. Shared lane markings and bicycle boulevard features are other potential treatments appropriate for corridors with Bicycle Modal Emphasis. Refer to the NACTO Urban Bikeway Design Guide and the AASHTO Guide for the Development of Bicycle Facilities for design guidance on shared lane markings and bicycle boulevard features.

**The 2020 VDOT Road Design Manual is in concurrence with the 2011 AASHTO Green Book.

(1) Flexible zones are best accommodated within a 10-foot wide lane for brief but frequent pick-up and drop-off and-or delivery activities completed by a variety of different vehicle types. These activities can be accommodated within an 8-foot wide lane in cases where an existing roadway is not being reconstructed or where adjoining, land use, roadway geometry, traffic volumes and or lane widths are deemed accommodating to a narrower flex zone width.

(2) **Optimal and minimum values for the Bicycle Element are subject to other criteria including type of curb and gutter, on-street parking, posted/design speeds, average daily traffic volumes, bicycle volumes, frequency of parking turnover, and percentage of heavy vehicles**. These values represent general ranges of potentially feasible widths to determine if a facility might possibly fit within the available right-of-way. See **Appendix B: Corridor Matrix Annotation Document** for more information on required widths in different circumstances.

(3) Travel lane width does not include the shy distance and curb or curb and gutter pan. Note: 12 ft is the optimum **only** for transit modal emphasis. Travel lane widths on Boulevards without transit modal emphasis should be minimized. (Refer to **Appendix B Corridor Matrix Annotation Document** for discussion.)

(4) Median element widths are measured from back of curb to back of curb. Median element widths do not include the width of the curb and shy distance.

(5) Section 7.3.3.2 of the 2018 AASHTO Green Book discusses considerations for lane widths on urban arterials. Lane widths may vary from 10 to 12 ft. 11-ft widths are normally adequate and have some advantages, but additional lane width may be desirable if substantial bus or truck traffic is anticipated.

(6) The NACTO Urban Street Design Guide indicates 11-foot lanes are only appropriate on designated truck or bus routes, and limited to one 11-foot lane in each direction. The NACTO USDG indicates 10-foot lanes are appropriate in all other instances.

Figure 66: Excerpt from the Corridor Matrix. The full Corridor Matrix is in Appendix A.

Updates to the Original Corridor Matrix

The 2020 Update to the Multimodal System Design Guidelines incorporates several changes to the Corridor Matrix, which are discussed briefly here and explained in more detail in Appendix B: Corridor Matrix Annotation Document.

Curbside Activity Element

As noted previously, the Parking element has been replaced with a Curbside Activity element. There are two options under the Curbside Activity Element: an option of on-street parallel parking, and an option for a flex zone, which consists of a mix of uses that could include on-street parallel parking, transit and ride-hailing pick-up and drop-off, and light deliveries.

Bicycle Element

The Bicycle element has been expanded to include separate rows for different treatment types. Separated bicycle facilities are those with some element of vertical separation (e.g. flexible delineators, on-street parking, curbed median, etc.) between the bicycle lane and the general-purpose travel lane. Non-separated bicycle facilities include conventional bicycle lanes and buffered bicycle lanes. Each of these terms is further defined in Appendix B: Corridor Matrix Annotation Document. A range of optimal and minimum values for each treatment type is provided, as well as a reference for further information. The exact width needed for these facilities depends greatly on a variety of factors, and the reader should refer to both the Corridor Matrix Annotation Document and the recommended resource guide to determine the exact width needed in a specific circumstance.

Transit Element

This is a new element, added in the 2020 Update to these Guidelines. There are two options under this element – a shared transit lane (i.e., transit vehicles operate in a general traffic lane), and a dedicated transit lane that has restrictions on the types of vehicles that can use the lane. Most dedicated transit lanes prohibit all vehicles except transit buses from using the lane, but there are exceptions, such as bike/bus lanes and lanes that allow right-turning vehicles to use the bus lane.

Travel Lane Element

As mentioned previously, the 2020 Update to these Guidelines adjusts the lower design speed for Boulevards and Major Avenues from 30 mph to 25 mph. The Travel Lane element in the Corridor Matrix has also been expanded to show the ranges of travel lane widths, design speeds and number of through lanes from three different sources – the 2020 VDOT Road Design Manual, the 2018 AASHTO Green Book, and the 2013 NACTO Urban Street Design Guide – for additional reference.

How to Use the Corridor Matrix in an Unconstrained Right-of-Way

Figure 67 is a summary page of all the Multimodal Corridor types followed by summaries of each Multimodal Corridor type in detail in Figures 68 through 72. The Corridor Matrix is a flexible framework for selecting corridor standards that allows a roadway designer to determine the best way to accommodate the identified travel modes for that corridor. In the case of an unconstrained right-of-way, such as is the situation with a new road, the designer may want to equally balance all the modes and not favor one over another. In that case, the designer would choose the optimal value for each Corridor Element. The resulting cross-section would reflect a corridor with true modal balance, with the optimal dimensions and design for each travel mode. The set of example cross-sections illustrated in Figures 68 though 72 reflect this "prototypical" condition for each of the Placemaking and Multimodal Through Corridor types. Note that not all T-Zones are applicable to each Multimodal Corridor type. The cross-sections illustrated assume that the right-of-way is unconstrained and all Corridor Elements are optimized.

The Corridor Prototype Cross-Sections

The set of example cross-sections illustrated in Figures 68 through 72 reflects the "prototypical" condition for each of the Placemaking and Multimodal Through Corridor types. Note that not all T-Zones are applicable to each Multimodal Corridor type. The cross-sections illustrated assume that the right-of-way is unconstrained and all Corridor Elements are optimized.

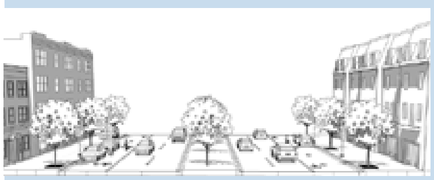
Boulevard					Major Avenue						Avenue						Local Street						Through Corridor					
T6	T5	T4	T3	T2	T6	T5	T4	T3	T2	T1	T6	T5	T4	T3	T2	T1	T6	T5	T4	T3	T2	T1	T6	T5	T4	T3	T2	T1

Each Corridor Type is modified by the Transect Zone it passes through.

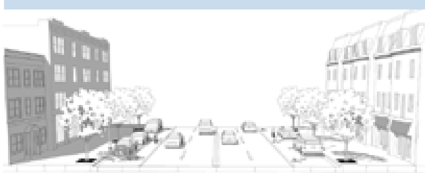
MULTIMODAL CORRIDOR TYPES

Placemaking Corridor

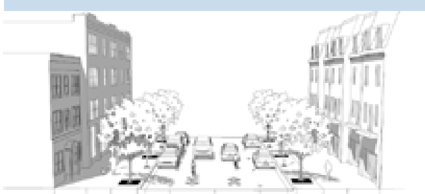
Boulevard



Major Avenue



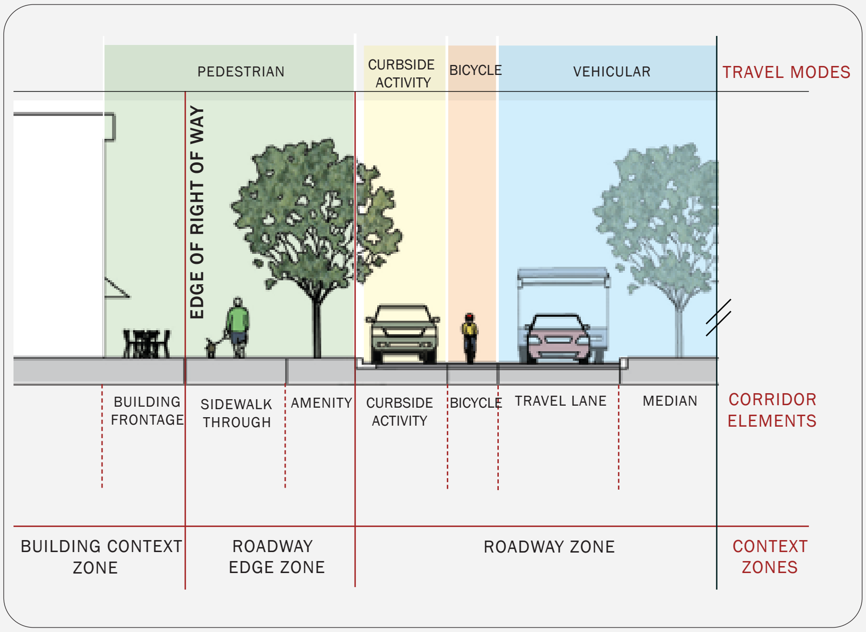
Avenue



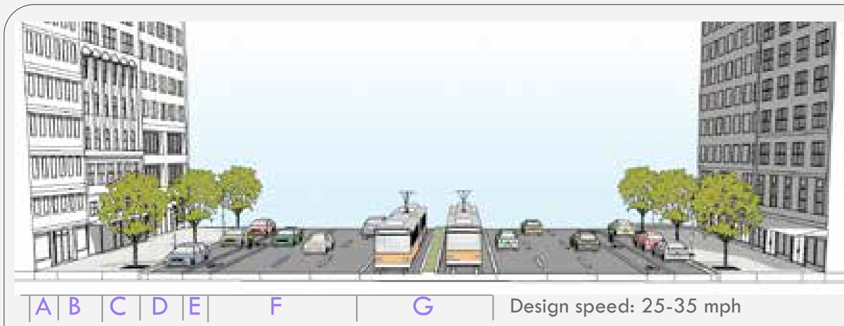
Local Street

Through Corridor

Multimodal Through Corridor



Multimodal Corridors are divided into Context Zones. Each element of the corridor relates to a Travel Mode.



Design speed: 25-35 mph

Optimal Values from the Corridor Matrix

Building Frontage	A	5'
Sidewalk Through	B	10'
Amenity	C	8'
Curbside Activity	D	8'
Bicycle	E	6'
Travel Lanes	F	12'
Transit Median	G	Transit*

Sample T6 Boulevard with a dedicated transit lane

* Varies based on transit median design

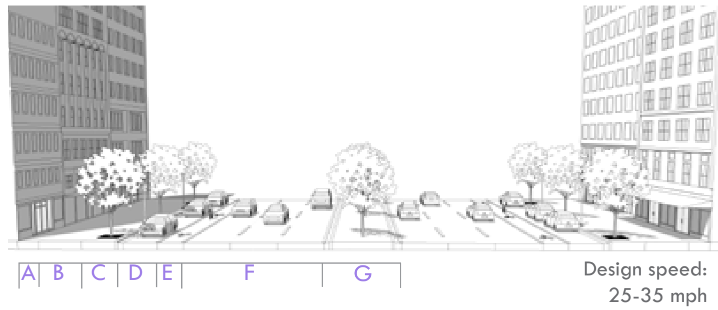
Figure 67: Multimodal Corridors Summary Page.

BOULEVARD
PLACEMAKING CORRIDOR

Optimal values from the Corridor Matrix | *Cross-sectional views of optimal values*

T6

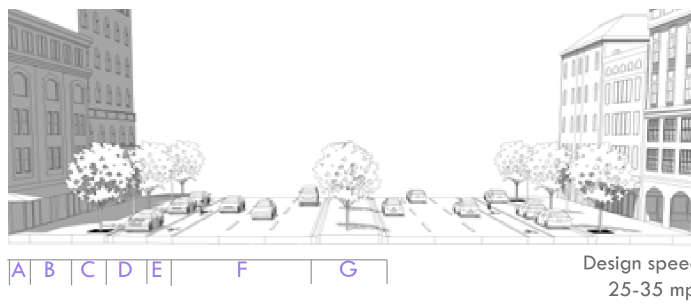
Building Frontage	A	5'
Sidewalk Through	B	10'
Amenity	C	8'
Curbside Activity	D	8'
Bicycle	E	6'
Travel Lane	F	12'
Median	G	18'



Design speed: 25-35 mph

T5

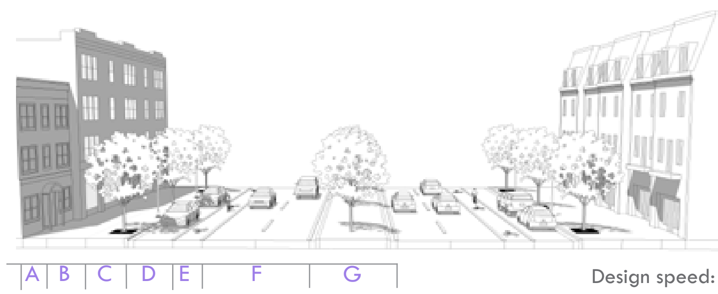
Building Frontage	A	5'
Sidewalk Through	B	10'
Amenity	C	8'
Curbside Activity	D	8'
Bicycle	E	6'
Travel Lane	F	12'
Median	G	18'



Design speed: 25-35 mph

T4

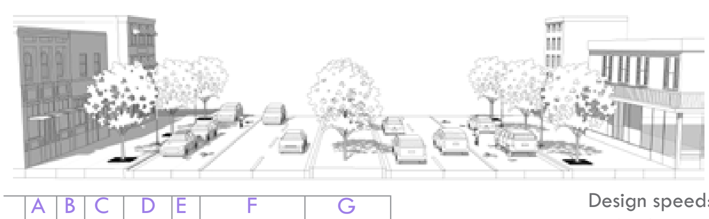
Building Frontage	A	5'
Sidewalk Through	B	8'
Amenity	C	8'
Curbside Activity	D	8'
Bicycle	E	6'
Travel Lane	F	12'
Median	G	18'



Design speed: 25-35 mph

T3

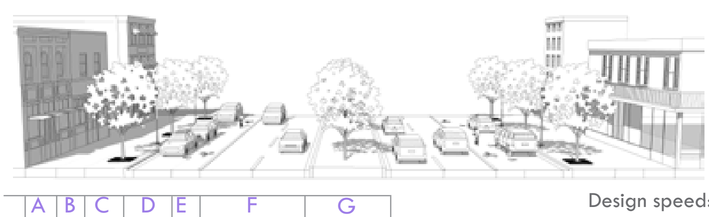
Building Frontage	A	7'
Sidewalk Through	B	6'
Amenity	C	8'
Curbside Activity	D	8'
Bicycle	E	6'
Travel Lane	F	12'
Median	G	18'



Design speed: 25-35 mph

T2

Building Frontage	A	12'
Sidewalk Through	B	6'
Amenity	C	9'
Curbside Activity	D	8'
Bicycle	E	6'
Travel Lane	F	12'
Median	G	18'



Design speed: 25-35 mph

NOTE: Cross sections depict "optimal" corridor element dimensions listed in the Corridor Matrix unless otherwise noted. The Bicycle element shown in these cross-sections is a non-separated conventional bicycle lane. The Curbside Activity element shown is a parallel parking only lane, not a flex zone.

Figure 68: Prototype Cross-Sections for Boulevards.

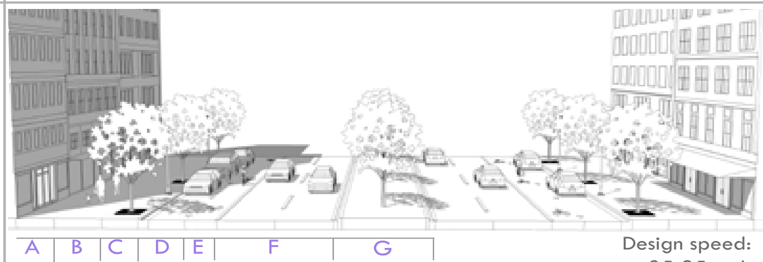
MAJOR AVENUE

PLACEMAKING CORRIDOR

Optimal values from the Corridor Matrix | *Cross-sectional views of optimal values*

T6

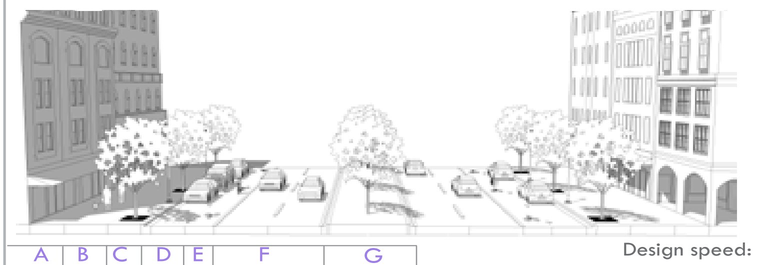
Building Frontage	A	7’
Sidewalk Through	B	9’
Amenity	C	7’
Curbside Activity	D	8’
Bicycle	E	6’
Travel Lane	F	12’
Median	G	18’



Design speed: 25-35 mph

T5

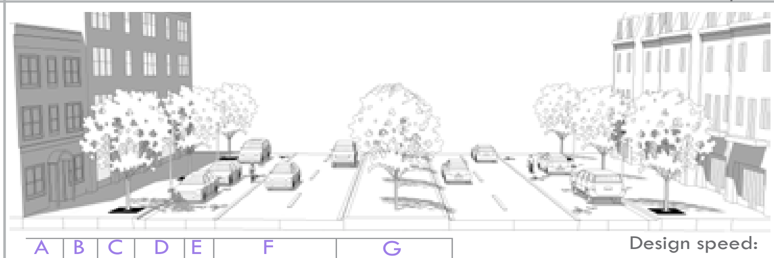
Building Frontage	A	7’
Sidewalk Through	B	9’
Amenity	C	7’
Curbside Activity	D	8’
Bicycle	E	6’
Travel Lane	F	12’
Median	G	18’



Design speed: 25-35 mph

T4

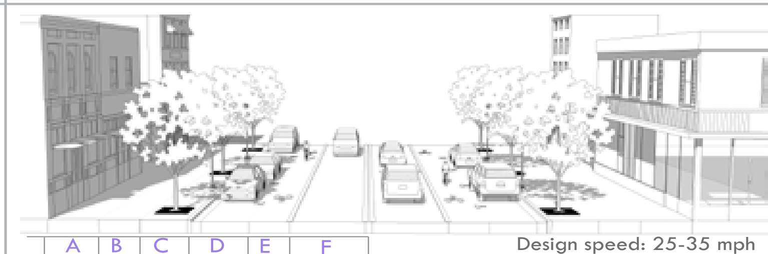
Building Frontage	A	7’
Sidewalk Through	B	6’
Amenity	C	7’
Curbside Activity	D	8’
Bicycle	E	6’
Travel Lane	F	12’
Median	G	18’



Design speed: 25-35 mph

T3

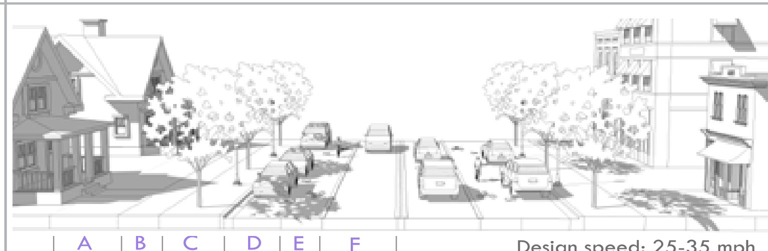
Building Frontage	A	7’
Sidewalk Through	B	6’
Amenity	C	7’
Curbside Activity	D	8’
Bicycle	E	6’
Travel Lane	F	12’
Median	G	18’*



Design speed: 25-35 mph

T2

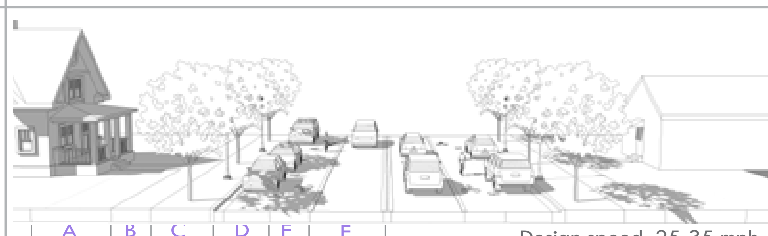
Building Frontage	A	12’
Sidewalk Through	B	6’
Amenity	C	9’
Curbside Activity	D	8’
Bicycle	E	6’
Travel Lane	F	12’
Median	G	18’*



Design speed: 25-35 mph

T1

Building Frontage	A	12’
Sidewalk Through	B	6’
Amenity	C	9’
Curbside Activity	D	8’
Bicycle	E	6’
Travel Lane	F	12’
Median	G	18’*



Design speed: 25-35 mph

NOTE: Cross sections depict “optimal” corridor element dimensions listed in the Corridor Matrix unless otherwise noted

**Median Element (G) is not shown in cross-section illustrations for some less intense Transect Zones.*

The Bicycle element shown in these cross-sections is a non-separated conventional bicycle lane.

The Curbside Activity element shown is a parallel parking only lane, not a flex zone.

Figure 69: Prototype Cross-Sections for Major Avenues.

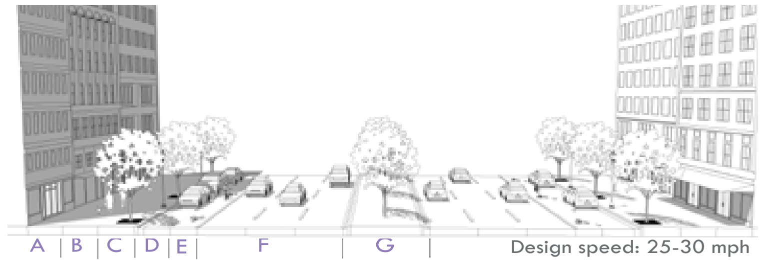
AVENUE

PLACEMAKING CORRIDOR

Optimal values from the Corridor Matrix | *Cross-sectional views of optimal values*

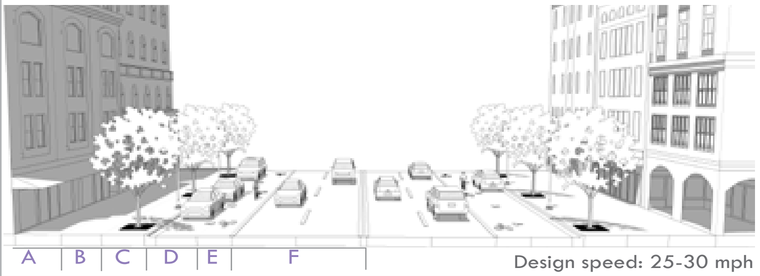
T6

Building Frontage	A	8’
Sidewalk Through	B	8’
Amenity	C	7’
Parking	D	8’
Bicycle	E	4’
Travel Lane	F	12’
Median	G	18’



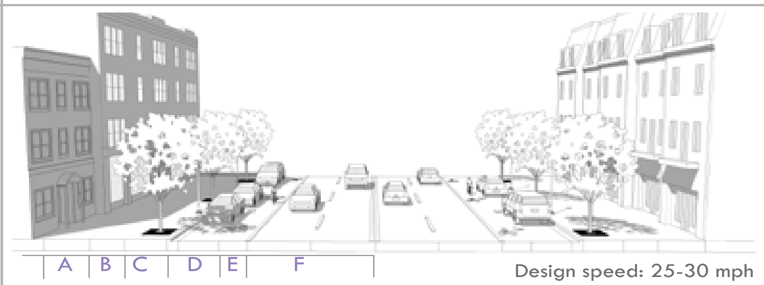
T5

Building Frontage	A	8’
Sidewalk Through	B	7’
Amenity	C	7’
Parking	D	8’
Bicycle	E	4’
Travel Lane	F	12’
Median	G	18’*



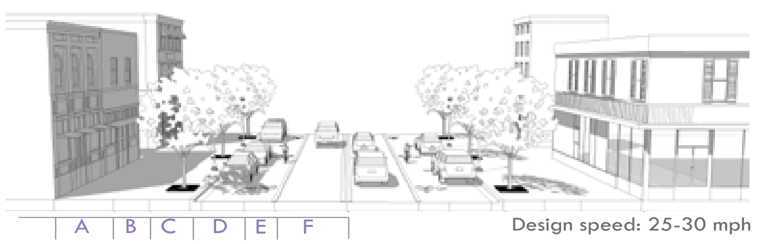
T4

Building Frontage	A	8’
Sidewalk Through	B	6’
Amenity	C	7’
Parking	D	8’
Bicycle	E	4’
Travel Lane	F	12’
Median	G	18’*



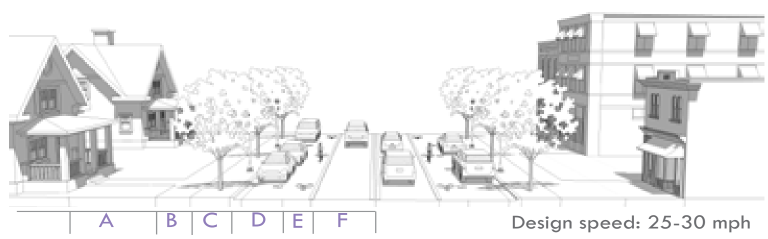
T3

Building Frontage	A	10’
Sidewalk Through	B	6’
Amenity	C	7’
Parking	D	7’
Bicycle	E	4’
Travel Lane	F	12’
Median	G	18’*



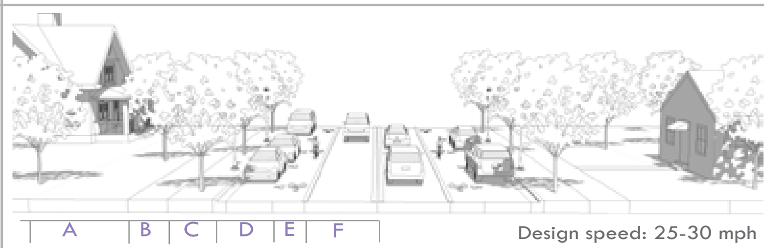
T2

Building Frontage	A	15’
Sidewalk Through	B	6’
Amenity	C	8’
Parking	D	7’
Bicycle	E	4’
Travel Lane	F	12’
Median	G	18’*



T1

Building Frontage	A	15’
Sidewalk Through	B	6’
Amenity	C	7’
Parking	D	7’
Bicycle	E	4’
Travel Lane	F	12’
Median	G	18’*



NOTE: Cross sections depict “optimal” corridor element dimensions listed in the Corridor Matrix unless otherwise noted
**Median Element (G) is not shown in cross-section illustrations for some less intense Transect Zones*

Figure 70: Prototype Cross-Sections for Avenues.

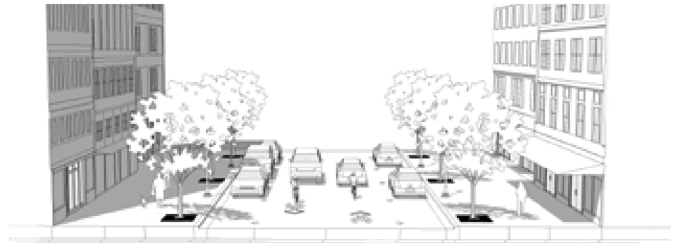
LOCAL STREET

PLACEMAKING CORRIDOR

Optimal values from the Corridor Matrix | *Cross-sectional views of optimal values*

T6

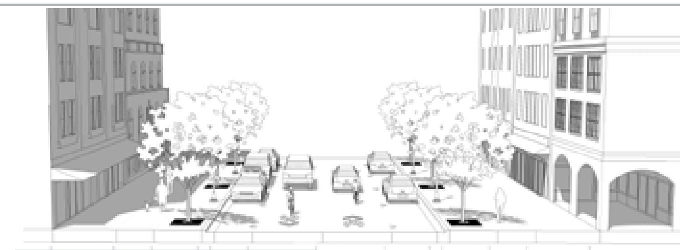
Building Frontage	A	8'
Sidewalk Through	B	6'
Amenity	C	7'
Curbside Activity	D	7'
Bicycle	E	shared*
Travel Lane	F	11'



Design speed: 25 mph

T5

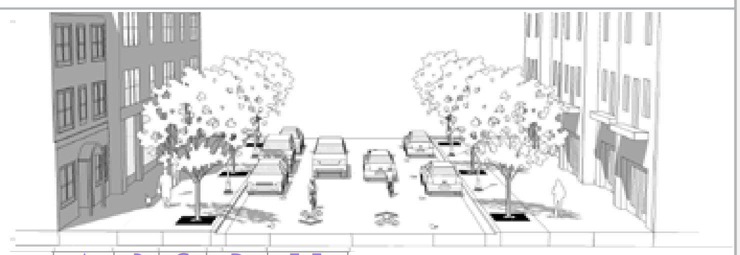
Building Frontage	A	8'
Sidewalk Through	B	6'
Amenity	C	7'
Curbside Activity	D	7'
Bicycle	E	shared*
Travel Lane	F	11'



Design speed: 25 mph

T4

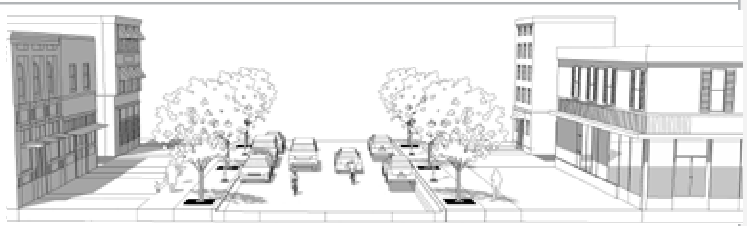
Building Frontage	A	8'
Sidewalk Through	B	6'
Amenity	C	7'
Curbside Activity	D	7'
Bicycle	E	shared*
Travel Lane	F	11'



Design speed: 25 mph

T3

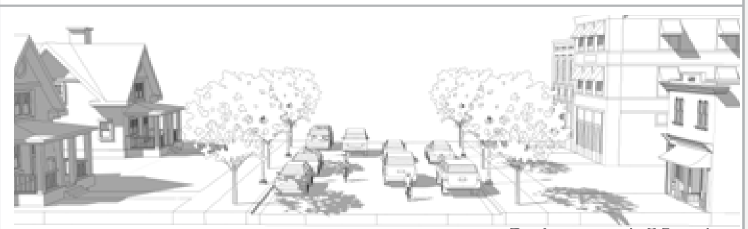
Building Frontage	A	15'
Sidewalk Through	B	6'
Amenity	C	7'
Curbside Activity	D	7'
Bicycle	E	shared*
Travel Lane	F	11'



Design speed: 25 mph

T2

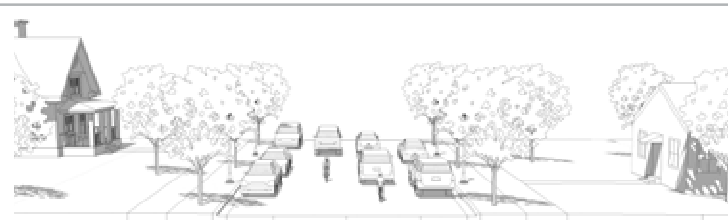
Building Frontage	A	20'
Sidewalk Through	B	5'
Amenity	C	6'
Curbside Activity	D	7'
Bicycle	E	shared*
Travel Lane	F	11'



Design speed: 25 mph

T1

Building Frontage	A	30'
Sidewalk Through	B	5'
Amenity	C	6'
Curbside Activity	D	7'
Bicycle	E	shared*
Travel Lane	F	11'



Design speed: 25 mph

NOTE: Cross sections depict "optimal" corridor element dimensions listed in the Corridor Matrix unless otherwise noted
**The Bicycle element shown in these cross-sections is a shared lane with bicycle boulevard features, which is appropriate for local streets with traffic volumes of 3,000 or fewer vehicles per day and speeds of 25 mph or less.*
The Curbside Activity element shown is a parallel parking only lane, not a flex zone.

Figure 71: Prototype Cross-Sections for Local Streets.

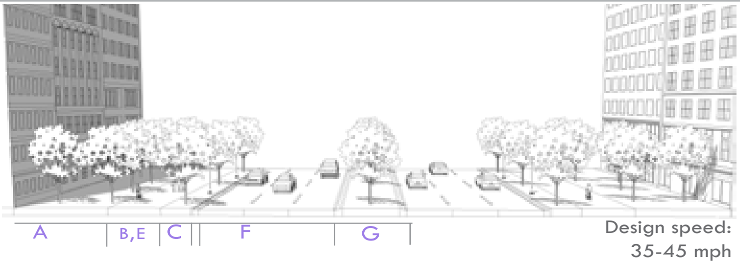
MULTIMODAL THROUGH CORRIDOR

THROUGH CORRIDOR

Optimal values from the Corridor Matrix — *Cross-sectional views of optimal values*

T6

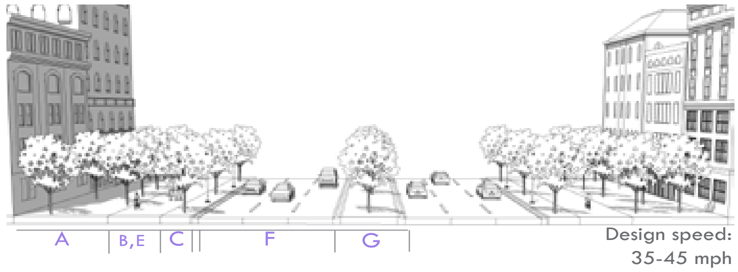
Building Frontage	A	25'
Sidewalk Through	B	14'*
Amenity	C	8'
Curbside Activity	D	n/a
Bicycle	E	shared*
Travel Lane	F	12'
Median	G	18'



Design speed: 35-45 mph

T5

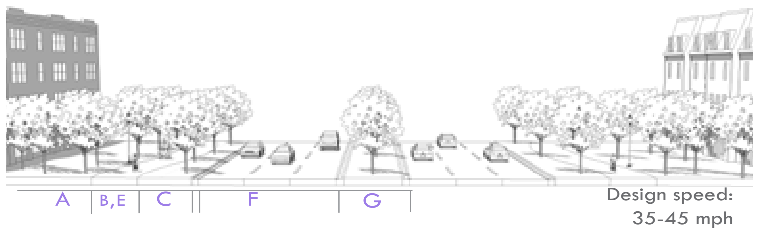
Building Frontage	A	25'
Sidewalk Through	B	14'*
Amenity	C	8'
Curbside Activity	D	n/a
Bicycle	E	shared*
Travel Lane	F	12'
Median	G	18'



Design speed: 35-45 mph

T4

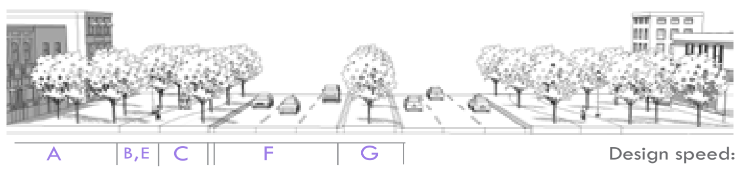
Building Frontage	A	35'
Sidewalk Through	B	12'*
Amenity	C	8'
Curbside Activity	D	n/a
Bicycle	E	shared*
Travel Lane	F	12'
Median	G	18'



Design speed: 35-45 mph

T3

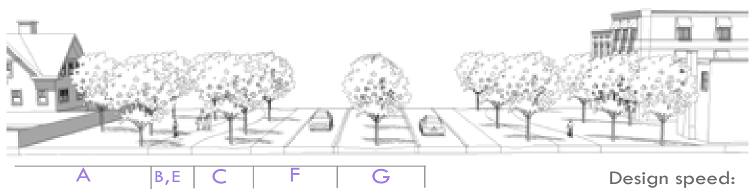
Building Frontage	A	35'
Sidewalk Through	B	12'*
Amenity	C	8'
Curbside Activity	D	n/a
Bicycle	E	shared*
Travel Lane	F	12'
Median	G	18'



Design speed: 35-55 mph

T2

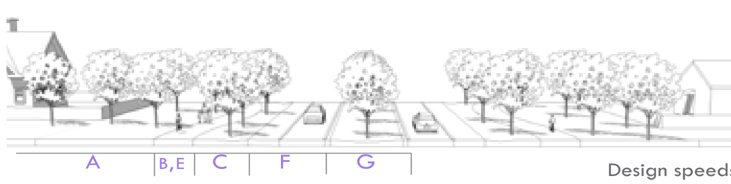
Building Frontage	A	45'
Sidewalk Through	B	10'*
Amenity	C	22'
Curbside Activity	D	n/a
Bicycle	E	shared*
Travel Lane	F	12'
Median	G	40'



Design speed: 45-55 mph

T1

Building Frontage	A	45'
Sidewalk Through	B	10'*
Amenity	C	8'
Curbside Activity	D	n/a
Bicycle	E	shared*
Travel Lane	F	12'
Median	G	40'



Design speed: 45-55 mph

NOTE: Cross sections depict "optimal" corridor element dimensions listed in the Corridor Matrix unless otherwise noted
**Shared-use path*

Figure 72: Prototype Cross-Sections for Multimodal Through Corridors.

It is important to note that the standards for each Corridor Element are modified by the T-Zones. As the context for the corridor lessens in density and intensity (from T-6 to T-1), the setbacks generally get wider and design standards get more relaxed – such as the bicycle lane becoming a shared lane in the lower intensity T-Zones.

How to Use the Corridor Matrix in a Constrained Right-of-Way

The typical cross-sections illustrated in Figures 68 through 72 can be used to build prototypical corridors in which all modes are equally balanced. In these cases, the "optimal" corridor standards are used, resulting in relatively generous right-of-way widths. In many cases, however, Multimodal Corridors must be retrofitted into existing rights-of-way that are too constrained to build a full prototype cross-section.

For constrained rights-of-way, the Corridor Matrix allows a great deal of flexibility to build a customized cross-section based on the travel modes that need to be emphasized on a particular corridor. Figure 73 below shows an example of how to build a cross-section for a T-4 Major Avenue with Pedestrian Modal Emphasis in a constrained right-of-way.

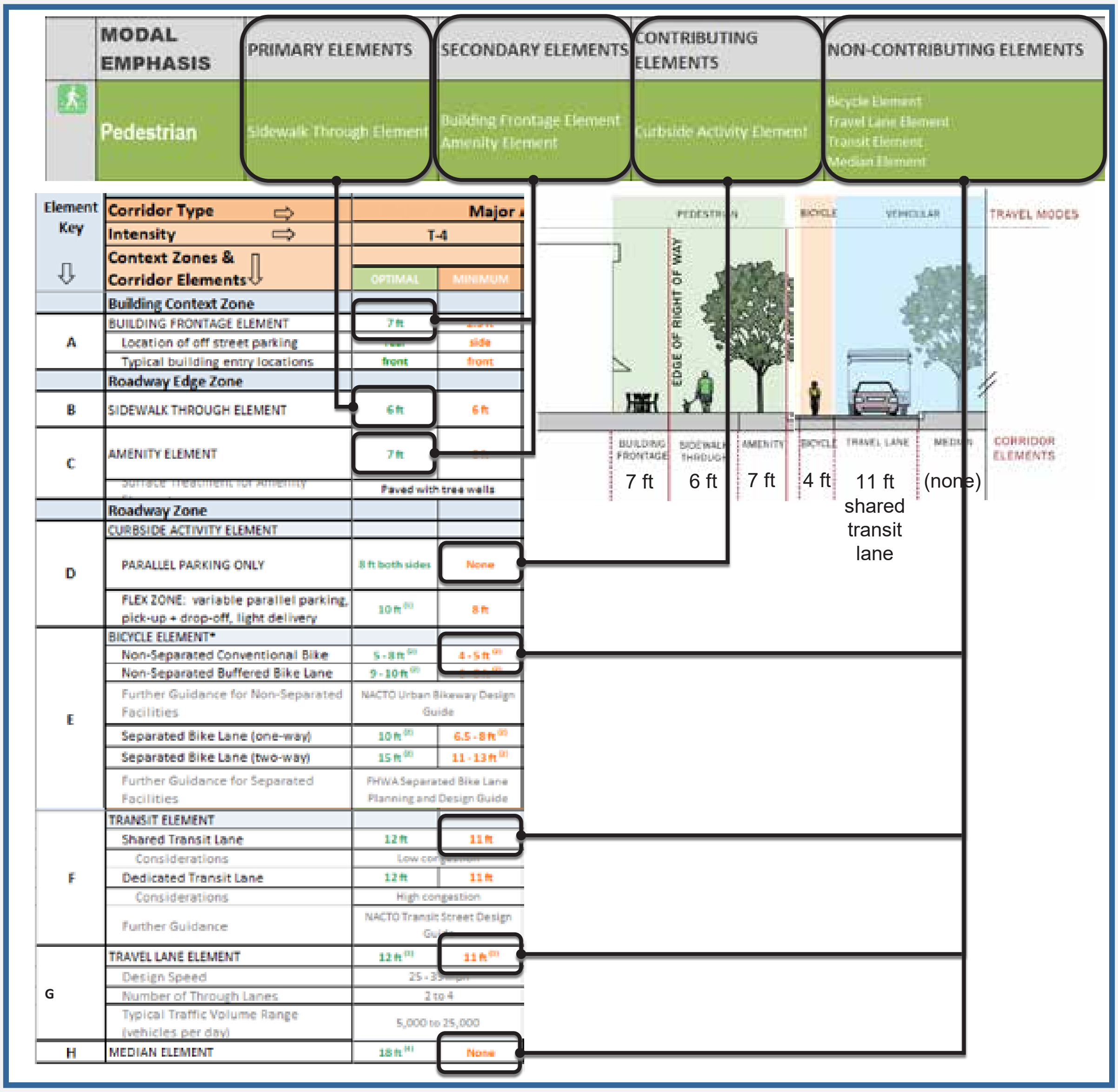


Figure 73: Example of Selecting Corridor Standards for a T-4 Major Avenue with Pedestrian Modal Emphasis.

Figure 73 shows how optimal or minimal corridor standards are chosen based on whether they are Primary, Secondary, Contributing or Non-Contributing for the Pedestrian Modal Emphasis. This method of selecting corridor standards ensures that the cross-section is no larger than needed for emphasizing pedestrians.

An Example of Retrofitting an Existing Corridor

In order to better illustrate the detailed process of selecting corridor standards in a retrofit situation, the following analysis was conducted on an actual corridor in a city in Virginia. The existing cross-section is illustrated Figure 74. It reflects accommodations for cars and pedestrians via one one-way travel lane, one parallel and one diagonal lane of parking, and sidewalks ranging from 8.5 to 9.5 feet wide.

APPLYING MODAL EMPHASIS IN CONSTRAINED ROW SITUATIONS

Existing Street Cross-Section

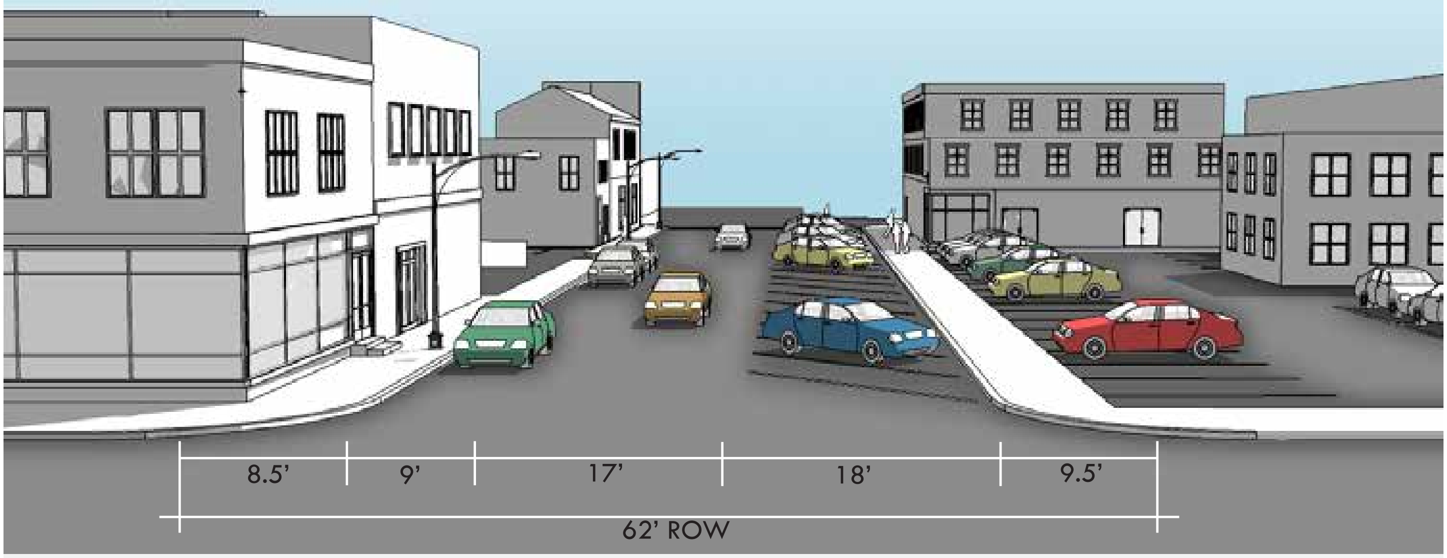


Figure 74: Illustration of an Existing Street to be Retrofitted to a Multimodal Corridor.

It should be noted that the proposed cross section was built using sound judgment and not just a mechanical application of the standards in the Matrix. For example, the existing constrained right of way did not allow for parking to be included on both sides of the street with two-way traffic. Therefore, a design decision was made to allow parking on only one side of the street, with the assumption that the new infill development, shown on the right side of the street, would also incorporate some structured parking to make up for the on-street diagonal parking and surface parking lot that would be lost in this redevelopment proposal.

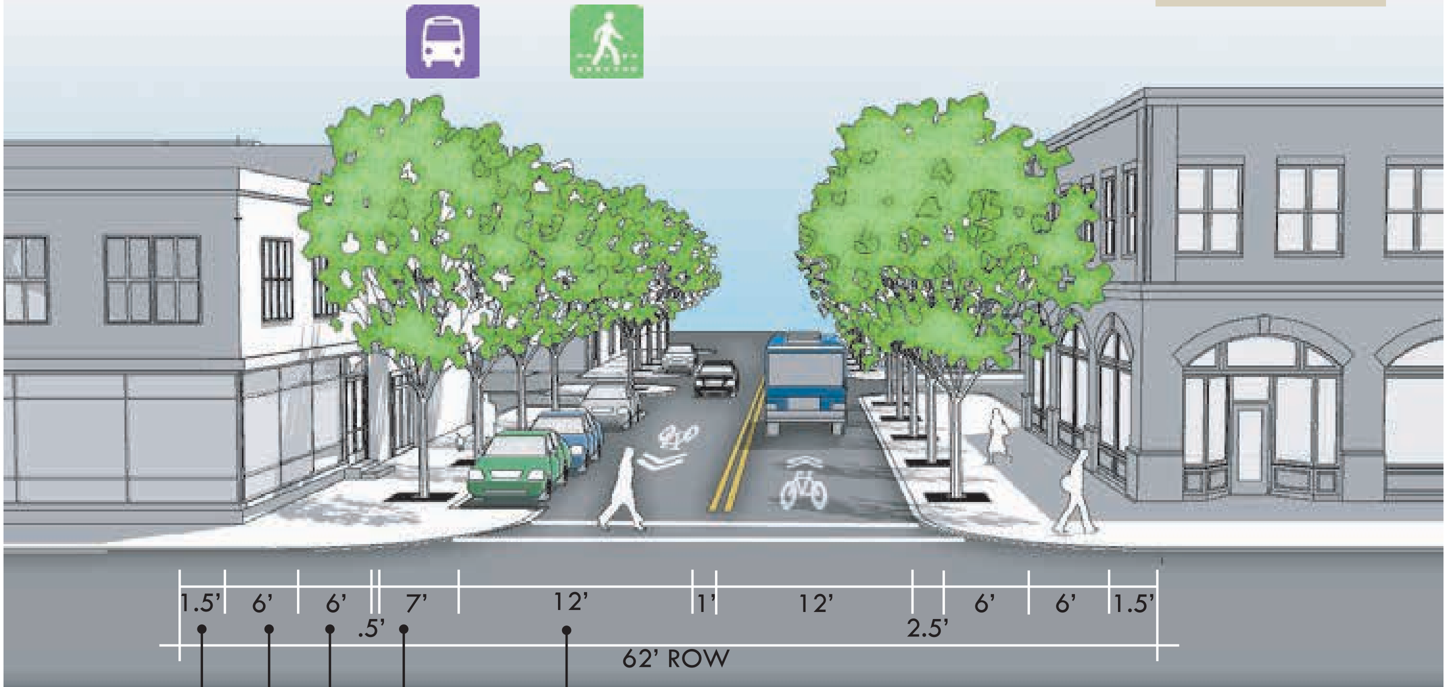
After analyzing the Multimodal Center type and the Multimodal System Plan for this region, it was determined that the proposed Multimodal Corridor type for this roadway would be a T-3 Avenue with both Transit and Pedestrian Modal Emphases. Figure 75 shows how the proposed cross-section was built using the Modal Emphasis applied to each Corridor Element.

Avenue

T3

BUILDING THE PROPOSED CROSS SECTION

Modal Emphasis = Transit + Pedestrian



	BUILDING FRONTAGE ELEMENT	SIDEWALK THROUGH ELEMENT	AMENITY ELEMENT	CURBSIDE ACTIVITY ELEMENT	BICYCLE ELEMENT	TRAVEL LANE ELEMENT	MEDIAN ELEMENT
Optimal	10 ft	6 ft	7 ft	7 ft both sides	5 - 8 ft*	12 ft	18 ft
Minimum	1.5 ft	5 ft	6 ft	None	4 - 5 ft*	11 ft	None
Standard Used	1.5 ft	6 ft	6 ft	7 ft one side	Shared Lane Markings*	12 ft	None

Optimal and Minimum values shown for the Bicycle element are for a non-separated conventional bicycle lane. Although not included in the Corridor Matrix, shared lane markings are a potential treatment discussed in other references, including FHWA's Bikeway Selection Guide. In this example, shared lane markings were determined to be appropriate because the average daily traffic on this street is less than 3,000 vehicles per day, and the posted speed limit is 25 mph.

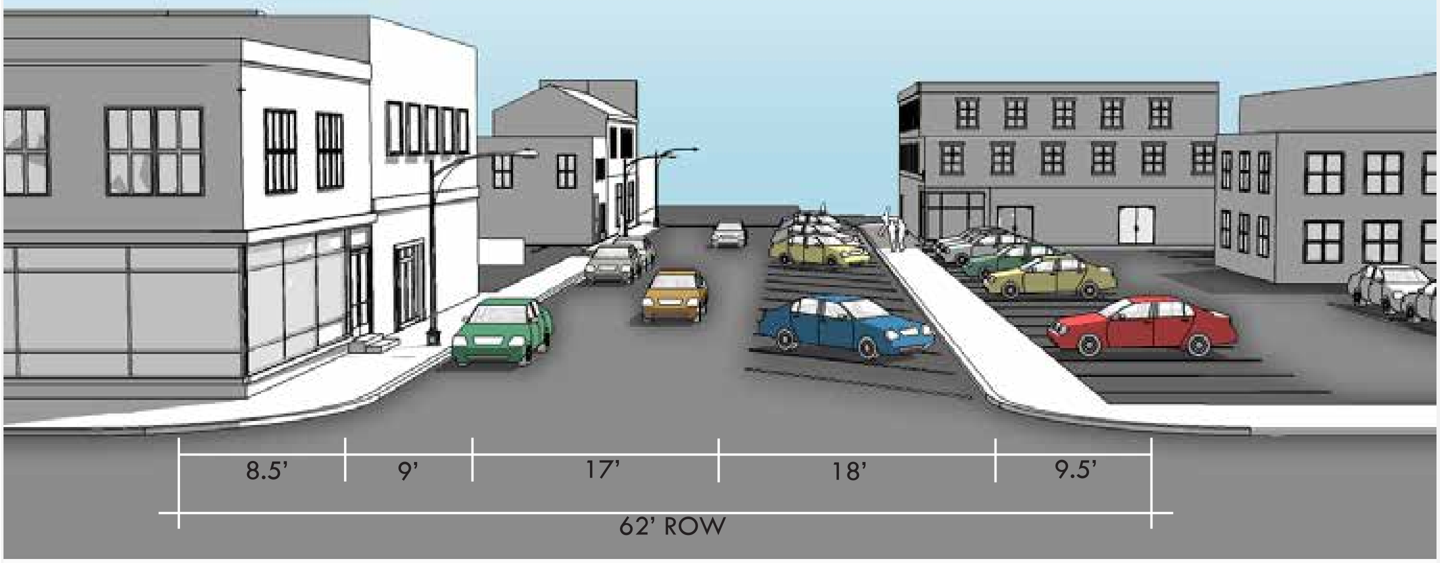
Figure 75: Using Optimal and Minimum Standards to Build the Proposed Cross Section.

It should be noted that the proposed cross-section was built using sound judgment and not just a mechanical application of the standards in the Corridor Matrix. For example, the existing constrained right-of-way did not allow for parking to be included on both sides of the street with two-way traffic. Therefore, a design decision was made to allow parking on only one side of the street, with the assumption that the new infill development, shown on the right side of the street, would also incorporate some structured parking to make up for the on-street diagonal parking and surface parking lot that would be lost in this redevelopment proposal.

Figure 76 shows the final comparison of the existing and proposed cross-sections.

APPLYING MODAL EMPHASIS IN CONSTRAINED ROW SITUATIONS

Existing Street Cross-Section



BUILDING THE PROPOSED CROSS SECTION

Modal Emphasis = Transit + Pedestrian

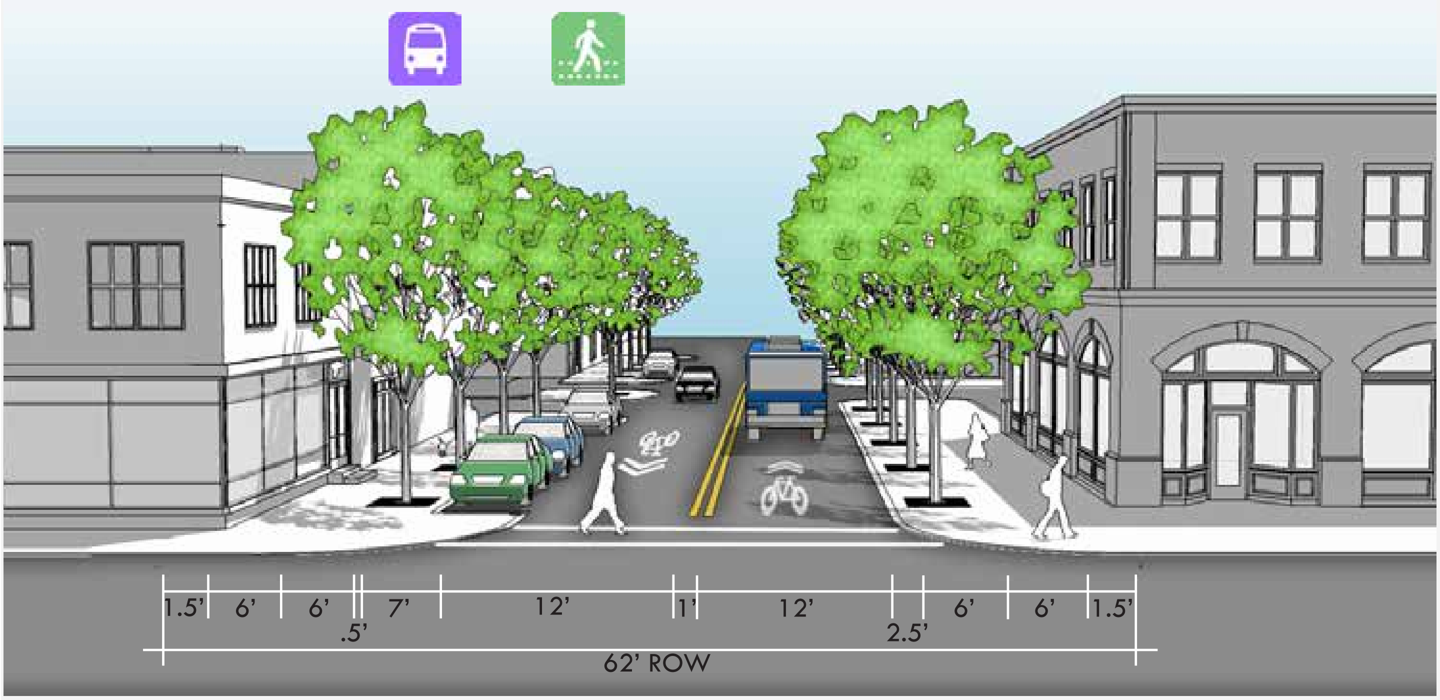


Figure 76: Comparison of Existing and Proposed Cross Sections.

The methodology described previously outlines a flexible process for Multimodal Corridor design. The basic steps of this methodology are as follows:

1. Identifying the Multimodal Corridor Type
2. Identifying the Transect Zone of the Multimodal Corridor
3. Identifying the Modal Emphasis for the Multimodal Corridor
4. Building the proposed cross-section for the Multimodal Corridor by applying Modal Emphasis to the standards for each Corridor Element

The benefits of applying this process to future road design for Multimodal Corridors are many. In addition to ensuring that the final corridor design conforms to the best industry standards and VDOT requirements, this design process will ensure an efficient and economical road design. Furthermore, by following a clear and logical step-by-step design process, the whole process of roadway design can become more transparent to all stakeholders and end users of the future corridor. A more clear and transparent process of making design decisions for future multimodal investments is also crucial to ensuring buy-in and support from the diverse group of stakeholders that stands to benefit from these types of public or private investments.

CHAPTER 6

Intersections

Intersections are areas of complex interactions between multiple modes of transportation. Drivers, pedestrians, and bicyclists must yield to each other from multiple directions, creating conflict points. More than 50 percent of crashes resulting in fatalities or injuries occur at or near intersections.[25] Intersection design is extremely important as it helps all road users better communicate and anticipate the movements of others.

This chapter presents multimodal design considerations at intersections as a set of best practices. It does not present detailed design standards for these intersection elements. Readers are encouraged to reference the list of resources on specific intersection design provided at the end of this chapter for further guidance.

Elements of Intersection Design

The following sections describe important elements of intersections for each travel mode. As with corridor design, different modes need different intersection elements, and limited right-of-way can constrain designers from optimizing the design of intersections. These Guidelines describe concepts to keep in mind, particularly for Modal Emphasis and different Multimodal Corridor types, but they are not directly tied to the Corridor Matrix that describes detailed corridor design.

The elements described in this section assume signal controlled intersections, however many elements are applicable at stop- and yield-controlled intersections, including roundabouts and mid-block crossings. These non-signal-controlled intersections are described in more detail in subsequent sections of this chapter.

Key Intersection Elements for Pedestrians

Intersections without safe facilities for pedestrians create critical gaps in the pedestrian network. Intersection design best practices incorporate features for persons with physical disabilities, including those who are blind or visually impaired. Often these kinds of design features that are optimized for persons with disabilities are advantageous to able-bodied pedestrians too.

Pedestrians who are Blind or Visually Impaired

Intersection design best practices incorporate features for persons with physical disabilities, including those who are blind or visually impaired. Often these kinds of design features that are optimized for persons with disabilities are advantageous to able-bodied pedestrians too.

[25] Federal Highway Administration, 2019. "Intersection Safety: Background and Objectives." Webpage accessed 17 Jan 2020 at https://cms7.fhwa.dot.gov/research/research-programs/safety/intersection-safety.

Crosswalks

Crosswalks provide critical connections for pedestrians, and should be striped on all approaches that provide a pedestrian link for all intersections along Placemaking Corridors and Multimodal Through Corridors. VDOT's IIM-TE-384: Pedestrian Crossing Accommodations at Unsignalized Locations provides requirements and guidance related to crosswalks relevant to both unsignalized and signalized locations.

Figure 77 shows examples of the three permissible crosswalk markings for VDOT maintained roadways – standard transverse lines, longitudinal lines, and bar pairs. VDOT's IIM-TE-384 provides guidance on when each crosswalk marking type is appropriate.

Figure 77: Example of Crosswalk Markings. From Left to Right: (1) Standard transverse lines in Norfolk, VA. (2) High-visibility longitudinal lines in Danville, VA. (3) High-visibility bar pairs in Norfolk, VA

Designers may consider subdued-colored aesthetic treatments (such as non-retroreflective StreetPrint pavement texturing that simulates brick lattice and mosaic stone designs through stamped asphalt) between the white retroreflective transverse crosswalk lines for crosswalks in Multimodal Districts and Centers to match the surrounding streetscape motif, such as those in Figure 78. A brick or stone pattern alone, however, does not provide enough contrast with the asphalt to draw drivers' attention. The white transverse (i.e. parallel) lines must be present on the outside of the crosswalk and should be retroreflective. The design within the transverse lines should be uniform and repetitive patterns, monotone earth tones, and non-retroreflective. FHWA advises against designs that have bright or multiple colors, display symbols, or represent artwork because they can present a distraction to drivers and degrade the contrast with the white transverse lines.[26] StreetPrint pavement texturing and stamped asphalt have fewer maintenance issues than pavers.

Figure 78: Special Crosswalk Paving. Crosswalks with brick pavers alert drivers to pedestrian areas and add visual appeal.

[26] FHWA, 2013. MUTCD – Official Ruling 3(09)-24(I) – Application of Colored Pavement. Memorandum. Retrieved 16 Jan 2020 from https://mutcd.fhwa.dot.gov/resources/interpretations/pdf/3_09_24.pdf.

VDOT IIM-TE-384 describes additional features for mid-block crossings including signs and activated flashing beacons. These features are described later in this chapter. All crossings should be in compliance with the MUTCD and the Public Right of Way Accessibility Guidelines (PROWAG).

Corner Radii

The size of the corner is a key design element for pedestrian comfort and safety. Corner radii determine crosswalk lengths and affect the speed of turning vehicles. In areas with a pedestrian modal emphasis, corner radii should be limited as much as possible to reduce crosswalk lengths and slow vehicles that are turning through the crosswalk.

The presence of on-street parallel parking can allow for a smaller actual curb radius that still accommodates larger design vehicles with an appropriate effective turning radius. Figure 79 illustrates this concept.

Curb Ramps

Curb ramps provide a transition between the curb and the roadway surface for people with wheelchairs or strollers, and others who are unable to step down from the curb. When curb ramps are provided at intersections, separate curb ramps shall be provided for each crossing and aligned across from the curb ramp on the opposite side. This means two curb ramps should be provided at each corner to align directly with the crosswalks, as shown in Figure 80.

Curb ramps shall have detectable warning surfaces such as truncated domes of a high color contrast, as shown in Figure 81. These detectable warning surfaces warn pedestrians who are visually impaired that they are about to step into the roadway.

All curb ramps shall be designed to meet VDOT Road and Bridge Standards and to prevent water from ponding at the base. For more information on curb ramps, refer to the following resources:

- VDOT IIM-LD-55 Guidelines for the Placement of Curb Ramps for Pedestrian Access Routes
- VDOT Road Design Manual, Appendix A(1)
- VDOT Road and Bridge Standards

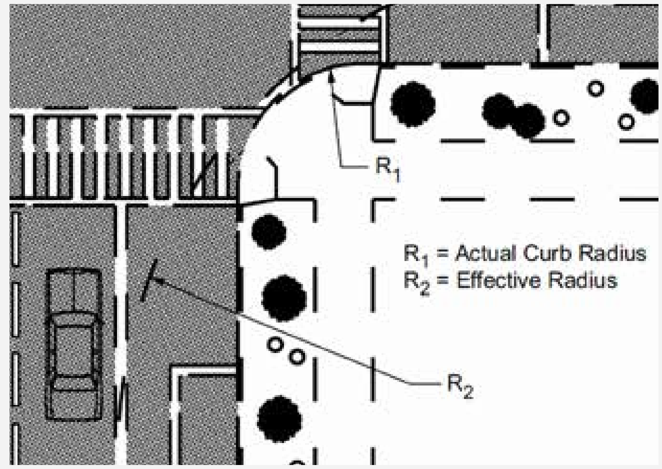


Figure 79: Actual Curb Radius and Effective Radius for Right-Turn Movements at Intersections. On-street parking can provide a larger effective radius than the actual curb radius. Image Source: AASHTO Green Book 7th Edition (2018), Figure 5-3.

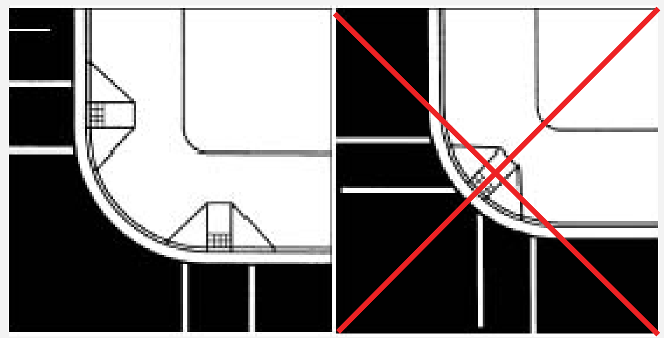


Figure 80: Curb Ramp Design. The design on the left is preferred with two curb ramps that align directly with the crosswalks. The image to the right design is undesirable, as it does not align with the crosswalks. Image source: Federal Highway Administration

Figure 81: Detectable Warning Surface. Truncated domes are a surface treatment for curb ramps that alert pedestrians who are visually impaired that they are about to walk off a sidewalk into a roadway.

Pedestrian Crossing Signals

Pedestrian crossing signals let pedestrians know when the pedestrian phase is on at signalized intersections. Pedestrian crossing signals are coordinated with the traffic signals and are especially helpful at intersections with complex phasing, such as left turn only phases. There are several different types of pedestrian signals.

Curb ramps shall have detectable warning surfaces such as truncated domes. These detectable warning surfaces warn pedestrians who are visually impaired that they are about to step into the roadway. All curb ramps shall be designed to meet PROWAG and VDOT Road and Bridge Standards and to prevent water from ponding at the base.

Countdown pedestrian signals indicate how much time is left during the 'flashing don't walk' phase.[27] Accessible pedestrian signals (APS) provide audible and vibratory cues for pedestrians who are visually impaired or hearing impaired. VDOT requires APS at all signalized pedestrian crossings.

Some pedestrian crossing signals are activated by a push-button. The push-button shall be located in accordance with the MUTCD.

Intersections with activated pedestrian phases and median refuges should include push buttons in the median to prevent pedestrians from becoming 'stranded' in a median refuge with no way to activate the pedestrian phase and finish crossing the street.

APS give auditory cues when the pedestrian phase is on. Some APS give vibratory cues for people who are hearing impaired. Pedestrians with hearing impairments can touch the push-button, and it will vibrate when the walk phase is on. APS that speak the name of the road are helpful for pedestrians who are visually impaired and required by VDOT.

Figure 82: Activated APS Push-Button. This traffic signal is activated, meaning pedestrians push the black button to call a pedestrian phase to cross the street. It is also an APS that speaks the name of the street and vibrates when the pedestrian phase is on.

For more information on APS, refer to the following resources:

- VDOT IIM-TE-388: Accessible Pedestrian Signals and Accessible Pedestrian Signal Detectors
- NCHRP Web-Only Document 117A: Accessible Pedestrian Signals: A Guide to Best Practices

All-Pedestrian Signal Phases

It may be appropriate to introduce all-pedestrian signal phases at intersections with high levels of pedestrian activity. In an all-pedestrian phase, all vehicles are held and pedestrians are given the light to cross all legs of the intersection, including diagonally.

[27] Pedestrian signals typically have three phases. The 'don't walk' phase displays a solid red or orange hand symbol that indicates pedestrians should wait. The 'walk' phase displays a white pedestrian symbol that indicates that the pedestrian phase is on and pedestrians should have adequate time to cross the street. The 'flashing don't walk' phase displays a flashing red or orange hand symbol that indicates that the pedestrian phase is on, but pedestrians leaving the curb to cross the street at that moment may not have enough time to cross the street before the pedestrian phase is over.

Median Refuges

The Corridor Matrix specifies that if median refuges are provided, they shall be a minimum of six feet wide measured from back of curb to back of curb, as shown in Figure B-11 in Appendix B. This minimum median refuge width will accommodate two two-foot wide detectable warning surfaces with a two-foot wide smooth surface between them. This allows all medians to serve as refuges for pedestrians if there is not enough time to cross.

All traffic signals should be timed such that pedestrians have adequate time to cross the entire roadway in a single phase, even when median refuges are provided. Push-buttons should be provided at median refuges for intersections with activated pedestrian phases, even if the signal phasing provides enough time to cross. If a pedestrian cannot cross the roadway in a single phase, push buttons in the median refuge island are required.

Median refuges that are at least six feet wide shall have detectable warning surfaces on either side to indicate to persons with visual impairments that they are stepping onto the roadway.[28] These refuges and any ramps on them shall be designed in accordance with VDOT Road and Bridge Standards.

Some intersections may have concrete curbed islands between same-direction traffic lanes, such as a ‘pork chop’ island between a channelized right turn lane and a through lane. These median islands may help vehicular traffic to flow faster at intersections, but they can be disadvantageous for pedestrians. These types of channelized turn lane treatments make the crossing distance longer for pedestrians and speed up traffic, making the overall environment more dangerous for pedestrians. Moreover, pedestrians who are visually impaired can find these islands particularly disorienting. These types of islands are not recommended for Placemaking Corridors in Multimodal Centers and should be avoided on Multimodal Through Corridors wherever possible, especially in areas of high pedestrian activity.

[28] VDOT Road & Bridge Standards Section 200 provides more information on pedestrian median refuge design.

Curb Extensions

Curb extensions, like those shown in Figure 83, are also called or 'bulb-outs' an intersection treatment where the curb is extended out into the roadway at the crosswalk to shorten the crossing distance. Curb extensions also serve as traffic calming devices, as they have been shown to slow traffic speeds. They are typically used in conjunction with on-street parking and/or bus pull-offs.

Curb extensions are recommended as a best practice for the design of Multimodal Corridors, as they provide additional space at the corner and allow pedestrians to see and be seen before entering the crosswalk. Curb extensions are especially recommended in Multimodal Centers, and on all corridors with Pedestrian Modal Emphasis. If space constraints limit the feasibility of curb extensions on both sides, one side may be constructed without the other.

VDOT's Road Design Manual Appendix B(1) provides design guidance for curb extensions, shown in Figure 84.

Curb extensions or 'bulb-outs' are an intersection treatment where the curb is extended out into the roadway at the crosswalk to shorten the crossing distance.

Figure 83: Curb Extensions. Curb extensions like these in Charlottesville, VA bring pedestrians out closer to the street at key crossing locations, putting them in better view of motorists. They provide more space for pedestrians, add aesthetic value, and can even create space for recreation.

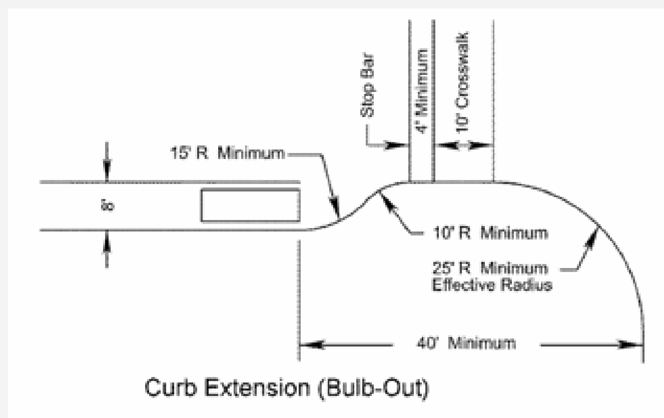


Figure 84: VDOT Curb Extension Design Requirements. Image Source: VDOT Road Design Manual Appendix B(1).

Raised Intersections and Raised Crosswalks

At a raised intersection, the level of the street is raised so that it is flush with the sidewalk. This encourages vehicular traffic to slow down and yield to pedestrians. Bollards can be used to prevent vehicles from driving into the pedestrian space. In lively pedestrian districts, removing the curbs and raising the street to the sidewalk level can enhance the quality of public space and signal to drivers that they are guests on a pedestrian-oriented street and should drive accordingly.
Raised crosswalks are similar to raised intersections, but only the crosswalk is raised. VDOT's Traffic Calming Guide for Neighborhood Streets addresses raised crosswalks, speed bumps, and speed humps.

Curbless and Shared Streets

In placemaking districts with high levels of pedestrian activity, Curbless and Shared Streets are options for prioritizing pedestrian safety and comfort. On Curbless Streets, the vertical separation between the roadway zone and the pedestrian zone provided by curbs is removed. Bollards or planters may be used to provide a barrier between travel lanes and the sidewalk but this is not required. Special pavers or pavement patterns are often used to indicate the pedestrian-orientation of the street and slow drivers. Curbless Streets are not considered Shared Streets because pedestrian and vehicle traffic are provided with separate travel ways. Curbless Streets should only be used in certain circumstances. Blended transitions are not allowed on newly constructed VDOT maintained roads. Curbless streets are not recommended when vehicles other than passenger cars are included in the mix of traffic. Figure 85 shows a photo of a curbless street in Fairfax's Mosaic District.

Figure 85: Curbless Street in the Mosaic District, Fairfax. Intersection of District Ave and Strawberry Ln.

Shared Streets are streets where pedestrians and vehicles are intended to occupy the same physical space with priority right-of-way given to pedestrians. In a typical Shared Street, a variety of design strategies combine to reduce vehicle speed and signal the streets' primary function as a human-centered place. Shared Streets are typically located in busy pedestrian districts with vibrant street life, including shops, outdoor cafes, and restaurants but are also appropriate on some residential streets. Shared Streets can be implemented with temporary low-cost materials on a trial basis to test effectiveness of the design before committing to a full roadway reconstruction. When creating Curbless and Shared Streets, designers must carefully consider accessibility for visually impaired individuals. For detailed design guidance for Curbless and Shared Streets, see the NACTO Urban Street Design Guide and FHWA's Accessible Shared Streets. Figure 86 shows a photo of a shared street in Asheville, NC.

Figure 86: Shared Street, Wall Street, Asheville, NC. Photo by NACTO.

Key Intersection Elements for Bicyclists

Intersections can be dangerous areas for all levels of bicyclists and often difficult to navigate particularly for inexperienced bicyclists. Best-practices in intersection design have advanced significantly in recent years with several new types of treatments in place in cities around the country. In 2019, NACTO released *Don't Give Up at the Intersection*, providing new guidance on bicycle intersection design. This guide recommends three core principles for designing safe bike lanes through intersections:

1. Reduce the speed of turning vehicles,
2. Make bikes more visible by providing good sight lines
3. Give bikes the right of way with bike-friendly signal strategies.

The following design elements can facilitate better interaction between bicyclists, vehicles, and pedestrians at intersections.

Turn Lanes

Wherever possible, bicycle lanes should be extended through the intersection. If limited right-of-way at the intersection makes this infeasible, proper upright and/or on-pavement signage should be used to make both vehicle drivers and bicyclists aware that the bicycle lane ends and bicyclists will be merging into the travel lane.

At intersections without a right-turn lane, bicycle lanes lines can be solid, dashed, or could be temporarily dropped to indicate the merging of bicyclists and vehicles, and to avoid conflicts between a right-turning vehicle and a bicyclist traveling through the intersections.

At intersections with exclusive right turn lanes, the bicycle lane shall be placed to the left of the right turn lane unless split-phase signal timing is used to separate through bike movements from turning vehicle movements. NACTO's Don't Give Up at the Intersection expansion to the Urban Bikeway Design Guide discusses signal phasing strategies for protected and dedicated bike intersections. Figure 87 shows an example of the bicycle lane transitioning to the left of a right turn lane at an intersection.

Figure 87: Bicycle Lane Transition at Intersection. Dashed lines indicate motor vehicles may encroach into the bicycle lane to enter the right turn lane and warn drivers to yield to bicyclists. Image source: City of Harrisonburg.

New intersection treatments that place the bike lane to the right of a turn lane are described in the Protected Intersections and Dedicated Intersections sections on the next page. Bicycle left-turn-only lanes may be provided, and are especially helpful on the larger Multimodal Corridor types with Bicycle Modal Emphasis, including Boulevards, Major Avenues, and Multimodal Through Corridors. Please refer to the 2012 AASHTO Guide for the Development of Bicycle Facilities, Section 4.8, for more detailed guidance on designing bike lanes at intersections.

Figure 88: Green Dashed Pavement Markings for Bicycle Lanes Through Intersections. At the intersection of East Franklin Street and North 7th Street in Richmond, green paint supplements the white dashed lines indicating the continuation of the bicycle lane through the intersection. (Image Credit: EPR, P.C.)

Intersection Crossing Markings

Intersection crossing markings show bicyclists their ideal path through the intersection and signal to drivers where to expect cyclists. Potential intersection markings include dashed lines, chevrons, and colored pavement. VDOT received interim approval from FHWA for green colored pavement to supplement (but not replace) the white lines used to denote bicycle lanes. Green color makes the dashed bicycle lanes through the intersection more conspicuous and easier to follow, as shown in Figure 88.

Protected Intersections

The protected intersection is a treatment that complements separated bike lanes and enhances protection for cyclists through an intersection. In this design, the bike lane is set back from the parallel vehicle travel lane at the intersection and given the right-of-way over turning vehicles. Corner islands are built as far into the intersection as possible, extending the bike lanes physical protection, slowing down turning vehicles, and improving sightlines between drivers and cyclists. Protected intersections also provide significant pedestrian safety benefits as they slow turning vehicles and provide space for pedestrian refuge islands. Figure 88 shows a protected intersection constructed in Montgomery County, MD.

Dedicated Intersections

Dedicated Intersection designs, such as the one shown in Figure 89, provide a dedicated route through an intersection for cyclists where there is not enough right-of-way to set back the bike lane. This treatment relies on turn speed reduction techniques and signal phasing to reduce conflicts between turning vehicles and bikes. Raised devices like flexible bollards, corner wedges, and speed bumps can be used to reduce the effective turning radius of vehicles and slow turns through the bike lane.

Bike Boxes

A bike box describes an intersection treatment that leaves space between the stop bar for motor vehicles and the crosswalk for bicyclists to wait in front of the motor vehicles. This configuration helps motorists to see the bicyclists, and allows the bicyclists to proceed through the intersection, either going straight or turning, before the motor vehicles, eliminating conflicts between turning vehicles and bicyclists going straight, or between turning bicyclists and vehicles going straight.

Bike boxes may be appropriate treatments for corridors with bike modal emphasis and high volumes of vehicular traffic, for example Boulevards, Transit Boulevards and Multimodal Through Corridors. The NACTO Urban Bikeway Design Guide provides detailed design guidance on the benefits and typical applications of bike boxes, and outlines the required, recommended and optional features. VDOT has not received interim approval from FHWA to use bike boxes.

Figure 89: Protected Intersection in Montgomery County, MD. Photo by the Montgomery County Division of Transportation Engineering.

Figure 90: Dedicated intersection in New York City. Photo by NYCDOT.

Bicycle Turn Treatments

Bicycle left-turn-only lanes and two-stage bicycle turn boxes are especially helpful on the larger Multimodal Corridor types with Bicycle Modal Emphasis, including Boulevards, Major Avenues, and Multimodal Through Corridors.

VDOT has not obtained interim approval for two-stage bicycle turn boxes. Localities interested in applying two-stage bicycle turn boxes must request and receive permission from FHWA before applying this device.

Bike boxes may be appropriate treatments for corridors with Bicycle Modal Emphasis and high volumes of vehicular traffic, for example Boulevards, Transit Boulevards and Multimodal Through Corridors. The NACTO Urban Bikeway Design Guide provides detailed design guidance on the benefits and typical applications of bike boxes, and outlines the required, recommended and optional features. VDOT has not received interim approval from FHWA to use bike boxes.

Figure 91: Bike Boxes. The model on the left (Image source: Richard Masoner) shows the preferred design of bike boxes as specified in the NACTO Urban Bikeway Design Guide. The photo on the right (Image source: Blind Pilot) shows a bike box installed on Commonwealth Avenue in Alexandria, Virginia.

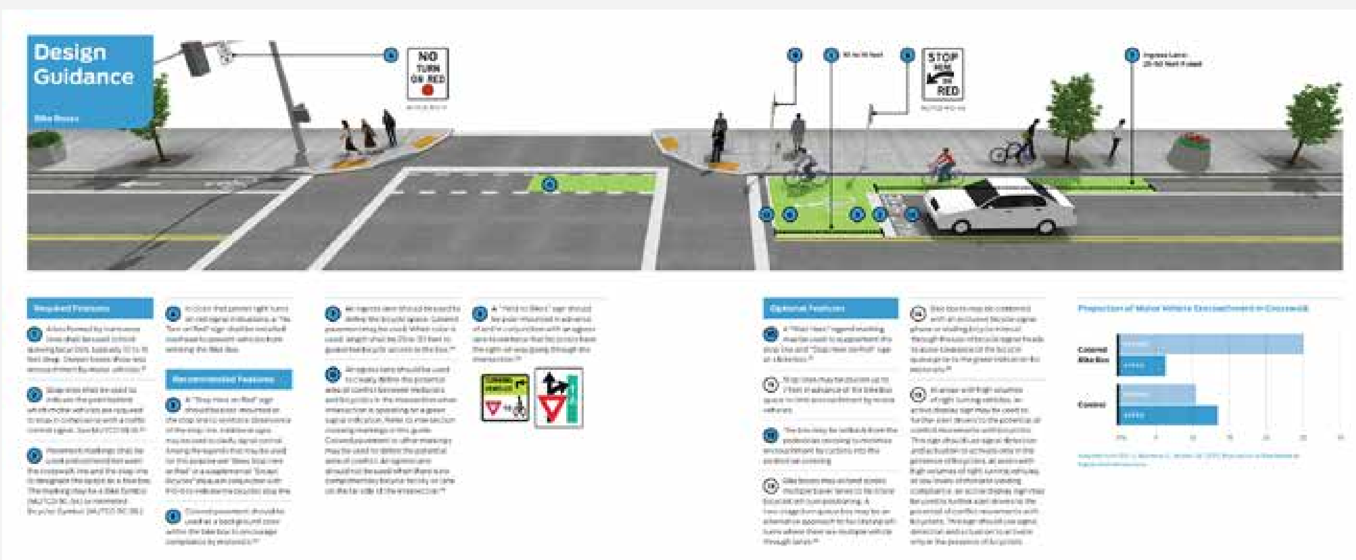


Figure 92: Bike Box Design Guidance. The NACTO Urban Bikeway Design Guide provides detailed recommendations for designing bike boxes at intersections. Image source: NACTO.

Bicycle Signals

Some actuated traffic signals are unable to detect bicyclists waiting at an intersection. On low volume roads, this becomes particularly problematic, as bicyclists will not be able to call a green signal without a motor vehicle. Actuated traffic signals should be upgraded to detect bicycles. The AASHTO Guide for the Development of Bicycle Facilities, provides guidance on a variety of detection systems that are available. Bicycle-only signals can also be used to separate bikes and vehicles through signal phasing strategies.

Pedestrian and Bicyclist Safety at Interchanges

Some multimodal corridors feature interchanges with grade-separated highways. On and off-ramps present a unique challenge to designing safe and comfortable pedestrian and bicyclist accommodations. In general, the intersection design principles described in this chapter also apply to interchanges. For example, ramps should be designed to reduce vehicle speed at crosswalks and ramps should intersect with multimodal corridors at or close to a ninety-degree angle to provide the best possible sight lines. For detailed guidance on interchange design, see the ITE's 2016 publication *Recommended Design Guidelines to Accommodate Pedestrians and Bicyclists at Interchanges*.

Key Intersection Elements for Buses

Intersections present numerous complexities to bus operations. Bus stops are typically located near intersections, requiring buses to pull out of the flow of traffic to pick up and drop off passengers, which can make it difficult to merge back into traffic, causing bus delays. Stopped buses may obstruct bicycle lanes, and bicyclists may need to merge into the travel lane to get around the bus. Several elements of intersection design described below can improve bus operations and reduce delay.

Bus Stops on Curb Extensions

On Placemaking Corridors with Transit Modal Emphasis, bus stops can often be located along curb extensions, sometimes called bus bulbs. This allows buses to stop and safely pick up riders without having to exit the flow of traffic and minimizes delay in bus travel.

Bus Stop Location

Bus stops are best placed on the far side of the intersection, instead of the near side of the intersection, to minimize conflicts with turning vehicles. For more information on far-side and near-side stop locations, refer to the following resources:

- VDOT Road Design Manual, Appendix A(1)
- NACTO Transit Street Design Guide
- AASHTO Guide for the Geometric Design of Transit Facilities on Highways and Streets

Bus Bulbs and Boarding Islands

In corridors with Transit Modal Emphasis, bus stops can often be located along curb extensions called bus bulbs. This allows buses to stop and safely pick up riders without exiting the flow of traffic and minimizes delay in bus travel. Bus boarding islands can also be used where drainage issues make bus bulbs infeasible or on streets with protected bike lanes. Temporary bus bulbs and islands have been successfully tested in a several American cities and can significantly reduce the cost and time needed to implement these improvements. Temporary bus bulbs are made of modular blocks that are pieced together onsite and can be removed and reassembled at other locations if desired. Bus bulbs and boarding islands should be designed to the meet bus-stop accessibility requirements of the Americans with Disabilities Act.

Queue Jump Lanes

Queue jump lanes are short intersection-approach bus lanes that are typically paired with a leading transit-only signal interval, allowing buses to move ahead of intersection queues and merge back into the general travel lane ahead of other traffic. Queue jump lanes can provide significant travel time and reliability benefits on corridors where full-length bus lanes are either not feasible or are not warranted due to moderate bus frequencies.

Transit Signal Priority

Transit signal priority is a way of modifying the traffic signal to give preferential treatment to transit vehicles, making it easier for them to pass through the intersection. Transit signal priority can detect transit vehicles and either hold a green signal until they pass through, or shorten the green time for other approaches to give the approach with a transit vehicle a green signal faster to reduce waiting time. Transit signal priority is highly recommended for Boulevards with Transit Modal Emphasis and Multimodal Through Corridors with Transit Modal Emphasis. Figure 49 in Chapter 4 provides an example of transit signal priority for the Pulse BRT on Broad Street in Richmond.

Turning Radii

In general, smaller curb radii are better for pedestrians, as they shorten the crossing distance, provide more room for pedestrians at the corner, and require vehicles to slow down as they turn the corner. However, small curb radii are particularly can be difficult for large vehicles like transit buses, emergency vehicles, and trucks to navigate. Design features like bicycle lanes and on-street parking can effectively increase the turning radius for larger vehicles without increasing the curb radius for pedestrians. Road designers must balance all factors to select the most appropriate curb radius at each intersection.

Other Intersection Elements

Free-Flow Turn Lanes

In general, free-flow turning movements, such as with channelized right turn lanes, should be avoided on all Placemaking Corridors and all Multimodal Through Corridors with high pedestrian activity, especially those with Pedestrian or Bicycle Modal Emphasis. Drivers are less likely to look for and yield to pedestrians or bicyclists at free-flow turns such as found with channelized turn lanes.

Wayfinding Signs

Wayfinding systems and street signs should be legible and visible for all users, including pedestrians and bicyclists, in addition to motorized vehicles.

Street Corners

Designers should keep intersection corners clear of all obstructions to allow pedestrians clear paths and for clear sight lines for motorists and bicyclists. Utility poles should be placed away from the intersection corners to avoid interfering with sight distance. Low bollards or planters may be used to separate pedestrians from traffic or enhance the aesthetic quality of an intersection. These bollards or planters should be less than 2.5 feet high. Hanging planters should be taller than nine feet high to keep the pedestrian sight line clear.

Figure 93: Bicycle Rack Placement in Arlington County. Obstructions like bicycle racks should be placed away from street corner areas. Bicycle racks should be place in the amenity zone between the sidewalk and curb.

[29] Block lengths to support walkability are preferably 200 to 300 feet in dense urban areas, and 200 to 400 feet in less dense areas. ITE/CNU's Designing Walkable Urban Thoroughfares: A Context Sensitive Approach, Chapter 3 provides guidance on block lengths and ideal street spacing.

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Mid-Block Crossings

All Placemaking Corridors within Multimodal Centers should have frequent pedestrian crossings. Ideally in Multimodal Centers, block sizes are small and intersections are rarely more than 400 feet apart in dense urban areas (T-4, T-5, and T-6), and no more than 600 feet apart in less dense areas (T-1, T-2, and T-3).[30] When intersection spacing exceeds 600 feet, mid-block pedestrian crossings should be considered to prevent pedestrians from crossing at unmarked locations.[31]

Pedestrian Hybrid Beacons (PHBs) and Rectangular Rapid Flashing Beacons (RRFBs) can be used at mid-block crossings under certain conditions. PHBs, like the one shown in Figure 94, are overhead traffic signals that allow pedestrians to press a button and stop traffic while crossing at a mid-block crossing. RRFBs are flashing lights that are typically mounted to a roadside pedestrian-crossing sign. Pedestrians may activate the flashing beacons to warn drivers that a pedestrian is using the mid-block crossing. Both treatments are in use in Virginia.

Figure 94: Pedestrian Hybrid Beacon in Fairfax, VA. (Image Source: Google Earth)

VDOT's IIM-TE-384 provides guidance for mid-block crossings, including requirements for signage and crosswalk markings, and considerations for high-visibility markings and raised crosswalks. Figure 95 shows an example of a mid-block pedestrian crossing with a high-visibility crosswalk marking and pedestrian warning signs

Mid-Block Crossings

When intersection spacing exceeds 600 feet, mid-block pedestrian crossings should be considered to prevent pedestrians from crossing at unmarked locations.

Figure 95: Mid-Block Pedestrian Crossing in Charlottesville, VA. (Image Source: Google Earth)

[30] Block lengths to support walkability are preferably 200 to 300 feet in dense urban areas, and 200 to 400 feet in less dense areas. ITE/CNU's *Designing Walkable Urban Thoroughfares*: A Context Sensitive Approach, Chapter 3 provides guidance on block lengths and ideal street spacing.

[31] AASHTO Bike Guide, Section 3.4 provides additional guidance on mid-block crossings.

Other Intersection Considerations

Many of the previously described design features for signalized intersections are also appropriate for stop-controlled intersections. Four-way stop signs are preferred for corridors with Bicycle Modal Emphasis that intersect with other major roads as opposed to two-way stop signs.

Intersections that differ from the typical four-leg perpendicular configuration may require special design considerations to adequately accommodate pedestrians and bicyclists.

Roundabouts should be designed in accordance with NCHRP Report 672 Roundabouts: An Informational Guide – Second Edition, which thoroughly addresses how to accommodate pedestrians and bicyclists at roundabouts Figure 96 shows a roundabout in Amherst, VA.

Other irregularly shaped intersections, such as skewed intersections where the angle of the intersection is less than 90 degrees or multileg intersections where five or more legs intersect at one point, should be designed in accordance with the latest AASHTO Green Book, and follow the guidance of the AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities and the AASHTO Guide for the Development of Bicycle Facilities.

Figure 96: Roundabout in Amherst, Virginia. Roundabouts should be designed in accordance NCHRP Report 672 Roundabouts: An Informational Guide – Second Edition, which thoroughly addresses how to accommodate pedestrians and bicyclists at roundabout. (Image source: VDOT)

Intersection Design Resources

Readers are encouraged to reference the following resources for further guidance on intersection design:

- Manual on Uniform Traffic Control Devices (MUTCD), published by FHWA
- Virginia Supplement to the MUTCD, published by VDOT
- Guide for the Planning, Design, and Operation of Pedestrian Facilities, published by AASHTO, referred to as the AASHTO Pedestrian Guide in future references
- A Policy on Geometric Design of Highways and Streets, published by AASHTO, referred to as the AASHTO Green Book in future references
- Road Design Manual, published by VDOT
- Guide for the Development of Bicycle Facilities, published by AASHTO, referred to as the AASHTO Bike Guide in future references
- Urban Bikeway Design Guide and follow-up guides Designing for All Ages & Abilities and Don't Give up at the Intersection, published by the NACTO
- Transit Street Design Guide, published by NACTO
- Pedestrian Crossing Accommodations at Unsignalized Locations, an Instructional and Informational Memorandum (IIM-TE-384.0), published by VDOT
- Recommended Design Guidelines to Accommodate Pedestrians and Bicycles at Interchanges, published by ITE
- Guide for Geometric Design of Transit Facilities on Highways and Streets, published by AASHTO

CHAPTER 7

Developing Multimodal Centers & Corridors Over Time

One of the potential benefits of these Guidelines to planners and designers is in providing a unified framework for coordinating land use and transportation investments over time. Traditionally transportation investments are made by the public sector, and land use investments are made by the private sector, although usually regulated to some degree by the public sector. However, as recent economic challenges are calling for more creative financing of infrastructure and closer public/private partnering, it is becoming even more important that our public and private investments work in concert towards a unified and agreed-upon vision of the future built environment. These Guidelines are intended to foster that integration between transportation, land use, and community design through their comprehensive approach to multimodal transportation design at the regional, neighborhood and street scale.

Visualizing How the Guidelines Could Be Applied

The following sequence of visualizations presents a capsule summary of the Guidelines methodology by showing how multimodal planning can work from the region down to the corridor scale. For the purpose of describing the methodology, a three dimensional computer model of a hypothetical region was built. The following images show how this hypothetical region can be analyzed to develop a series of interlocking plans, including:

- Region – Multimodal System Plan
- Neighborhood – Multimodal Center Plan
- Street – Multimodal Corridor Plan

Figure 97 shows the hypothetical region, highlighting the built form and roadway system. The region contains two general hubs of activity that are separated by a major expressway. A third activity hub is planned in the future in a relatively undeveloped area in one quadrant of the expressway interchange.

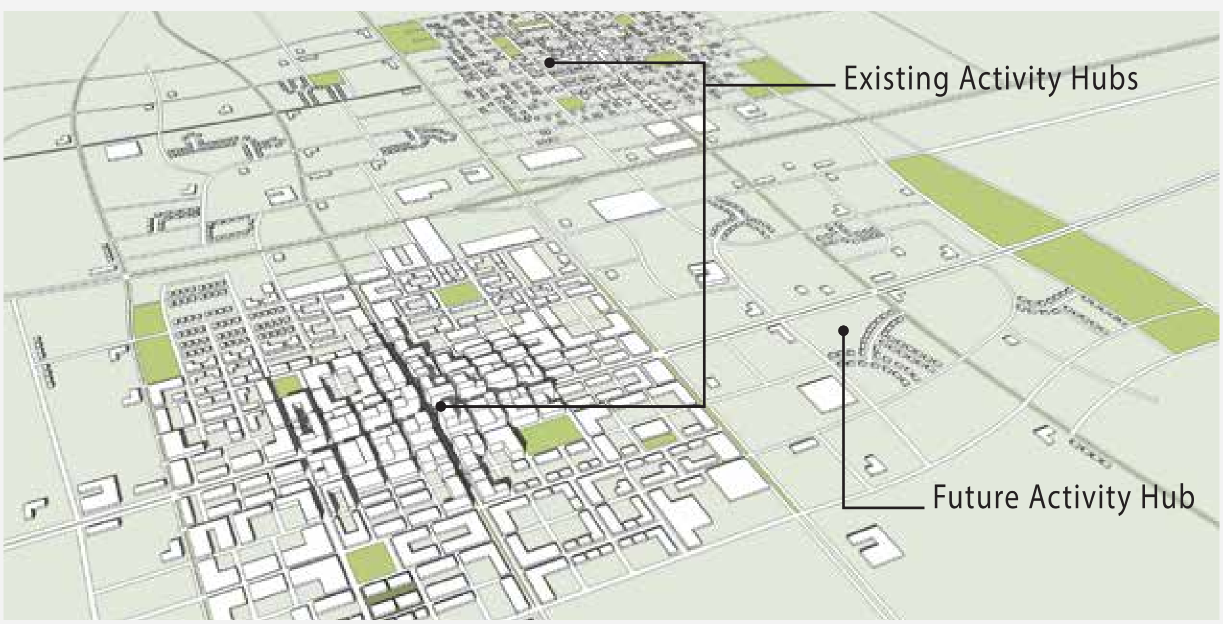


Figure 97: Hypothetical Region Showing Activity Areas Separated by a Major Expressway.

Figure 98 shows an analysis of the Activity Densities in this region. As described previously in Chapter 2, this is the first step in developing the potential Multimodal Districts and Multimodal Centers. Note that the future Activity Density for the proposed activity hub is also included.

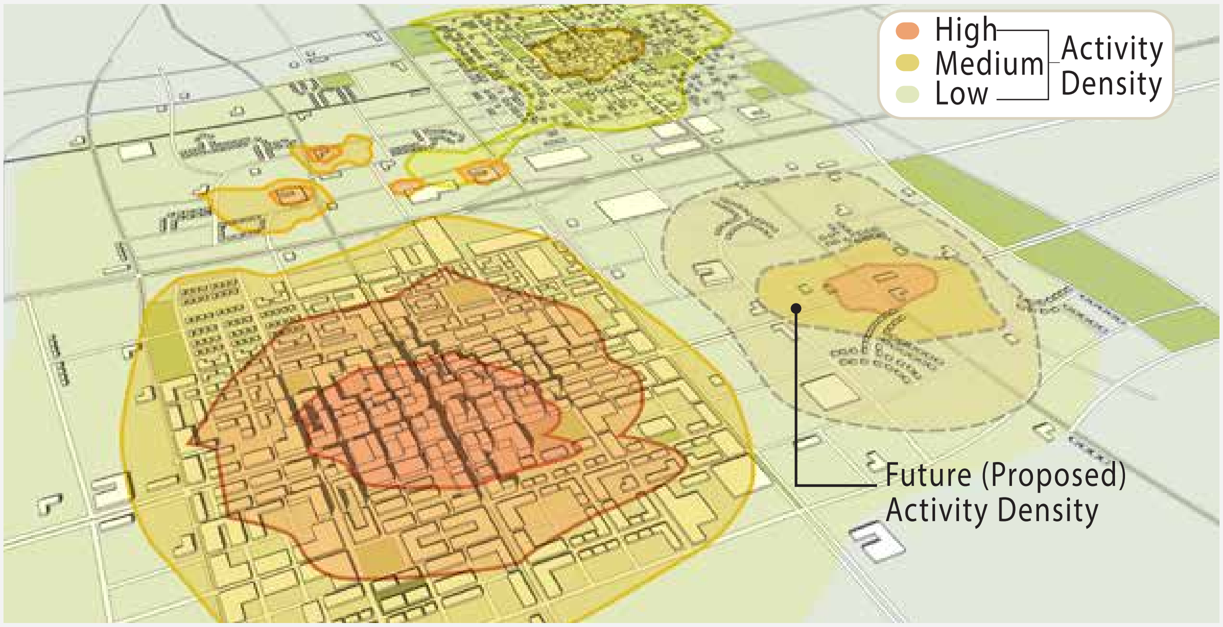


Figure 98: Analysis of Activity Density in the Region. Activity Density is the sum of jobs and population divided by the acreage.

Based on this analysis of Activity Density, the potential Multimodal District can be identified, with three potential Multimodal Centers centered on the areas with the highest Activity Densities.

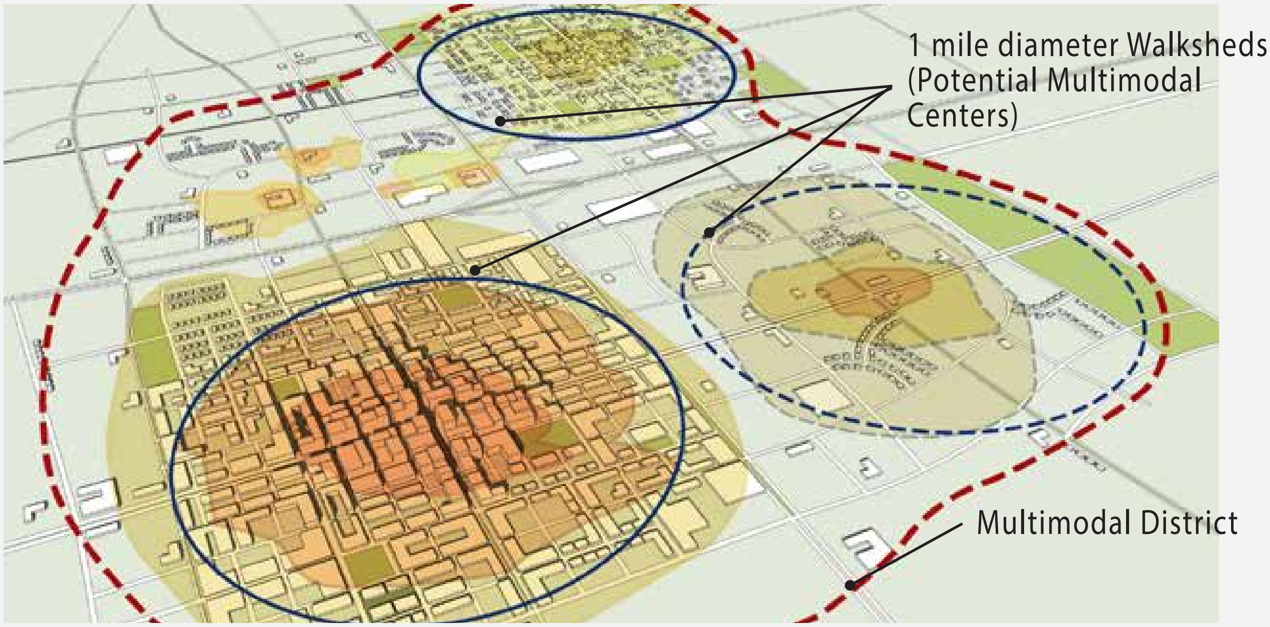


Figure 99: Potential Multimodal District and Potential Multimodal Centers. Based on the regional Activity Density.

As noted in Chapter 2, the dimensions of a Multimodal District vary and should encompass any area that has good potential multimodal connectivity. The potential Multimodal Centers, however, start with identifying half-mile radius circles since these are based on a primary walk-shed and are a more focused area for high multimodal connectivity. After measuring general half-mile radius walksheds, the Multimodal Centers are defined, allowing for more flexible boundaries that accord with actual features on the ground.

Figure 100 shows how the Multimodal Center boundaries have been modified to fit with actual conditions on the ground.

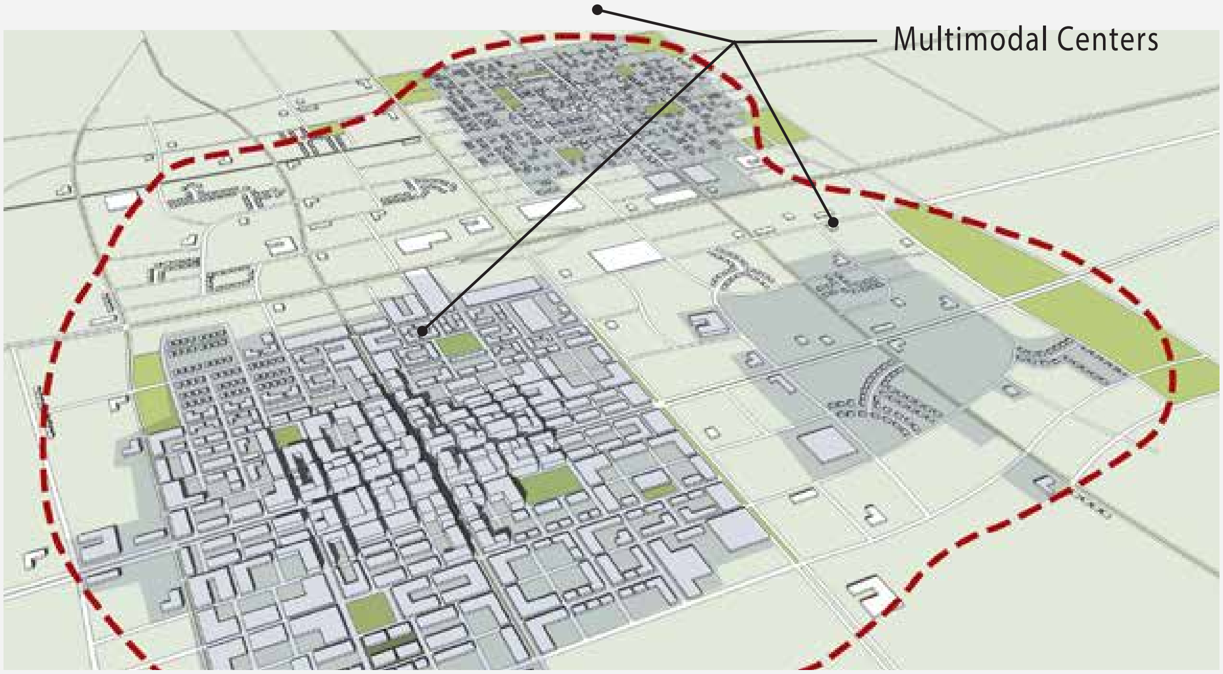


Figure 100: Multimodal District and Multimodal Centers. Multimodal Center boundaries have been modified to fit with actual conditions.

As described in Chapter 5, a key organizing principle is to organize a region into a logical and flexible multimodal network through the designation of Multimodal Through Corridors and Placemaking Corridors. The Multimodal Through Corridors can be thought of as the routes "to" and "between" Multimodal Districts and Multimodal Centers, and the Placemaking Corridors as the routes "through" and "within" Multimodal Districts and Multimodal Centers.

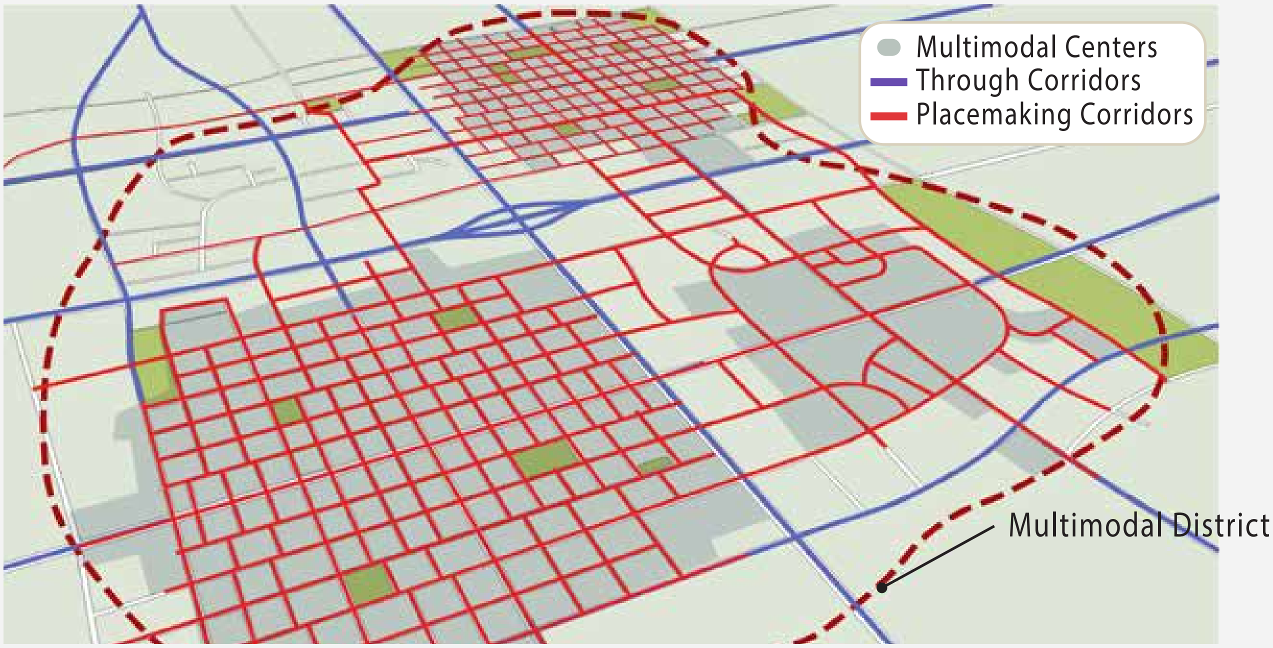


Figure 101: Multimodal Through Corridors and Placemaking Corridors. Showing a logical network of corridors in the region for getting "through" and "to" Multimodal Districts and Centers.

The next step in planning the multimodal region is to identify the applicable travel modes for Modal Emphasis on each corridor, as shown in Figure 102. The designation of Modal Emphasis should be done as part of the development of the Multimodal System Plan, as described in Chapter 2.

Figure 102: Using Modal Emphasis to Designate the Emphasized Travel Modes on Each Corridor.

Figure 103 shows the fully developed Multimodal System Plan for this region, with each of the Multimodal Corridors and Multimodal District and Centers identified, along with the basic network for each travel mode in the region.

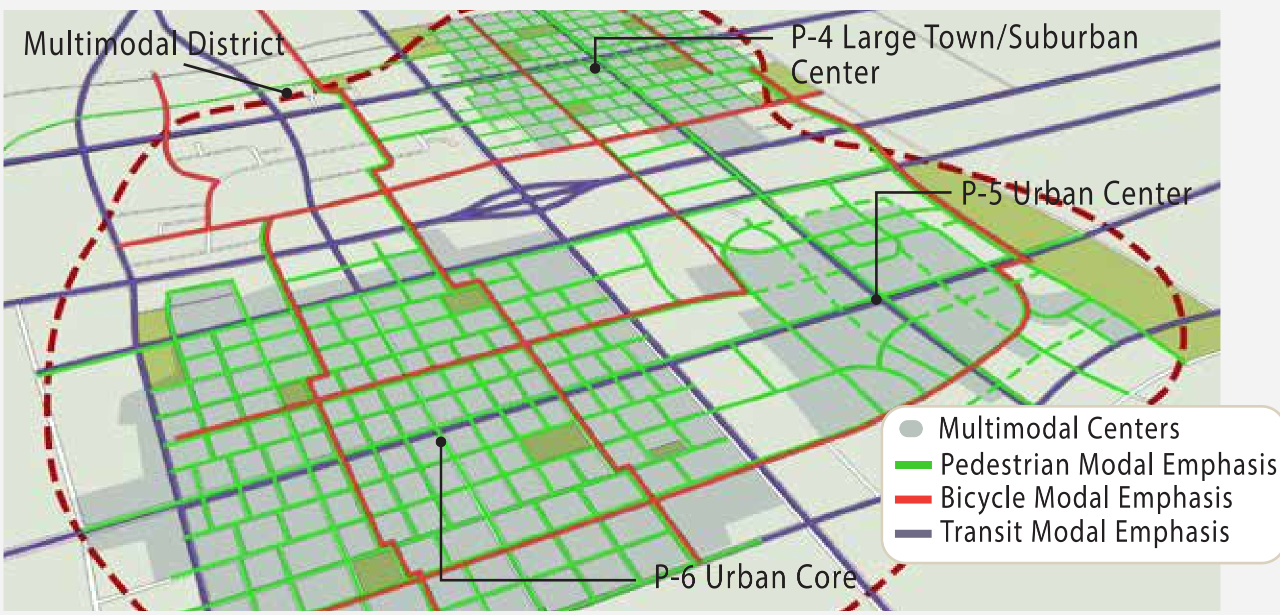


Figure 103: Complete Multimodal System Plan for the Region.

As shown in Figure 103, the three Multimodal Centers identified in this region are P-6, P-5, and P-4 Multimodal Centers, according to the typology described in Chapter 3.

Now that the basic Multimodal System Plan has been developed for the region, the next step is to plan for an individual Multimodal Center and the Multimodal Corridors within it.

The following series of images zooms into one of those centers, the P-4 Large Town or Suburban Center at a closer scale.

Figure 104 represents a "before" version of the Multimodal Center and one of the Multimodal Corridors within it. It is assumed for this case study that the locality has designated this as a future P-4 Multimodal Center and has aligned its planning and zoning policy framework to help implement the intended future Multimodal Center. Based on the Guidelines, a P-4 Multimodal Center should ideally have a Major Avenue as its main cross street.

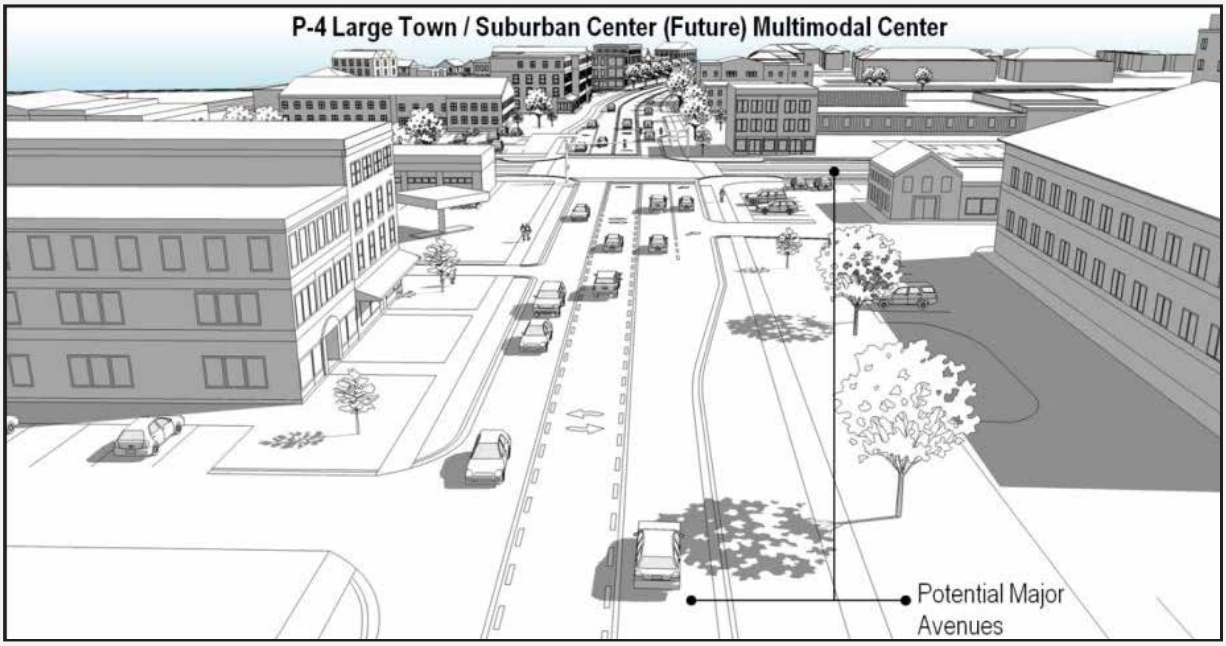


Figure 104: A View Zooming into the Main Intersection of the P-4 Center.

As shown in Figure 105, the corridor that is designated as a "future" Major Avenue has very few modal options, being primarily oriented toward the auto/vehicular travel mode with a minimal accommodation for those on foot.

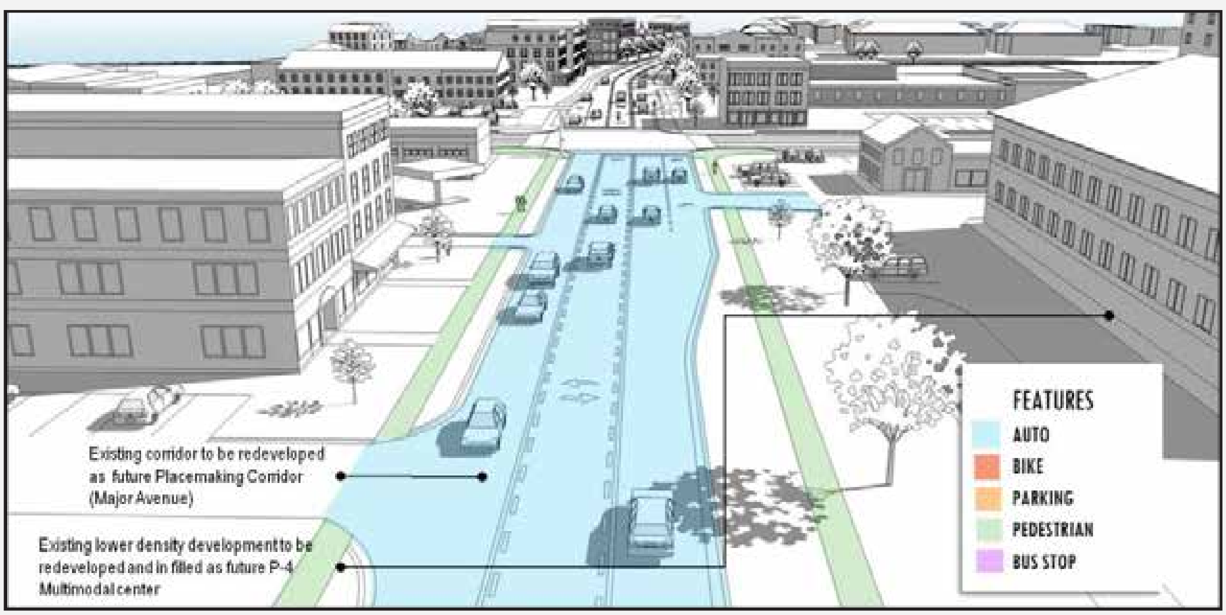


Figure 105: P-4 Multimodal Center Main Intersection. "Before" Image. Existing conditions in this P-4 Multimodal Center include lower density development and non-multimodal corridors.

The intent of these Guidelines is to show how to get from the "before" image to the "after" image in a series of logical steps, with flexibility for making key design decisions at both the Corridor and the Center scale. The following image shows how the corridor has been transformed into a Major Avenue (Placemaking) Corridor with the addition of wider sidewalks, on-street parking, bicycle lanes and a curbed median with turn lanes. In addition, it shows how private development has responded over time to public investment in the Multimodal Corridor with more intense infill development and redevelopment of buildings fronting the corridor.

Moreover, both the private investment and the public investment have been done in accordance with the overall framework of standards identified in these Guidelines, ensuring that the built environment is appropriately scaled for the type of Multimodal Corridor and that the corridor has sufficient capacity among all travel modes to serve the intensity of development that it contains.

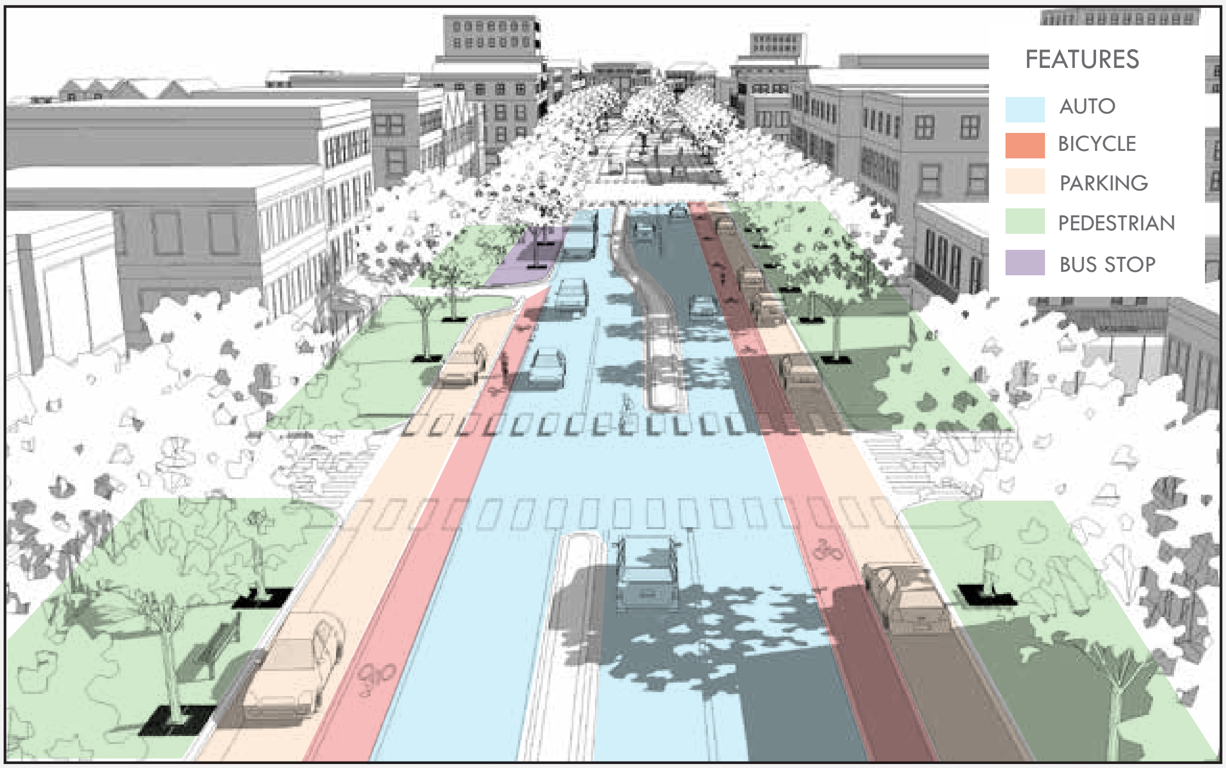


Figure 106: P-4 Multimodal Center Main Intersection "After" Image. The area gradually evolves into a true Multimodal Center.

Figures 97 through 103 showed how a hypothetical region could be planned for according to the basic principles of these Guidelines. In addition, the example shows how these same principles can be applied at both the Center and Corridor scales to facilitate the gradual transformation of a primarily auto-oriented community into a true Multimodal Center and Multimodal Corridor. It is important to note that these kinds of transformations are typically gradual and require efforts on the part of both the public and private sectors in a community over many years or even decades. However, one of the primary intents behind these Guidelines is to allow communities to establish a blueprint for this transformation over time. As described later in Chapter 9, there are several options for implementing and funding multimodal improvements through state and federal funding programs.

The most important long term issue, though, is not which funding option is selected, but to have an agreed-upon vision for how multimodal places should evolve over time. These Guidelines are intended not to give a one-size-fits-all version of that vision for all communities, but to provide a flexible framework, using industry standards and best practices, to allow communities to build a clear picture of their multimodal future.

Modifying the Typology of Multimodal Centers and Corridors for Real Places

The delineation of Multimodal Centers is based on the concept of a travel-shed for a ten minute walk, hence the one-mile circle geometry of the ideal Multimodal Center types. Planning theory makes general assumptions that most people will consider walking if they can reach their destination within a five to ten minute walk, but likely will not consider walking if they perceive their destination to be further away than this. The one-mile circle geometry is a simple approximation of a ten minute walk from center to edge. Concentrating land uses within these one-mile circles brings trip origins and destinations close enough so that walking becomes a viable means of transportation. This is a core concept of the Multimodal Center types.

Yet the simple approximation of a one-mile circle masks many complex factors in people's decisions about whether to walk, drive or use other modes. Some factors depend on an individual's personal characteristics, such as their age, physical health, time availability and access to a personal vehicle. Other factors depend on the fairly inalterable external environment, such as steep terrain or physical barriers such as rivers or busy highways. Other factors that depend on the built environment include elements such as the quality of surroundings, perceived safety and access to transit among many others. Any of these external factors may modify the actual walk-shed of a Multimodal Center beyond a pure one-mile wide circle.

These Guidelines recognize that a perfect one-mile circle will need to be modifiable and flexible when defining Multimodal Centers and dealing with on-the-ground conditions. The one-mile circle is a valid construct in initial planning for Multimodal Centers and is also useful in having a standard geography to use when measuring relative Activity Density in an existing or proposed Multimodal Center. Using one mile circles to measure Activity Density in designating a Multimodal Center as P-2 or P-3, for example allows all users of these Guidelines to be consistent in how they are applying the typology. Actual Multimodal Center delineation, however, may often stray from the perfect geometry of one mile wide circles.

Modifying Multimodal Center Boundaries for Actual Conditions

Local planners are typically familiar with the dynamics of neighborhoods, transportation facilities and community preferences, and should keep these in mind when modifying the one-mile circles for Multimodal Centers to apply to real life situations. The following considerations are important in preserving the integrity of the Multimodal Center concept in application:

Preserve the Principles behind the Multimodal Center Concept: Multimodal Centers should be roughly the size and shape of the area within a ten minute walk. They should have a centralized gravitational shape centered on a key transit station, intersection or other center of activity; they are generally not linear. The one mile wide circle should define the boundary within which Activity Density is calculated in order to determine which Multimodal Corridor types are appropriate, while actual Multimodal Center boundaries may stray from the perfect one-mile circle geometry.

As explained in greater detail in Chapter 5, the location of Multimodal Centers should be selected such that Multimodal Through Corridors are either located at the edges of the Multimodal Center or transition to Placemaking Corridors if they go through the Multimodal Center. Planners should carefully consider the placement of the Multimodal Center so as not to bisect them with a road that cannot transition to a Placemaking Corridor.

Consider Natural and Man-Made Barriers to Walking: Interstate highways, rivers, and railroads are barriers for those on foot and bicycle. Ideally planners would locate Multimodal Centers so that these barriers frame the edges, rather than bisect a Multimodal Center. In these instances, two Multimodal Centers on either side of the barrier may be more appropriate.

Communicate with Community Members: As part of any planning process, the opinions and concerns of local residents, landowners, and other community members should be considered meaningfully in the designation of future Multimodal Centers. Community involvement can be an opportunity to converse with residents about the benefits of planning for multimodal systems and how the designation of Multimodal Centers plays a vital role in the broader transportation system.

Combine Multimodal Centers where Overlap Occurs: Multimodal Centers may overlap, especially in dense downtowns or business districts. In these instances, Multimodal Center boundaries may be combined to form a larger area.

Example of Applying Multimodal Centers in a Real Place

The City of Richmond's planning effort for the Pulse BRT station areas provides an example of applying these considerations and translating the idealized one-mile Multimodal Center circles into actual walksheds. In Figure 107, the thick blue line shows the outline of the half-mile walksheds to the 14 BRT stations, representing a 10-minute walk. These areas are analogous to the one-mile diameter circles for Multimodal Centers, modified to reflect on-the-ground barriers and network disconnects.

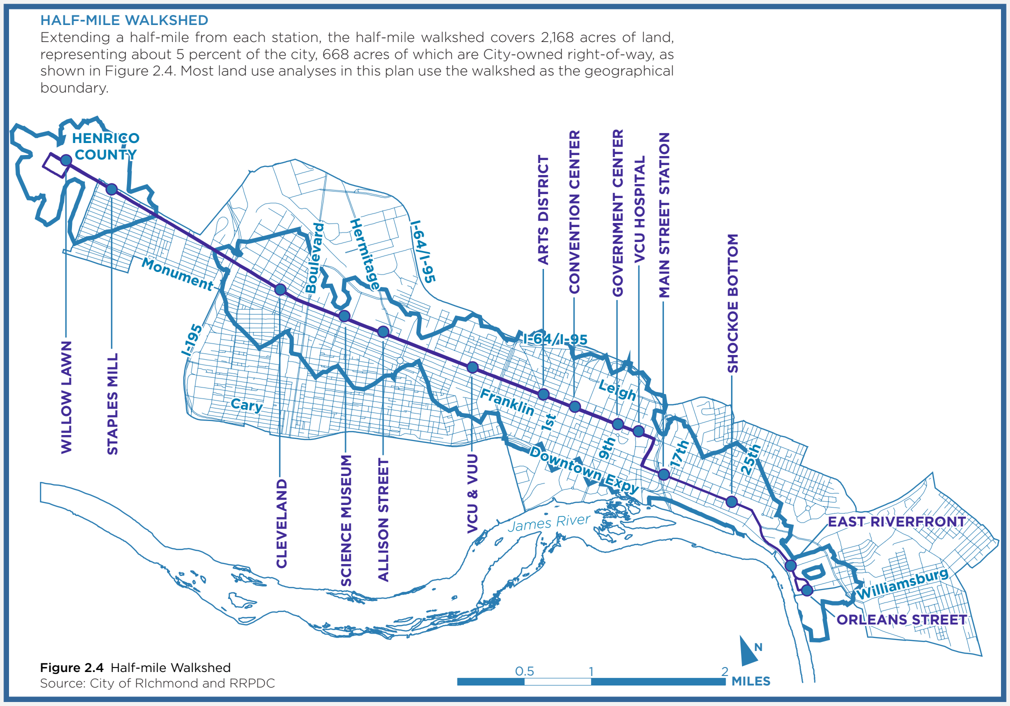


Figure 107: Half-Mile Walksheds around the Pulse Bus Rapid Transit Stations. In planning for the Pulse Bus Rapid Transit, the City of Richmond identified the areas within a half-mile walk to the 14 BRT stations. These areas are analogous to the one-mile diameter circles for Multimodal Centers, modified to reflect on-the-ground barriers and network disconnects. (Image Credit: City of Richmond and Richmond Regional PDC)

Applying the Multimodal Corridors Methodology in Real Places

Monticello Avenue in Norfolk is one of the streets that have been transformed by the development of the Tide light rail system. Although it took place before these Guidelines were developed, it is an example of a corridor transformation that is consistent with the methodology of the Multimodal Corridor types, and illustrates the complexities involved with re-designing a corridor to serve a more multimodal function. Monticello Avenue transformed into what would under these Guidelines be called a Boulevard with Transit Modal Emphasis with the construction of the Tide Light Rail system in 2012. It illustrates the decisions and tradeoffs involved in the reconfiguring right-of-way to better serve non-auto modes. Designers had to eliminate some on-street parking and reduce building setbacks in some areas in order to make room for the light rail vehicles. Furthermore, in some areas, the light rail was designed to operate in shared traffic lanes, as opposed to its own dedicated right-of-way due to space constraints. Figure 108 shows the before and after views of this corridor, which demonstrate the transformation to better emphasize transit and walking within the right-of-way.

Figure 108: Monticello Avenue in Norfolk. Before and after views show Monticello Avenue's transformation to accommodate light rail.

At a more modest scale, the City of Charlottesville retrofitted 6th Street to provide a contra-flow bike lane and on-street parking to slow down traffic speeds and create a safer pedestrian environment. This is an example of retrofitting a corridor at much lower cost and without moving curbs. Sixth Street was an unmarked one-way street. By simply striping the pavement and installing signs, planners transformed the street to retain two rows of parking,
but added one contra-flow bicycle lane and a shared lane in the direction of vehicular travel. The new street configuration makes those on bikes more visible while retaining on-street parking.

Finally, maintenance can often be a complex issue. VDOT maintains all state roads and most local roads on the primary and secondary road network. Localities sometimes maintain their own roads. Sometimes property owners are responsible for maintaining the sidewalk and amenity element. Some roads may have unique maintenance agreements for different elements. When communities are considering a project to re-design a Multimodal Corridor, communication with all agencies involved should be a priority to establish clear maintenance responsibilities and agreements.

Figure 109: Sixth Street in Charlottesville. Before and after views show 6th Street's transformation to provide a contra-flow bicycle lane and a shared lane while retaining on-street parking and slowing speeds to enhance the pedestrian environment.

Planning for an Autonomous Future

Although autonomous vehicle (AV) technology is still in its infancy, it is steadily improving, and AVs are now being tested on public streets and highways. Proponents have made many claims about the benefits of AVs and their impacts to urban and rural transportation systems. Possible benefits include reduced traffic congestion, lower demand for parking, improved safety, more affordable travel, and better utilization of personal time in transit. However, AV technology is still under development, its impacts are still being analyzed, and it is unclear if these potential benefits will be realized. Some transportation planners and policy makers have raised concerns that AV technology will negatively impact transportation networks. By reducing the overall cost of driving in terms of money, time, and inconvenience, AVs could increase traffic congestion, encourage sprawling development patterns, erode support for public transit, and lead to road design that places an even greater emphasis on automobile performance at the expense of walking, biking, transit, and place making. Like any new transportation technology, the impact of AVs will be shaped by planners, designers, and policy makers who will lay the foundation for a future of autonomous mobility.

NACTO published the Blueprint for Autonomous Urbanism in 2017 to help transportation officials understand AV technology and lay the groundwork for an autonomous transportation system that supports safe, sustainable, equitable, and vibrant places. Although AV technology may significantly alter the transportation ecosystem, the challenge of planning for autonomous transportation is not that different than the planning demands of today. In this publication, NACTO encourages transportation officials to establish values and goals for the future, use policy levers to optimize autonomous transportation, and use design to achieve safe, efficient, and vibrant people-friendly streets. The NACTO guide lays out six principles for autonomous urbanism:

1. Design for Safety. Prioritize people on foot and bike so that streets are safe for all. Since speed is a major factor in safety, design for lower speeds on multi-modal streets. AVs should be programmed to operate at low speeds in urban environments.
2. Move People Not Cars. If AV technology is focused on single-occupant vehicles, congestion will likely increase. Cities should prioritize efficient modes like walking, cycling, and transit by providing on-street priority. Smart pricing and curb management should optimize efficient use of public space.
3. Distribute the Benefits Equitably. Cities must consider equity and act in order to ensure the benefits of autonomous transportation are available to all.
4. Data-Driven Decision Making. New transportation technologies are generating more data about activity on streets and highways. Transportation officials should harness this data to make informed decisions about policy and design.
5. Technology is a Tool:. AV technology is a tool, not a solution unto itself. Transportation officials should ensure this tool is used to achieve human-centered goals and priorities.
6. Act Now! Localities should not wait for industry or federal and state governments to determine the autonomous future. Cities and towns should redesign their streets now to create the safe, efficient, and vibrant future that they want.

The NACTO guide presents a general framework for transforming streets for the autonomous era. Today, most streets are dominated by space requirements for single-occupancy vehicles leaving other modes to compete for remaining space. In the near term, before AVs are widespread, cities and towns should allocate street space to prioritize efficient modes and increase safety. In the more-distant future when AVs are widely adopted, AVs could allow additional efficiency and safety gains. The guide provides several design concepts for street typologies ranging from narrow residential streets to wide boulevards. These concepts provide strategies for responding to changes introduced by AV technology and reallocating street space to efficient and sustainable modes. Figure 110 is a graphic from the NACTO guide showing how a street can evolve in the near and long term so that AV technologies reduce VMT and improve safety.

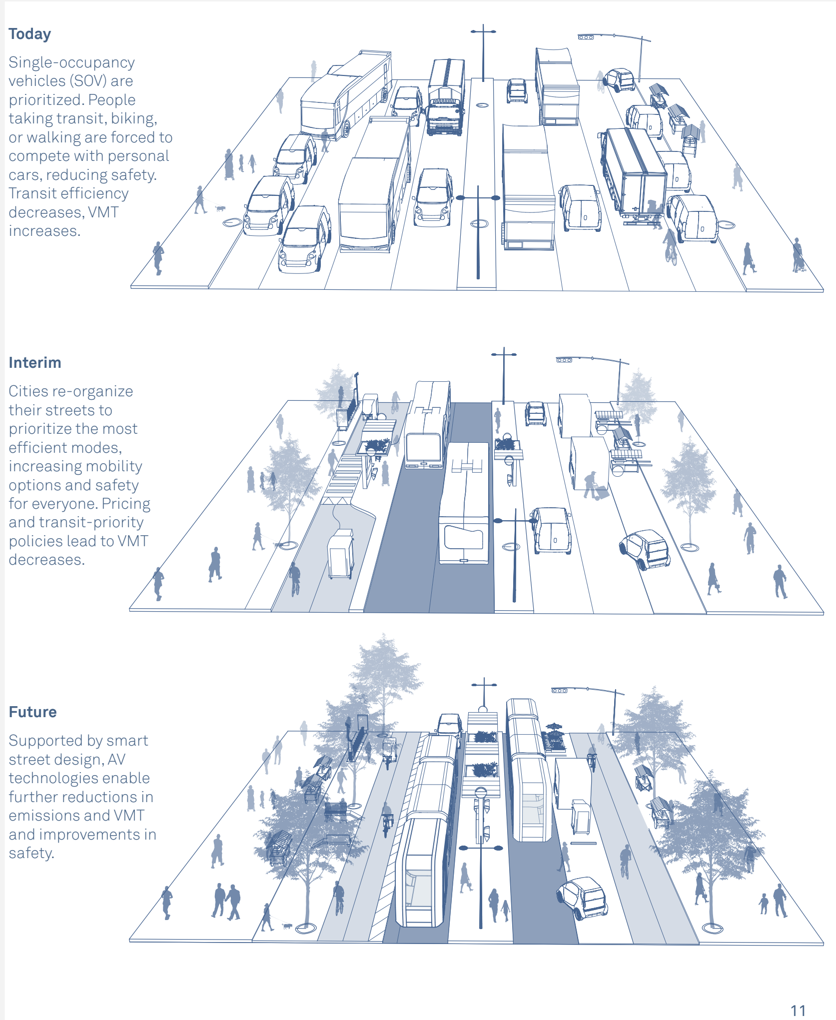


Figure 110: Street Transformation for an Autonomous Future. The NACTO Blueprint for Autonomous Urbanism describes how cities can change their policies and redesign their streets to ensure autonomous vehicles help achieve, rather than hinder, the future multimodal transportation system (Image Credit: NACTO).

CHAPTER 8

Integrating Transportation Demand Management into the Planning and Designing Process

Planning multimodal places and designing Multimodal Corridors can benefit communities by increasing transportation choices and improving transportation system efficiency. Transportation Demand Management (TDM), (also referred to as Travel Demand Management) is an area of transportation planning and operations that involves services, strategies, and policies to maximize transportation system efficiency through improved travel choices, travel time reliability, and information on travel options. This chapter illustrates how TDM can be used in multimodal planning and transportation system design. Communities can use TDM in concert with the planning framework for multimodal places and design guidance for Multimodal Corridors to further enhance overall benefits for a community's transportation system and maximize the movement of people.

While these Guidelines are primarily concerned with how multimodal regions, Multimodal Centers, and Multimodal Corridors are physically planned and developed, the synergy with TDM strategies is critically important as part of an overall picture of improving travel choices in a region. TDM strategies and policies provide travelers with real-time information and create options to enhance flexibility and reliability. TDM initiatives affect demand by enhancing travelers' choices about whether to make a trip, where to travel, which mode of transportation to use, which route to take, and when to travel.

TDM encompasses a broad spectrum of strategies, services, facilities and operations. Many TDM strategies are included in other chapters (e.g. those that discuss bicycle and pedestrian infrastructure, park-and-ride lots, and transit). One set of TDM services and strategies that is often overlooked is providing travel information and travel options. This is usually provided by commuter assistance programs that reach out to travelers and employers and provided travel information and ridematching services.

The application of TDM in the planning process can have significant impact on addressing several needs and policies, including:

- Improving regional mobility and accessibility
- Traffic congestion reduction
- Transportation system reliability and safety
- Air quality and the environment
- Economic development
- Land use
- Quality of life, livability and health

Transportation Demand Management (TDM) is an area of transportation planning and operations that involves services, strategies, and policies to maximize transportation system efficiency through improved travel choices, travel time reliability, and information on travel options.

For additional information on TDM, readers can refer to FHWA's *Integrating Demand Management into the Transportation Planning Process: A Desk Reference*, published in 2012. It discusses how demand management relates to key policy objectives that are often included in transportation plans, such as congestion and air quality, and how demand management might be integrated into transportation planning at statewide, metropolitan, corridor, and local levels. The report also includes information on tools available for evaluating demand management strategies.

Commuter Assistance Programs Serving Virginia

Commuter Assistance Program Name	Operating Agency/Agencies	Service Area
Telework!VA	DRPT	All of Virginia, but mainly employers in the large and small urban areas.
Arlington County Commuter Services	Arlington County Department of Environmental Services	Arlington County
Commuter Services by RRRC	Rappahannock-Rapidan Regional Commission	Counties of Culpeper, Fauquier, Madison, Orange and Rappahannock; Towns of Culpeper, Gordonsville, Madison, Orange, Remington, The Plains, Warrenton, and Washington
Fairfax County Commuter Services	Fairfax County Department of Transportation	Arlington and Fairfax County
GO Alex	Alexandria Department of Transportation and Environmental Services	City of Alexandria
GWRideConnect	George Washington Regional Commission	Fredericksburg; Counties of Caroline, King George, Spotsylvania and Stafford
LiveMore	Dulles Area Transportation Association	City of Manassas and Manassas Park, Parts of the counties of Fairfax, Loudoun and Prince William around the Dulles International Airport
Loudoun County Commuter Services	Loudoun County Department of Transportation and Capital Infrastructure	Loudoun County
Middle Peninsula Rideshare	Middle Peninsula Planning District Commission	Counties of Essex, Gloucester, King and Queen, King William, Mathews and Middlesex; Towns of Tappahannock, Urbanna and West Point
Northern Neck Commute Services	Northern Neck Planning District Commission	Counties of Lancaster, Northumberland, Richmond, and Westmoreland
PRTC OmniMatch	Potomac and Rappahannock Transportation Commission	Prince William County; Cities of Manassas and Manassas Park
RideFinders	Greater Richmond Transit Company	Cities of Richmond, Colonial Heights, Hopewell, Petersburg; Town of Ashland; Counties of Charles City, Chesterfield, Goochland, Hanover, Henrico, New Kent and Powhatan
RideShare	Central Shenandoah Planning District Commission Thomas Jefferson Planning District Commission	Counties of Albemarle, Augusta, Bath, Fluvanna, Greene, Highland, Louisa, Nelson, Rockbridge and Rockingham; Cities of Buena Vista, Charlottesville, Harrisonburg, Lexington, Staunton, and Waynesboro
RideSmart	Northern Shenandoah Valley Regional Commission	City of Winchester; Towns of Luray, Front Royal, and Stephens City; Counties of Clarke, Frederick, Page, Shenandoah and Warren
RIDE Solutions	Roanoke Valley-Alleghany Regional Commission, New River Valley Regional Commission, Central Virginia Planning District Commission, West Piedmont Workforce Investment Board	Counties of Alleghany, Amherst, Appomattox, Bedford, Botetourt, Campbell, Craig, Floyd, Franklin, Giles, Henry, Montgomery, Patrick, Pittsylvania, Pulaski and Roanoke; Cities of Radford, Roanoke, Salem, Lynchburg, Martinsville, Danville, Covington; Towns of Bedford, Blacksburg, Christiansburg, Clifton Forge, Rocky Mount and Vinton
TRAFFIX	Hampton Roads Transit	Counties of Accomack, Franklin, Gloucester, Isle of Wight, James City, King George, Northampton, Southampton, Surry, and York; Cities of Chesapeake, Hampton, Newport News, Norfolk, Portsmouth, Suffolk, Williamsburg, and Virginia Beach
Tysons TMA	Tysons Partnership, Inc.	Tysons Corner area of Fairfax County

Table 13: Commuter Assistance Programs Serving Virginia. In Virginia there are 18 Commuter/TDM programs serving the public and employers. These programs are operated by local governments, transit agencies, planning/regional commissions, and Transportation Management Associations (TMAs) that provide Commuter/TDM programs and services.

TDM Strategies

There are a multitude of TDM strategies that can increase the efficiency of the transportation system and manage travel demand. This section describes many of these strategies by TDM service category, as categorized in the 2014 Statewide Public Transportation and TDM Plan.

Transportation Information

Giving commuters more information about travel conditions and travel options helps them plan their trip and adjust their travel mode, departure time, and route to avoid long delays. Travelers might decide to drive another route if their usual route is delayed; or they may choose to walk, bike, or take the bus to avoid using a car. Mobility centers and information kiosks at transit hubs can attract walk-in users for information on rideshare modes and offer transit fare sales. Call centers and help lines can help travelers approaching congested areas make detours, and travelers stuck in congestion can provide information to these call centers to distribute to other travelers. Additionally, call centers can help bicyclists with flat tires or other bike problems, as well as stranded or confused transit passengers. Updated information on radio, television, and newspapers can warn travelers of upcoming roadwork schedules and possible delays. Websites and social media and other real-time travel information strategies provide up-to-the-minute information on crashes and other areas of congestion as they occur, so travelers can continually adjust their travel plans. Commuters can check transit agencies' websites to see exactly when the next bus is arriving; or this information may be posted at the transit stop via a LED display.

Employer Services

TDM Strategies

There are a multitude of TDM strategies that can increase the efficiency of the transportation system and manage travel demand. This section describes many of these strategies by TDM service category.

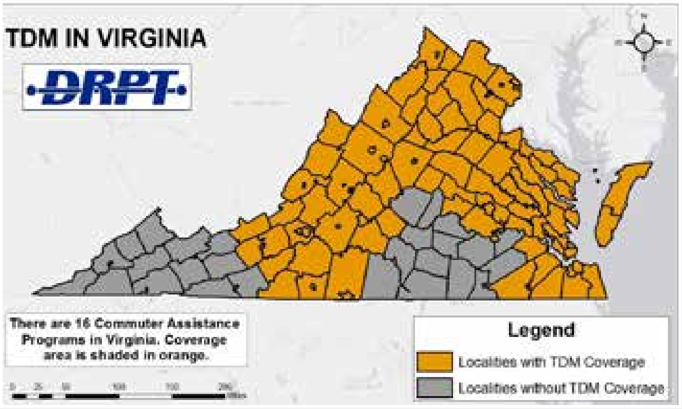


Figure 111: TDM Commuter Assistance Program Coverage Area in Virginia. Local commuter assistance programs are available for most northern, central and eastern Virginia residents. TDM gaps exist in southwest and south-central Virginia.

Employers can incentivize employees to consider making changes to their daily commutes. Commute planning efforts make employees aware of travel options like carpooling or vanpooling. Telework support programs help employers find ways to make working remotely a viable option for employees. Employees can work from home at least one day a week, or work at a telework center closer to home to reduce the number of trips and the trip distance of their commute. Commuter benefit programs offer pre-tax paycheck deductions or subsidies to help save money on commute expenses when employees do not drive to work. Alternative work schedules, including compressed work schedules, enable employees to work flexible hours to avoid commuting during peak travel times or work more hours each day with more days off to reduce commute trips.

Education & Outreach

Education and outreach efforts can make residents and workers aware of travel options. Corridor-level programs focus on severely congested roads. General bike and walk advocacy and education efforts help commuters find safe routes and provide safety tips. New resident kits can be distributed to real estate offices to give information about commuter assistance to new residents.

Ridesharing

Carpooling and vanpooling help commuters save money and stress. Ride matching strategies connect workers to others who live or work nearby. Vanpool subsidies provide financial incentives for using or starting up a vanpool service. Slug lines make it easy for driving commuters to pick up additional passengers to use an HOV facility.

Infrastructure

Park and Ride facilities provide dedicated places for commuters who would normally drive to work to meet up with others to carpool, vanpool, or take transit. VDOT maintains an interactive map of around 300 park and ride facilities across Virginia at http://www.virginiadot.org/travel/parkride/home.asp. Providing signs and stops for private shuttles can help take commuters to destinations not served by the public transportation system. Carshare and bikeshare signs and spaces make it more convenient for travelers to bike when they can, and drive a car when they need to, without worrying about the cost and maintenance of ownership. See VDOT's Park & Ride Design Guidelines for detailed information about designing safe and efficient park and ride facilities.

Financial Incentives

Goal-based programs create financial incentives to meet certain quantitative goals like mode share or percent teleworking.

Support Services

Support services like Guaranteed Ride Home programs ensure commuters that they will not be left stranded if they need to work late or travel outside of normal commuting hours.

Land Use & Zoning

Localities can implement several TDM strategies through land use and zoning regulations. Localities can coordinate site plan development with commuter and transit services through TDM site plan conditions, which are agreements between developers and local governments, usually negotiated, during the development review process. Localities may require developers to provide infrastructure (e.g. bicycle parking facilities and van-accessible garages) or services (e.g. managing showers and lockers for bicycle commuters and distributing brochures about local transportation options like bus routes and schedules and bicycle routes) in order to gain the necessary approval to move forward with construction. Parking management techniques include reduced parking requirements for developers, 'unbundling' the cost of parking spaces from rental leases, maximum parking ratios, and real-time information on parking space availability.

Fairfax County and the City of Alexandria are two examples of localities that have fully integrated TDM initiatives into the land development process. Fairfax County requires developers to include various TDM elements for development plans to be approved. Basic program requirements include designating an on-site transportation coordinator, providing a Guaranteed Ride Home program, distributing information on travel choices, offering transit incentives, and providing bicycle amenities and carpool/vanpool preferred parking. Fairfax County also requires regular monitoring and reporting of the performance of these TDM initiatives to ensure they are reducing travel demand.

The City of Alexandria's zoning ordinance requires large development projects to submit transportation management plans (TMPs) as part of the special use permit application. The TMPs specify strategies to provide transportation options besides driving alone, such as discounted transit fares, shuttle bus services, registration for car sharing, etc., and set up a TMP fund to finance these strategies.

Shared Mobility Services

The widespread adoption of smart phones has given rise to new forms of technology-enabled mobility services, including online ride-hailing, short-term car share, bike share, and scooter share. These services give users on-the-fly access to a shared pool of vehicles or taxi services, providing options beyond traditional public transit and private vehicle trips.

TDM in the Land Development Process

Fairfax County and the City of Alexandria are two examples of localities that have fully integrated TDM initiatives into the land development process. Fairfax County requires developers to include various TDM elements in order for their development plans to be approved.

The City of Alexandria's zoning ordinance requires large development projects to submit transportation management plans (TMPs) as part of the special use permit application.

Demand-Response Transit

Demand-response transit services can increase the reach of public transit to areas that do not support traditional fixed-route transit. Places with disconnected street networks or low activity densities are a challenge to serve with efficient transportation modes and often result in high levels of drive-alone trips. Rural demand-response transit and urban micro-transit can bridge the gap and increase the efficiency of the transportation system in these areas.

Shared mobility services and demand-response transit (especially urban micro-transit) have blossomed in availability and popularity since 2014. These two TDM service categories were not included in the 2014 Statewide Public Transportation and TDM Plan but are included in these 2020 Multimodal System Design Guidelines for reference.

TDM Strategy Recommendations By Multimodal Center and Area Types

Some of the TDM strategies discussed in the previous section are more applicable in urban or suburban areas; others are more useful in rural areas. Many TDM strategies are beneficial regardless of context. This section describes which TDM strategies are most beneficial for different kinds of contexts and relates these contexts to the Multimodal Center types used in these Guidelines. Table 13 summarizes which TDM strategies are recommended based on areas with different intensities of Multimodal Centers.

TDM Strategies in Areas with Higher Intensity Multimodal Centers

Urban areas with higher intensity Multimodal Centers (P-6 and P-5) typically have enough destinations and travel activity to support all of the possible TDM strategies. Mobility centers and private shuttles are likely only applicable for the densest (P-6) Multimodal Centers.

TDM Strategies in Areas with Moderate Intensity Multimodal Centers

Areas with moderate intensity Multimodal Centers (P-4 and P-3) will likely have some concentration of employment, making employer services key strategies for these areas. Land use and zoning strategies within these areas can shorten trips and encourage travelers coming from outside of the area to find alternatives to driving alone.

TDM Strategies in Areas with Low Intensity Multimodal Centers

High priority strategies for areas with low intensity Multimodal Centers (P-2 and P-1) focus on distributing information for travel choices and providing designated spaces for commuters to meet up to transfer to a carpool or vanpool. Ride matching is difficult in more dispersed areas, therefore ride matching assistance is a high priority. Residents in areas with low intensity Multimodal Centers may have longer commutes, making telework and alternative work schedules key to reducing commuting trips and trip lengths.

Service Category	TDM Strategy	Areas with Higher Intensity Multimodal Centers (P-6 to P-5)	Areas with Moderate Intensity Multimodal Centers (P-4 to P-3)	Areas with Lower Intensity Multimodal Centers (P-2 to P-1)
Transportation Information	Retail/Mobile Store	High priority	Low priority	Not applicable
	Call Center/Help Line	High priority	High priority	Not applicable
	Radio/TV/Paper	High priority	Low priority	Low priority
	Websites/Social Media	High priority	High priority	High priority
	Real-Time Travel Information	High priority	High priority	High priority
Employer Services	Commute Planning	High priority	High priority	High priority
	Telework Support	High priority	High priority	High priority
	Commuter Benefit Programs	High priority	High priority	Low priority
	Alternative Work Schedules	High priority	High priority	High priority
Education & Outreach	Transit Marketing	High priority	High priority	Low priority
	Corridor-Level Programs	High priority	Low priority	Not applicable
	Bike	High priority	Low priority	Not applicable
	Walk	High priority	Low priority	Not applicable
	New Resident Kits	High priority	High priority	High priority
Ridesharing	Ridematching	High priority	High priority	High priority
	Vanpool Subsidy	High priority	Low priority	Low priority
	Slug Lines	High priority	Low priority	Not applicable
Infrastructure	Park & Ride Lots	High priority	High priority	High priority
	Private Shuttles	High priority	Low priority	Not applicable
	Carshare	High priority	Low priority	Not applicable
	Bikeshare	High priority	Low priority	Not applicable
Financial Incentives	Goal-Based Programs	High priority	Low priority	Low priority
Support Services	Guaranteed Ride Home	High priority	High priority	High priority
Land Use & Zoning	TDM Conditions for Development Approval	High priority	High priority	Low priority
	Parking Management	High priority	High priority	Not applicable

Table 14: Recommended TDM Strategies.[32]

[32] This table is adapted from the 2014 Statewide Public Transportation and Transportation Demand Management Plan. Area types were translated to Multimodal Center types to more closely correlate to the Multimodal Centers described in previous chapters of the Guidelines.

CHAPTER 9

Implementation & Funding Best Practices

Identifying specific improvements for Multimodal Corridors, as discussed in previous chapters, is crucial to realizing the benefits of multimodal transportation. Identifying a source of funding for these improvements is a fundamental implementation step. This chapter provides a broad overview of funding options for multimodal improvements.

This chapter is not intended to be an exhaustive description of how to fund multimodal improvement projects. Rather, it covers the highlights and points toward options that can be explored further, depending on the nature of improvements and the local funding priorities. It should be noted that these opportunities are changing annually in many cases and should be checked for any revisions subsequent to the publishing of this document.

This chapter is not intended to be an exhaustive description of how to fund multimodal improvement projects. Rather, it covers the highlights and points toward options that can be explored further, depending on the nature of improvements and the local funding priorities.

It should also be noted that these opportunities are changing annually in many cases and should be checked for any revisions subsequent to the publishing of this document.

Potential Funding Sources for Multimodal Transportation Projects

Federal Funding Sources

Federal Funding Opportunities for Pedestrian and Bicycle Projects

The Federal Highway Administration identifies funding programs that different types of pedestrian and bicycle projects may be eligible for in this resource, available at https://www.fhwa.dot.gov/environment/bicycle_pedestrian/funding/funding_opportunities.cfm.

The most relevant federal funding programs are summarized below.

Transportation Alternatives Set-Aside

The Transportation Alternatives (TA) Set-Aside is a funding program within the Federally funded Surface Transportation Block Grant Program specifically targeted to pedestrian and bicycle facilities, community improvements, and mitigating the negative impacts of the highway system. The TA Set-Aside funds community-based projects that expand non-motorized travel choices and enhance the transportation experience by improving the cultural, historical, and environmental aspects of transportation infrastructure. More information is available at http://www.virginiadot.org/business/prenhancegrants.asp.

Highway Safety Improvement Program

The Highway Safety Improvement Program (HSIP) is a Federal funding program whose purpose is to achieve a significant reduction in fatalities and serious injuries on all public roads. States receive HSIP funds for highway safety improvement projects that support a reduction in fatalities and serious injuries. More information is available at http://www.virginiadot.org/business/ted_app_pro.asp.

Federal Lands Access Program

The Federal Lands Access Program (FLAP) provides funds for projects that improve transportation facilities that provide access to, are adjacent to, or are located within Federal lands. The FLAP supplements state and local resources for public roads, transit systems, and other transportation facilities, with an emphasis on high-use recreation sites and economic generators. Pedestrian and bicycle improvement projects have been funded in Prince William County, Arlington County, Roanoke County, Franklin County, and the City of Norton through the FLAP. More information is available at http://www.virginiadot.org/business/local-assistance-special-federal-programs.asp.

Congestion Mitigation and Air Quality Improvement Program

The Congestion Mitigation and Air Quality Improvement (CMAQ) Program supports surface transportation projects that contribute air quality improvements and provide congestion relief. CMAQ funding is provided to areas in nonattainment or maintenance for ozone, carbon monoxide, and/or particulate matter. More information is available at http://www.fhwa.dot.gov/environment/air_quality/cmaq.

Regional Surface Transportation Program

Regional Surface Transportation Program (RSTP) funds are available through certain Metropolitan/Transportation Planning Organizations (M/TPOs) whose population is above 200,000. Localities apply through the M/TPO for surface transportation projects. The funds must be federally obligated within 12 month of allocation and expended within 36 months of obligation.

State Administered Funding Programs

SMART SCALE

SMART SCALE is the prioritization system that the Commonwealth Transportation Board uses to inform their selection of capital transportation projects to be funded through the Construction District Grant Program and the High-Priority Projects Program. SMART SCALE is an objective and quantitative method of scoring projects to ensure that the Commonwealth invests its limited tax dollars in the projects that meet the most critical needs through a transparent process. SMART SCALE scoring measures related to multimodal facilities and services are discussed in more detail later in this chapter. More information on SMART SCALE is available at http://vasmartscale.org.

Revenue Sharing Program

The CTB's Revenue Sharing Program provides state funding for immediately needed improvements or to supplement funding for existing projects for counties, cities, and towns to construct, reconstruct, improve, or maintain the highway system. The program matches local funds with state funds. Eligible projects include sidewalks, trails, and other facilities that accommodate pedestrian and/or bicycle access along the highway network. More information is available at http://www.virginiadot.org/business/local-assistance-access-programs.asp.

Recreational Access Program

VDOT administers the Recreational Access Program - a state-funded program to assist localities in providing access to or within public recreational and historic areas owned by the Commonwealth of Virginia or a local government. Eligible projects include construction, reconstruction, maintenance, and improvement of roads and bikeways that serve a publicly developed recreational area or historic site. More information is available at http://www.virginiadot.org/business/local-assistance-access-programs.asp.

DRPT MERIT Funding Assistance

MERIT-Making Efficient and Responsible Investments in Transit- is the Virginia Department of Rail and Public Transportation's (DRPT) statewide public transportation grants program. This program provides financial assistance to support Public Transportation and Transportation Demand Management (TDM) services throughout the state and is designed to support DRPT's core mission. The MERIT program consists of the following individually administered grant programs that are relevant to multimodal projects:

Capital Assistance

The Capital Assistance program is guided by a prioritization process for capital needs that allows DRPT to allocate and assign limited resources to projects and investments identified as the most critical. The prioritization process determines which projects achieve the policy objective of maintaining a state-of-good repair of existing assets and determines which projects receive funding for new investments.

Under the Capital Assistance program, projects are classified, scored, and prioritized separately in the following categories:

- State of Good Repair (SGR): Projects or programs to replace or rehabilitate an existing asset.
- Minor Enhancement (MIN): Projects or programs to add capacity, new technology, or a customer facility with a cost of less than $2 million or include a vehicle expansion of no more than five vehicles or 5% of the existing fleet size.
- Major Expansion (MAJ): Projects or programs to add, expand, or improve service with a cost exceeding $2 million or, for expansion vehicles, an increase of greater than five vehicles or 5% of fleet size, whichever is greater.

Applicants that are eligible for Federal Public Transportation grant programs may combine federal and state capital assistance grant funds to decrease the local match needed for each project.

Demonstration Project Assistance

The Demonstration Project Assistance program is a competitive grant program that is meant to support local efforts to improve transit reliability, improving access to housing and employment centers, and improving public transportation mobility options. Demonstration projects also serve as examples and opportunities for learning and replication for other transportation agencies throughout the Commonwealth.

The projects that are eligible for this program fall under two categories:

1. Type 1: New Service: The deployment of new traditional public transportation services such as:
   - New service in an area or market not currently served by public transportation
   - New service that provides additional connections to areas that are currently served
2. Type 2: Technology and Innovation: The deployment of projects designed to test the "proof of concept" for new technologies used in the provision of public transportation services. This includes, but is not limited to:
   - The deployment or testing of autonomous vehicle technology
   - The deployment of a micro-transit demand response system
   - The deployment of new Intelligent Transportation Systems (ITS) solutions that would augment the provision of service and/or data collections

Technical Assistance

The Technical Assistance grant program supports studies, plans, research, data collection, and evaluation projects to help improve and evaluate public transportation or commuter assistance services. This program can be used to conduct a wide range of planning and technical analysis that is needed as input into a decision making or evaluation process.

The goal of the program is to help grantees answer questions related to the provision of public transportation services and commuter assistance programs. This includes, but is not limited to providing technical analysis and guidance on operations, service delivery, customer service, expansions of service, and program delivery.

Transportation Demand Management (TDM) Operating Assistance

The TDM Operating Assistance program provides funding to support local and regional commuter assistance programs that aim to reduce single occupant vehicle trips, and increase carpool, vanpool, and transit use. The overall goal of the program is to mitigate traffic congestion throughout the state.

The commuter assistance programs that are supported by the TDM Operating Assistance program provide information, encouragement, and incentives to help people understand and utilize all transportation options and modes available. Though specific transportation options vary from region to region, these programs generally provide information on transit systems, ridesharing, and non-motorized travel options.

Mobility Programs

Mobility Programs is a competitive grant program that supports local and regional transportation demand management (TDM) programs that support employer outreach, telework, and vanpools. This is an outcome focused grant program which requires all candidate programs or projects to demonstrate that they will achieve measurable reductions in congestion by eliminating single occupancy vehicle (SOV) trips. These programs or projects must aim to shift SOV trips to carpool, vanpool, or transit services, or promote telework as an option that would take commuters out of the transportation system entirely.

The Mobility Programs grant supports Employer Outreach program that:

- Increase the number of private sector employers providing commuter benefits to employees that use public transportation or vanpools;
- Increase the number of private sector employers providing assistance to employees commuting in carpools and vanpools; or
- Increase the number of private sector employees commuting via transit, carpools, or vanpools
- In addition, the Mobility Programs grant supports Telework programs that:
- Increase the number of private sector employers providing telework programs for their employees; or
- Increase the number of private sector teleworkers

Additional information on DRPTs MERIT program is available online at http://www.drpt.virginia.gov/transit/merit/

Strategies for Project Funding

From the standpoint of funding local multimodal corridor improvements, there are several complementary strategies that can be pursued at various levels. Four strategies are outlined below, based on the current structure of transportation funding in Virginia to pursue funding for the multimodal improvements described elsewhere in these Guidelines.

1. Localities can incorporate improvement projects into City or County Capital Improvement Programs and MPO plans and priority lists (such as the Constrained Long Range Plan, TIP Alternatives Projects List, and Congestion Management Process) to ensure their eligibility for funding under various federal and state programs.
2. MPOs can consider increasing the amount of funds set aside from federal funding allocations each year to provide an ongoing funding allocation for bicycle and pedestrian projects that would not get completed as part of widening, resurfacing, or other major roadway projects.
3. Local governments and MPOs can coordinate with OIPI to identify multimodal VTrans needs and coordinate with VDOT to ensure a project will meet a mid-term transportation need identified in VTrans.
4. Localities and MPOs can pursue SMART SCALE funding as well as funding from additional sources as described in the previous sections.
5. Localities can work with MPOs and their transit provider(s) to apply for DRPT funding including assistance related to planning activities for transit and multimodal systems through the MERIT Technical Assistance grant program.
6. Localities can work with VDOT and their MPO or Planning District Commission to leverage resources such as VDOT's STARS (Strategically Targeted Affordable Roadway Solutions) program. STARS can help with corridor planning and identifying current corridor deficiencies related to safety, pedestrian improvements and bike ped. More information on the STARS program is available from VDOT's website or VDOT District Planners. Additional planning resources may be available through the Districts or TMPD.

Additional Local Implementation Options

In addition to revenue from local jurisdiction budgets, several other opportunities for funding multimodal transportation improvements can be explored exclusively at the local level. These options will vary from locality to locality, depending on the availability of revenue and political receptiveness to local taxing programs.

Proffers

Under the State enabling legislation, localities may negotiate with developers for voluntary proffers during a rezoning approval process for a variety of improvements related to the proposed development. This has been a very effective way to fund limited and localized improvements related to a project, as well as to obtain dedications of right of way for future multimodal improvements such as widened sidewalks or bike lanes. It is by its nature an incremental approach, though, and may be a very long-term approach to funding a corridor- wide improvement.

Revenue Sharing

As mentioned under the State Funding Sources section, VDOT administers a Revenue Sharing Program that can provide funding for counties, cities and towns to construct, reconstruct and improve the highway system. Localities' governing bodies pass resolutions to apply for funds. Multimodal corridor and streetscaping improvements may be included as improvement projects.

Public Private Partnerships

Partnering with private entities can streamline implementation and maximize available financial and technical resources by leveraging the best resources from multiple parties. Public-private partnerships are formed as ventures between a government organization and a private business. The government organization contracts out a public service or project to a private business. The private party assumes some or all of the financial and other risks associated with the project. The financial agreement between the public and private parties can vary depending upon the scale, timeline and risk of the project. Public sector contributions may be onetime grants, revenue subsidies, tax breaks, guaranteed annual revenues, or in-kind asset transfers. Multimodal and streetscape improvement projects can be implemented through public-private partnerships.

Special Districts

Business improvement districts and downtown business partnerships can generate funds for a specified area. Transportation Improvement Finance Districts are authorized in the Virginia code (Title 33.1 Chapter 15). These are land value-based tax assessments that can generate a maximum additional tax assessment of $0.40 per $100 of the assessed fair market value of any taxable real estate within the district. When multimodal improvements are desired for a particular small area, this option can not only generate additional revenue for improvement, but also bring together the business owners and residents in a small area to work for a common vision of a downtown or main street corridor. Other types of business improvement districts would likely need legislative approval, including those where a new local sales tax would be dedicated to transportation.

In summary, multimodal improvements can be funded by a variety of federal, state and local sources. Most of the funding strategies identified above can be used in combination. A comprehensive strategy for funding a package of multimodal enhancements should explore the full range of local, state, and federal opportunities outlined in order to maximize the opportunities for implementing multimodal improvements.

Tax Increment Financing

Tax-Increment Financing (TIF) is another funding strategy that is currently enabled in Virginia (Title 58.1 Chapter 32) based on the assumption that public improvements raise property values. A locality would pass an ordinance that designates a TIF area, and issue bonds to construct an improvement in that area. Any increases on property tax revenues would then be used to pay off the construction bonds used to originally fund the improvements.

Other Potential Partnering Opportunities

Many other sectors of the community benefit from allocating resources to multimodal transportation projects, including economic development, community health, and private employers. These connections could lead to potential creative funding solutions in the future. These include partnerships between transit agencies and institutions.

- Charlottesville Area Transit's free Downtown Trolley which is supported by the University of Virginia.
- Greater Richmond Transit Company has partnered with Virginia Commonwealth University and Bon Secours on funding for the Pulse BRT.

Transportation planners should engage in ongoing communication with representatives from these sectors and can use the multi-faceted nature of transportation benefits as justification for future allocation of local funds.

In summary, multimodal improvements can be funded by a variety of federal, state and local sources. Most of the funding strategies identified above can be used in combination. A comprehensive strategy for funding a package of multimodal enhancements should explore the full range of local, state, and federal opportunities outlined in order to maximize the opportunities for implementing multimodal improvements.

SMART SCALE Scoring Measures for Multimodal Facilities and Services

Several of SMART SCALE's evaluation measures include multimodal components. Projects that have a multimodal component may be able to receive scoring points in these factor areas, which include:

- Congestion Mitigation
- Safety
- Accessibility
- Economic Development
- Environmental Quality
- Land Use Coordination

The following sections describe how projects involving transit, bicycle, and pedestrian improvements can receive scoring points for these factor areas.

Congestion Mitigation

Transit, bicycle, and pedestrian projects can receive points for demonstrating that a project will change or increase person-throughput. Transit projects can also receive points for demonstrating that the project will shift demand from auto to transit, resulting in overall travel time savings or reduction in person hours of delay.

Safety

Transit, bicycle, and pedestrian projects can receive points on how each project addresses multimodal transportation safety concerns through implementation of best practice crash reduction strategies. The safety benefits for transit projects are estimated based on reduced vehicle miles traveled from expected shift from auto to transit with the assumption that dedicated transit vehicles have minimal crash frequencies. Bicycle and pedestrian improvements are evaluated like highway projects scoring based on crashes expected to be avoided due to project implementation.

Accessibility

Transit, bicycle, and pedestrian projects can receive points for demonstrating that the project will improve the time-decayed accessibility score of jobs within a 60-minute transit trip. This means the project would reduce the time it takes to travel by transit to nearby jobs. Transit projects can improve the accessibility score by providing faster or more frequent service. Bicycle and pedestrian projects can improve the accessibility score by creating more direct pathways from the trip origin to the transit stop or from the transit stop to the destination. Additional points are awarded if the project improves the accessibility score averaged for low-income, minority, or limited-English proficiency populations.

A project with a pedestrian, bicycle, transit, or TDM element can also receive points simply by having any one or more of the characteristics shown in Table 16, including the construction or replacement of bicycle or pedestrian facilities.

Project Type (Mode) and Characteristics	Points (If Yes)
Project includes transit system improvements or reduces delay on a roadway with scheduled peak service of 1 transit vehicle per hour.	5
Project includes improvements to an existing or proposed park-and-ride lot. Ex. New lot, more spaces, entrance/exit, technology (payment, traveler information).	4
Project includes improvements to existing or new HOV/HOT lanes or ramps to HOV/HOT	2
Project includes construction or replacement of bike facilities. For bicycle projects, off-road or on-road buffered or clearly delineated facilities are required.	1.5
Project includes construction or replacement of pedestrian facilities. For pedestrian projects, sidewalks, pedestrian signals, marked crosswalks, refuge islands, and other treatments are required (as appropriate).	1.5
Project provides real-time traveler information or wayfinding specifically for intermodal connections (access to transit station or park&ride lot).	1
Provides traveler information or is directly linked to an existing TMC network/ITS architecture.	1
Total Points Possible	**5 points maximum**
Measure Scaling: Points are multiplied by the number of new peak period non-SOV users	

Table 15: SMART SCALE Scoring Points for Improving Access to Multimodal Choices. Source: SMART SCALE Technical Guide, Revised February 21, 2018

Economic Development

Transit, bicycle, and pedestrian projects can receive points on how each project addresses regional and local economic development plans and new development activity, as well as improvements to intermodal freight movement access and efficiency, and travel time reliability to support the movement of goods and people.

Environmental Quality

Transit, bicycle, and pedestrian projects can receive points on how each project addresses the reduction of pollutant emissions and energy consumption and minimize the impact on natural and cultural resources. Additional points are awarded for not impacting natural and cultural resources, it is unique among evaluation measures because it is adjusted, or scaled, by the benefit values for all other measures.

Land Use Coordination

Projects that include a pedestrian improvement can receive points for demonstrating that the project will improve the distance-decayed accessibility score of non-work destinations (e.g. schools, grocery stores, entertainment, etc.) within three miles of the project area. This means the project would reduce the time it takes to walk to nearby destinations. Projects in areas with higher densities receive more points through a multiplication formula.

Guidance for SMART SCALE Applicants

As explained in the previous section, the SMART SCALE evaluation criteria include scoring elements for improvements for pedestrian, bicycle, and transit facilities.

Chapter 2 of these Guidelines explains the importance and benefits of assembling a Multimodal System Plan to integrate usually separate modal plans and highlight any disconnects between modes. The Multimodal System Plan ensures that all modes have a seamlessly connected network within centers of intense activity and links between centers. It is through this system-based approach that the value of a specific improvement project, such as new bicycle facility, enhanced transit stop, or new sidewalk is fully understood.

SMART SCALE applicants who are considering adding a bicycle, pedestrian, or transit element to a project application should consult several sections of these Guidelines:

- Chapter 2 describes the process of preparing a Multimodal System Plan and the importance of taking a systems approach to multimodal planning.
- Chapter 3 explains how to analyze population and employment densities to identify Multimodal Districts and Multimodal Centers. This analysis can be helpful for applicants to identify areas with higher densities that will attain higher scores in the Land Use Coordination Measures. A project with a pedestrian improvement in an area with higher density will score higher than in an area with lower density.
- Chapter 4 discusses the symbiotic relationship between density and transit, addresses the importance of providing multimodal connections to transit stops, and provides additional resources for designing multimodal access to transit stations.
- Chapter 5 explains the concept of Modal Emphasis. It describes how Modal Emphasis informs the selection of bicycle and pedestrian facilities and ensures they are consistent with the overall system plan.
- Chapter 6 provides guidance on treatments for bicycle and pedestrian facilities at intersections, including new guidance from NACTO on transitioning separated bicycle facilities safely through intersections.
- The Corridor Matrix in Appendix A and the accompanying Corridor Matrix Annotation Document in Appendix B provide specific design guidance on bicycle and pedestrian facility treatments with references to additional design guides for more information.

APPENDIX A.

CORRIDOR MATRIX

The following Appendix contains the Corridor Matrix. The Corridor Matrix is a spreadsheet file, laid out by Multimodal Corridor type in the following pages.

CORRIDOR MATRIX

Multimodal System Design Guidelines - 2020 Update

Corridor Element Key											
	Corridor Type ⇨	Boulevard									
	Intensity ⇨	T-6		T-5		T-4		T-3		T-2	
	Context Zones & Corridor Elements ⇩	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM
⇩	**Building Context Zone**										
A	BUILDING FRONTAGE ELEMENT	5 ft	3 ft	5 ft	3 ft	5 ft	2.5 ft	7 ft	1.5 ft	12 ft	1.5 ft
	Location of off street parking	rear	rear	rear	rear	rear	rear	rear	rear	rear	rear
	Typical building entry locations	front	front	front	front	front	front	front	front	front	front
	Roadway Edge Zone										
B	SIDEWALK THROUGH ELEMENT	10 ft	6 ft	10 ft	6 ft	8 ft	6 ft	6 ft	6 ft	6 ft	6 ft
C	AMENITY ELEMENT	8 ft	6 ft	8 ft	6 ft	8 ft	6 ft	8 ft	6 ft	9 ft	6 ft
	Surface Treatment for Amenity Element	Paved with tree wells		Paved with tree wells		Paved with tree wells		Paved with tree wells		Grassy strip with trees	
	Roadway Zone										
D	CURBSIDE ACTIVITY ELEMENT										
	PARALLEL PARKING ONLY	8 ft both sides	None	8 ft both sides	None	8 ft both sides	None	8 ft both sides	None	8 ft both sides	None
	FLEX ZONE: variable parallel parking, pick-up + drop-off, light delivery	10 ft (1)	8 ft	10 ft (1)	8 ft	10 ft (1)	8 ft	10 ft (1)	8 ft	10 ft (1)	8 ft
E	BICYCLE ELEMENT*										
	Non-Separated Conventional Bike Lane	5 - 8 ft (2)	4 - 5 ft (2)	5 - 8 ft (2)	4 - 5 ft (2)	5 - 8 ft (2)	4 - 5 ft (2)	5 - 8 ft (2)	4 - 5 ft (2)	5 - 8 ft (2)	4 - 5 ft (2)
	Non-Separated Buffered Bike Lane	9 - 10 ft (2)	6 - 8 ft (2)	9 - 10 ft (2)	6 - 8 ft (2)	9 - 10 ft (2)	6 - 8 ft (2)	9 - 10 ft (2)	6 - 8 ft (2)	9 - 10 ft (2)	6 - 8 ft (2)
	Further Guidance for Non-Separated Facilities	NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide	
	Separated Bike Lane (one-way)	10 ft (2)	6.5 - 8 ft (2)	10 ft (2)	6.5 - 8 ft (2)	10 ft (2)	6.5 - 8 ft (2)	10 ft (2)	6.5 - 8 ft (2)	10 ft (2)	6.5 - 8 ft (2)
	Separated Bike Lane (two-way)	15 ft (2)	9.5 - 11 ft (2)	15 ft (2)	9.5 - 11 ft (2)	15 ft (2)	9.5 - 11 ft (2)	15 ft (2)	9.5 - 11 ft (2)	15 ft (2)	9.5 - 11 ft (2)
	Further Guidance for Separated Facilities	FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide	
F	TRANSIT ELEMENT										
	Shared Transit Lane	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft
	Considerations	Low congestion		Low congestion		Low congestion		Low congestion		Low congestion	
	Dedicated Transit Lane	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft
	Considerations	High congestion		High congestion		High congestion		High congestion		High congestion	
	Further Guidance	NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide	

Corridor Element Key											
		CORRIDOR MATRIX Multimodal System Design Guidelines - 2020 Update									
	Corridor Type ⇨	**Boulevard**									
	Intensity ⇨	**T-6**		**T-5**		**T-4**		**T-3**		**T-2**	
⇩	**Context Zones & Corridor Elements** ⇩	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM
G	TRAVEL LANE ELEMENT	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]
	Design Speed	25 - 35 mph		25 - 35 mph		25 - 35 mph		25 - 35 mph		25 - 35 mph	
	Number of Through Lanes	4 to 6		4 to 6		4 to 6		4 to 6		2 to 6	
	Typical Traffic Volume Range (vehicles per day)	15,000 to 40,000		15,000 to 40,000		10,000 to 50,000		8,000 to 40,000		5,000 to 30,000	
		The following rows provide guidance on design speeds, lane widths, and number of though lanes from other guidebooks. This guidance was considered and incorporated in the values above, and is provided here for additional reference.									
	*2020 VDOT Road Design Manual***										
	Lane Widths	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]
	Design Speeds	30 - 40 mph		30 - 40 mph		30 - 40 mph		40 - 60 mph		40 - 60 mph	
	2018 AASHTO Green Book										
	Lane Widths	11 ft [5]	10 ft	11 ft [5]	10 ft	11 ft [5]	10 ft	11 ft [5]	10 ft	11 ft [5]	10 ft
	Design Speeds	30 mph OR LESS		30 mph OR LESS		25 - 45 mph		25 - 45 mph		20 - 45 mph	
	Number of Through Lanes	4 to 6		4 to 6		4 to 6		4 to 6		2 to 6	
	2013 NACTO Urban Street Design Guide							NACTO Urban Street Design Guidance is not applicable.		NACTO Urban Street Design Guidance is not applicable.	
	Lane Widths	11 ft [6]	10 ft	11 ft [6]	10 ft	11 ft [6]	10 ft				
	Design Speeds	35 mph or less		35 mph or less		35 mph or less					
H	MEDIAN ELEMENT	18 ft [4]	6 ft [4]	18 ft [4]	6 ft [4]	18 ft [4]	6 ft [4]	18 ft [4]	6 ft [4]	18 ft [4]	6 ft [4]

*The bicycle element treatments listed here are discussed in more detail in **Appendix B: Corridor Matrix Annotation Document**. Shared lane markings and bicycle boulevard features are other potential treatments appropriate for corridors with Bicycle Modal Emphasis. Refer to the NACTO Urban Bikeway Design Guide and the AASHTO Guide for the Development of Bicycle Facilities for design guidance on shared lane markings and bicycle boulevard features.

**The 2020 VDOT Road Design Manual is in concurrence with the 2011 AASHTO Green Book.

[1] Flexible zones are best accommodated within a 10-foot wide lane for brief but frequent pick-up and drop-off and-or delivery activities completed by a variety of different vehicle types. These activities can be accommodated within an 8-foot wide lane in cases where an existing roadway is not being reconstructed or where adjoining, land use, roadway geometry, traffic volumes and or lane widths are deemed accommodating to a narrower flex zone width.

[2] **Optimal and minimum values for the Bicycle Element are subject to other criteria including type of curb and gutter, on-street parking, posted/design speeds, average daily traffic volumes, bicycle volumes, frequency of parking turnover, and percentage of heavy vehicles**. These values represent general ranges of potentially feasible widths to determine if a facility might possibly fit within the available right-of-way. See **Appendix B: Corridor Matrix Annotation Document** for more information on required widths in different circumstances.

[3] Travel lane width does not include the shy distance and curb or curb and gutter pan. Note: 12 ft is the optimum **only** for transit modal emphasis. Travel lane widths on Boulevards without transit modal emphasis should be minimized. (Refer to **Appendix B Corridor Matrix Annotation Document** for discussion.)

[4] Median element widths are measured from back of curb to back of curb. Median element widths do not include the width of the curb and shy distance.

[5] Section 7.3.3.2 of the 2018 AASHTO Green Book discusses considerations for lane widths on urban arterials. Lane widths may vary from 10 to 12 ft. 11-ft widths are normally adequate and have some advantages, but additional lane width may be desirable if substantial bus or truck traffic is anticipated.

[6] The NACTO Urban Street Design Guide indicates 11-foot lanes are only appropriate on designated truck or bus routes, and limited to one 11-foot lane in each direction. The NACTO USDG indicates 10-foot lanes are appropriate in all other instances.

CORRIDOR MATRIX

Multimodal System Design Guidelines - 2020 Update

Corridor Element Key	Corridor Type ⇨	Major Avenue											
	Intensity ⇨	T-6		T-5		T-4		T-3		T-2		T-1	
	Context Zones & Corridor Elements ⇩	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM
	Building Context Zone												
A	BUILDING FRONTAGE ELEMENT	7 ft	3 ft	7 ft	3 ft	7 ft	2.5 ft	7 ft	2.5 ft	12 ft	2 ft	12 ft	2 ft
A	Location of off street parking	rear	rear	rear	rear	rear	side	rear	side	rear	side	rear	side
A	Typical building entry locations	front	front	front	front	front	front	front	side	front	side	front	side
	Roadway Edge Zone												
B	SIDEWALK THROUGH ELEMENT	9 ft	6 ft	9 ft	6 ft	6 ft	6 ft	6 ft	6 ft	6 ft	5 ft	6 ft	5 ft
C	AMENITY ELEMENT	7 ft	6 ft	7 ft	6 ft	7 ft	6 ft	7 ft	6 ft	9 ft	6 ft	9 ft	6 ft
C	Surface Treatment for Amenity Element	Paved with tree wells		Paved with tree wells		Paved with tree wells		Paved with tree wells		Grassy strip with trees		Grassy strip with trees	
	Roadway Zone												
D	CURBSIDE ACTIVITY ELEMENT												
D	PARALLEL PARKING ONLY	8 ft both sides	None	8 ft both sides	None	8 ft both sides	None	8 ft both sides	None	8 ft both sides	None	8 ft both sides	None
D	FLEX ZONE: variable parallel parking, pick-up + drop-off, light delivery	10 ft (1)	8 ft	10 ft (1)	8 ft	10 ft (1)	8 ft	10 ft (1)	8 ft	10 ft (1)	8 ft	10 ft (1)	8 ft
E	BICYCLE ELEMENT*												
E	Non-Separated Conventional Bike Lane	5 - 8 ft (2)	4 - 5 ft (2)	5 - 8 ft (2)	4 - 5 ft (2)	5 - 8 ft (2)	4 - 5 ft (2)	5 - 8 ft (2)	4 - 5 ft (2)	5 - 8 ft (2)	4 - 5 ft (2)	5 - 8 ft (2)	4 - 5 ft (2)
E	Non-Separated Buffered Bike Lane	9 - 10 ft (2)	6 - 8 ft (2)	9 - 10 ft (2)	6 - 8 ft (2)	9 - 10 ft (2)	6 - 8 ft (2)	9 - 10 ft (2)	6 - 8 ft (2)	9 - 10 ft (2)	6 - 8 ft (2)	9 - 10 ft (2)	6 - 8 ft (2)
E	Further Guidance for Non-Separated Facilities	NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide	
E	Separated Bike Lane (one-way)	10 ft (2)	6.5 - 8 ft (2)	10 ft (2)	6.5 - 8 ft (2)	10 ft (2)	6.5 - 8 ft (2)	10 ft (2)	6.5 - 8 ft (2)	10 ft (2)	6.5 - 8 ft (2)	10 ft (2)	6.5 - 8 ft (2)
E	Separated Bike Lane (two-way)	15 ft (2)	9.5 - 11 ft (2)	15 ft (2)	9.5 - 11 ft (2)	15 ft (2)	9.5 - 11 ft (2)	15 ft (2)	9.5 - 11 ft (2)	15 ft (2)	9.5 - 11 ft (2)	15 ft (2)	9.5 - 11 ft (2)
E	Further Guidance for Separated Facilities	FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide	
F	TRANSIT ELEMENT												
F	Shared Transit Lane	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft
F	Considerations	Low congestion		Low congestion		Low congestion		Low congestion		Low congestion		Low congestion	
F	Dedicated Transit Lane	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft
F	Considerations	High congestion		High congestion		High congestion		High congestion		High congestion		High congestion	
F	Further Guidance	NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide	

Corridor Element Key		CORRIDOR MATRIX Multimodal System Design Guidelines - 2020 Update											
	Corridor Type ⇨	**Major Avenue**											
	Intensity ⇨	**T-6**		**T-5**		**T-4**		**T-3**		**T-2**		**T-1**	
⇩	**Context Zones & Corridor Elements** ⇩	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM
	TRAVEL LANE ELEMENT	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]
G	Design Speed	25 - 35 mph		25 - 35 mph		25 - 35 mph		25 - 35 mph		25 - 35 mph		25 - 35 mph	
	Number of Through Lanes	2 to 4		2 to 4		2 to 4		2 to 4		2 to 4		2 to 4	
	Typical Traffic Volume Range (vehicles per day)	10,000 to 30,000		8,000 to 25,000		5,000 to 25,000		5,000 to 20,000		2,000 to 10,000		2,000 to 10,000	
		The following rows provide guidance on design speeds, lane widths, and number of though lanes from other guidebooks. This guidance was considered and incorporated in the values above, and is provided here for additional reference.											
	*2020 VDOT Road Design Manual***												
	Lane Widths	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]
	Design Speeds	30 - 40 mph		30 - 40 mph		30 - 40 mph		30 - 60 mph		30 - 60 mph		30 - 60 mph	
	2018 AASHTO Green Book												
	Lane Widths	11 ft [5]	10 ft	11 ft [5]	10 ft	11 ft [5]	10 ft	11 ft [5]	10 ft	11 ft [5]	10 ft	11 ft [5]	10 ft
	Design Speeds	35 mph OR LESS		35 mph OR LESS		25 - 45 mph		25 - 45 mph		45 mph OR LESS		45 mph OR LESS	
	Number of Through Lanes	4 to 8		4 to 8		2 to 6		2 to 6		2 to 4		2 to 4	
	2013 NACTO Urban Street Design Guide							NACTO Urban Street Design Guidance is not applicable.		NACTO Urban Street Design Guidance is not applicable.		NACTO Urban Street Design Guidance is not applicable.	
	Lane Widths	11 ft [6]	10 ft	11 ft [6]	10 ft	11 ft [6]	10 ft						
	Design Speeds	35 mph or less		35 mph or less		35 mph or less							
H	MEDIAN ELEMENT	18 ft [4]	None	18 ft [4]	None	18 ft [4]	None	18 ft [4]	None	18 ft [4]	None	18 ft [4]	None

*The bicycle element treatments listed here are discussed in more detail in **Appendix B: Corridor Matrix Annotation Document**. Shared lane markings and bicycle boulevard features are other potential treatments appropriate for corridors with Bicycle Modal Emphasis. Refer to the NACTO Urban Bikeway Design Guide and the AASHTO Guide for the Development of Bicycle Facilities for design guidance on shared lane markings and bicycle boulevard features.

**The 2020 VDOT Road Design Manual is in concurrence with the 2011 AASHTO Green Book.

[1]Flexible zones are best accommodated within a 10-foot wide lane for brief but frequent pick-up and drop-off and-or delivery activities completed by a variety of different vehicle types. These activities can be accommodated within an 8-foot wide lane in cases where an existing roadway is not being reconstructed or where adjoining, land use, roadway geometry, traffic volumes and or lane widths are deemed accommodating to a narrower flex zone width.

[2]**Optimal and minimum values for the Bicycle Element are subject to other criteria including type of curb and gutter, on-street parking, posted/design speeds, average daily traffic volumes, bicycle volumes, frequency of parking turnover, and percentage of heavy vehicles.** These values represent general ranges of potentially feasible widths to determine if a facility might possibly fit within the available right-of-way. See **Appendix B: Corridor Matrix Annotation Document** for more information on required widths in different circumstances.

[3]Travel lane width does not include the shy distance and curb or curb and gutter pan. Note: 12 ft is the optimum **only** for transit modal emphasis. Travel lane widths on Major Avenues without transit modal emphasis should be minimized. (Refer to **Appendix B: Corridor Matrix Annotation Document** for discussion.)

[4]Median element widths are measured from back of curb to back of curb. Median element widths do not include the width of the curb and shy distance.

[5]Sections 6.3.2.1 and 7.3.3.2 of the 2018 AASHTO Green Book discuss considerations for lane widths on urban collectors and urban arterials, respectively. Lane widths may vary from 10 to 12 ft. 11-ft widths are normally adequate and have some advantages, but additional lane width may be desirable if substantial bus or truck traffic is anticipated.

[6]The NACTO Urban Street Design Guide indicates 11-foot lanes are only appropriate on designated truck or bus routes, and limited to one 11-foot lane in each direction. The NACTO USDG indicates 10-foot lanes are appropriate in all other instances.

CORRIDOR MATRIX

Multimodal System Design Guidelines - 2020 Update

Corridor Element Key													
	Corridor Type ⇨	**Avenue**											
	Intensity ⇨	**T-6**		**T-5**		**T-4**		**T-3**		**T-2**		**T-1**	
⇩	**Context Zones & Corridor Elements** ⇩	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM
	Building Context Zone												
A	BUILDING FRONTAGE ELEMENT	8 ft	2.5 ft	8 ft	2.5 ft	8 ft	2.5 ft	10 ft	1.5 ft	15 ft	1.5 ft	15 ft	1.5 ft
	Location of off street parking	rear	rear	rear	rear	rear	side	rear	side	rear	side	rear	side
	Typical building entry locations	front	front	front	front	front	front	front	side	front	side	front	side
	Roadway Edge Zone												
B	SIDEWALK THROUGH ELEMENT	8 ft	5 ft	7 ft	5 ft	6 ft	5 ft	6 ft	5 ft	6 ft	5 ft	6 ft	5 ft
C	AMENITY ELEMENT	7 ft	6 ft	7 ft	6 ft	7 ft	6 ft	7 ft	6 ft	8 ft	6 ft	7 ft	6 ft
	Surface Treatment for Amenity Element	Paved with tree wells		Paved with tree wells		Paved with tree wells		Paved with tree wells		Grassy strip with trees		Grassy strip with trees	
	Roadway Zone												
D	CURBSIDE ACTIVITY ELEMENT												
	PARALLEL PARKING ONLY	8 ft both sides	None	8 ft both sides	None	8 ft both sides	None	7 ft both sides	None	7 ft both sides	None	7 ft both sides	None
	FLEX ZONE: variable parallel parking, pick-up + drop-off, light delivery	10 ft [1]	8 ft	10 ft [1]	8 ft	10 ft [1]	8 ft	10 ft [1]	8 ft	10 ft [1]	8 ft	10 ft [1]	8 ft
E	BICYCLE ELEMENT*												
	Non-Separated Conventional Bike Lane	5 - 8 ft [2]	4 - 5 ft [2]	5 - 8 ft [2]	4 - 5 ft [2]	5 - 8 ft [2]	4 - 5 ft [2]	5 - 8 ft [2]	4 - 5 ft [2]	5 - 8 ft [2]	4 - 5 ft [2]	5 - 8 ft [2]	4 - 5 ft [2]
	Non-Separated Buffered Bike Lane	9 - 10 ft [2]	6 - 8 ft [2]	9 - 10 ft [2]	6 - 8 ft [2]	9 - 10 ft [2]	6 - 8 ft [2]	9 - 10 ft [2]	6 - 8 ft [2]	9 - 10 ft [2]	6 - 8 ft [2]	9 - 10 ft [2]	6 - 8 ft [2]
	Further Guidance for Non-Separated Facilities	NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide	
	Separated Bike Lane (one-way)	10 ft [2]	6.5 - 8 ft [2]	10 ft [2]	6.5 - 8 ft [2]	10 ft [2]	6.5 - 8 ft [2]	10 ft [2]	6.5 - 8 ft [2]	10 ft [2]	6.5 - 8 ft [2]	10 ft [2]	6.5 - 8 ft [2]
	Separated Bike Lane (two-way)	15 ft [2]	9.5 - 11 ft [2]	15 ft [2]	9.5 - 11 ft [2]	15 ft [2]	9.5 - 11 ft [2]	15 ft [2]	9.5 - 11 ft [2]	15 ft [2]	9.5 - 11 ft [2]	15 ft [2]	9.5 - 11 ft [2]
	Further Guidance for Separated Facilities	FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide	
F	TRANSIT ELEMENT												
	Shared Transit Lane	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft
	Considerations	Low congestion		Low congestion		Low congestion		Low congestion		Low congestion		Low congestion	
	Dedicated Transit Lane	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft
	Considerations	High congestion		High congestion		High congestion		High congestion		High congestion		High congestion	
	Further Guidance	NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide	

CORRIDOR MATRIX

Multimodal System Design Guidelines - 2020 Update

Corridor Element Key	Corridor Type / Intensity / Context Zones & Corridor Elements	Avenue T-6 OPTIMAL	T-6 MINIMUM	T-5 OPTIMAL	T-5 MINIMUM	T-4 OPTIMAL	T-4 MINIMUM	T-3 OPTIMAL	T-3 MINIMUM	T-2 OPTIMAL	T-2 MINIMUM	T-1 OPTIMAL	T-1 MINIMUM
	TRAVEL LANE ELEMENT	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]
G	Design Speed	25-30 mph		25-30 mph		25-30 mph		25-30 mph		25-30 mph		25-30 mph	
G	Number of Through Lanes	2 to 4		2 to 4		2 to 4		2 to 4		2 to 4		2 to 4	
G	Typical Traffic Volume Range (vehicles per day)	2,000 to 20,000		2,000 to 15,000		1,500 to 10,000		1,000 to 10,000		1,000 to 5,000		1,000 to 5,000	
G		*The following rows provide guidance on design speeds, lane widths, and number of though lanes from other guidebooks. This guidance was considered and incorporated in the values above, and is provided here for additional reference.*											
G	*2020 VDOT Road Design Manual***												
G	*Lane Widths*	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]	12 ft [3]	11 ft [3]
G	*Design Speeds*	20 - 40 mph		20 - 40 mph		20 - 40 mph		20 - 60 mph		20 - 60 mph		20 - 60 mph	
G	*2018 AASHTO Green Book*												
G	*Lane Widths*	11 ft [5]	10 ft	11 ft [5]	10 ft	11 ft [5]	10 ft	11 ft [5]	10 ft	11 ft [5]	10 ft	11 ft [5]	10 ft
G	*Design Speeds*	35 mph OR LESS		35 mph OR LESS		20 - 45 mph		20 - 45 mph		45 mph OR LESS		45 mph OR LESS	
G	*Number of Through Lanes*	4 to 8		4 to 8		2 to 6		2 to 6		2 to 4		2 to 4	
G	*2013 NACTO Urban Street Design Guide*							NACTO Urban Street Design Guidance is not applicable.		NACTO Urban Street Design Guidance is not applicable.		NACTO Urban Street Design Guidance is not applicable.	
G	*Lane Widths*	11 ft [6]	10 ft	11 ft [6]	10 ft	11 ft [6]	10 ft						
G	*Design Speeds*	30 mph or less		30 mph or less		30 mph or less							
H	MEDIAN ELEMENT	18 ft [4]	None	18 ft [4]	None	18 ft [4]	None	18 ft [4]	None	18 ft [4]	None	18 ft [4]	None

*The bicycle element treatments listed here are discussed in more detail in **Appendix B: Corridor Matrix Annotation Document**. Shared lane markings and bicycle boulevard features are other potential treatments appropriate for corridors with Bicycle Modal Emphasis. Refer to the NACTO Urban Bikeway Design Guide and the AASHTO Guide for the Development of Bicycle Facilities for design guidance on shared lane markings and bicycle boulevard features.

**The 2020 VDOT Road Design Manual is in concurrence with the 2011 AASHTO Green Book.

[1] Flexible zones are best accommodated within a 10-foot wide lane for brief but frequent pick-up and drop-off and-or delivery activities completed by a variety of different vehicle types. These activities can be accommodated within an 8-foot wide lane in cases where an existing roadway is not being reconstructed or where adjoining, land use, roadway geometry, traffic volumes and or lane widths are deemed accommodating to a narrower flex zone width.

[2] **Optimal and minimum values for the Bicycle Element are subject to other criteria including type of curb and gutter, on-street parking, posted/design speeds, average daily traffic volumes, bicycle volumes, frequency of parking turnover, and percentage of heavy vehicles.** These values represent general ranges of potentially feasible widths to determine if a facility might possibly fit within the available right-of-way. See **Appendix B: Corridor Matrix Annotation Document** for more information on required widths in different circumstances.

[3] Travel lane width does not include the shy distance and curb or curb and gutter pan. Note: 12 ft is the optimum **only** for transit modal emphasis. Travel lane widths on Avenues without transit modal emphasis should be minimized. (Refer to **Appendix B: Corridor Matrix Annotation Document** for discussion.)

[4] Median element widths are measured from back of curb to back of curb. Median element widths do not include the width of the curb and shy distance.

[5] Sections 6.3.2.1 and 7.3.3.2 of the 2018 AASHTO Green Book discuss considerations for lane widths on urban collectors and urban arterials, respectively. Lane widths may vary from 10 to 12 ft. 11-ft widths are normally adequate and have some advantages, but additional lane width may be desirable if substantial bus or truck traffic is anticipated.

[6] The NACTO Urban Street Design Guide indicates 11-foot lanes are only appropriate on designated truck or bus routes, and limited to one 11-foot lane in each direction. The NACTO USDG indicates 10-foot lanes are appropriate in all other instances.

CORRIDOR MATRIX

Multimodal System Design Guidelines - 2020 Update

Corridor Element Key	Corridor Type ⇨	Local Street											
	Intensity ⇨	T-6		T-5		T-4		T-3		T-2		T-1	
⇩	Context Zones & Corridor Elements ⇩	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM
	Building Context Zone												
A	BUILDING FRONTAGE ELEMENT	8 ft	2.5 ft	8 ft	2.5 ft	8 ft	2.5 ft	15 ft	1.5 ft	20 ft	1.5 ft	30 ft	1.5 ft
	Location of off street parking	rear	rear	rear	rear	rear	rear	rear	side	rear	side	rear	side
	Typical building entry locations	front	front	front	front	front	front	front	side	front	side	front	side
	Roadway Edge Zone												
B	SIDEWALK THROUGH ELEMENT	6 ft	5 ft	6 ft	5 ft	6 ft	5 ft	6 ft	5 ft	5 ft	5 ft	5 ft	5 ft
C	AMENITY ELEMENT	7 ft	6 ft	7 ft	6 ft	7 ft	6 ft	7 ft	6 ft	6 ft	6 ft	6 ft	6 ft
	Surface Treatment for Amenity Element	Paved with tree wells		Paved with tree wells		Paved with tree wells		Paved with tree wells		Grassy strip with trees		Grassy strip with trees	
	Roadway Zone												
D	CURBSIDE ACTIVITY ELEMENT												
	PARALLEL PARKING ONLY	7 ft both sides	None	7 ft both sides	None	7 ft both sides	None	7 ft both sides	None	7 ft both sides	None	7 ft both sides	None
	FLEX ZONE: variable parallel parking, pick-up + drop-off, light delivery	8 ft	7 ft	8 ft	7 ft	8 ft	7 ft	8 ft	7 ft	8 ft	7 ft	8 ft	7 ft
E	BICYCLE ELEMENT*												
	Non-Separated Conventional Bike Lane	5 - 8 ft [1]	4 - 5 ft [1]	5 - 8 ft [1]	4 - 5 ft [1]	5 - 8 ft [1]	4 - 5 ft [1]	5 - 8 ft [1]	4 - 5 ft [1]	5 - 8 ft [1]	4 - 5 ft [1]	5 - 8 ft [1]	4 - 5 ft [1]
	Non-Separated Buffered Bike Lane	9 - 10 ft [1]	6 - 8 ft [1]	9 - 10 ft [1]	6 - 8 ft [1]	9 - 10 ft [1]	6 - 8 ft [1]	9 - 10 ft [1]	6 - 8 ft [1]	9 - 10 ft [1]	6 - 8 ft [1]	9 - 10 ft [1]	6 - 8 ft [1]
	Further Guidance for Non-Separated Facilities	NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide	
	Separated Bike Lane (one-way)	10 ft [1]	6.5 - 8 ft [1]	10 ft [1]	6.5 - 8 ft [1]	10 ft [1]	6.5 - 8 ft [1]	10 ft [1]	6.5 - 8 ft [1]	10 ft [1]	6.5 - 8 ft [1]	10 ft [1]	6.5 - 8 ft [1]
	Separated Bike Lane (two-way)	15 ft [1]	9.5 - 11 ft [1]	15 ft [1]	9.5 - 11 ft [1]	15 ft [1]	9.5 - 11 ft [1]	15 ft [1]	9.5 - 11 ft [1]	15 ft [1]	9.5 - 11 ft [1]	15 ft [1]	9.5 - 11 ft [1]
	Further Guidance for Separated Facilities	FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide	
F	TRANSIT ELEMENT												
	Shared Transit Lane	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft
	Considerations	Low congestion		Low congestion		Low congestion		Low congestion		Low congestion		Low congestion	
	Dedicated Transit Lane	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	*Not Recommended*		*Not Recommended*	
	Considerations	High congestion		High congestion		High congestion		High congestion					
	Further Guidance	NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide	

CORRIDOR MATRIX

Multimodal System Design Guidelines - 2020 Update

Corridor Element Key													
	Corridor Type	Local Street											
	Intensity	T-6		T-5		T-4		T-3		T-2		T-1	
	Context Zones & Corridor Elements	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM
	TRAVEL LANE ELEMENT	11 ft [2]	10 ft [2]	11 ft [2]	10 ft [2]	11 ft [2]	10 ft [2]	11 ft [2]	10 ft [2]	11 ft [2]	10 ft [2]	11 ft [2]	10 ft [2]
G	Design Speed	25 mph		25 mph		25 mph		25 mph		25 mph		25 mph	
G	Number of Through Lanes	2 to 4		2 to 4		2		2		2		2	
G	Typical Traffic Volume Range (vehicles per day)	less than 10,000		less than 10,000		less than 8,000		less than 5,000		less than 2,000		less than 2,000	
G		*The following rows provide guidance on design speeds, lane widths, and number of though lanes from other guidebooks. This guidance was considered and incorporated in the values above, and is provided here for additional reference.*											
G	*2020 VDOT Road Design Manual***												
G	*Lane Widths*	11 ft [2]	10 ft [2]	11 ft [2]	10 ft [2]	11 ft [2]	10 ft [2]	11 ft [2]	10 ft [2]	11 ft [2]	10 ft [2]	11 ft [2]	10 ft [2]
G	*Design Speeds*	20-30 mph		20-30 mph		20-30 mph		20-30 mph		20-30 mph		20-30 mph	
G	*2018 AASHTO Green Book*												
G	*Lane Widths*	11 ft [3]	10 ft [3]	11 ft [3]	10 ft [3]	11 ft [3]	10 ft [3]	11 ft [3]	10 ft [3]	11 ft [3]	10 ft [3]	11 ft [3]	10 ft [3]
G	*Design Speeds*	20 - 30 mph		20 - 30 mph		20 - 30 mph		20 - 30 mph		20 - 30 mph		20 - 30 mph	
G	*Number of Through Lanes*	2 to 4		2 to 4		2		2		2		2	
G	*2013 NACTO Urban Street Design Guide*							NACTO Urban Street Design Guidance is not applicable.		NACTO Urban Street Design Guidance is not applicable.		NACTO Urban Street Design Guidance is not applicable.	
G	*Lane Widths*	11 ft [4]	10 ft	11 ft [4]	10 ft	11 ft [4]	10 ft						
G	*Design Speeds*	30 mph or less		30 mph or less		30 mph or less							
H	MEDIAN ELEMENT	None	None	None	None	None	None	None	None	None	None	None	None

*The bicycle element treatments listed here are discussed in more detail in **Appendix B: Corridor Matrix Annotation Document**. Shared lane markings and bicycle boulevard features are other potential treatments appropriate for corridors with Bicycle Modal Emphasis. Refer to the NACTO Urban Bikeway Design Guide and the AASHTO Guide for the Development of Bicycle Facilities for design guidance on shared lane markings and bicycle boulevard features.

**The 2020 VDOT Road Design Manual is in concurrence with the 2011 AASHTO Green Book.

[1] **Optimal and minimum values for the Bicycle Element are subject to other criteria including type of curb and gutter, on-street parking, posted/design speeds, average daily traffic volumes, bicycle volumes, frequency of parking turnover, and percentage of heavy vehicles.** These values represent general ranges of potentially feasible widths to determine if a facility might possibly fit within the available right-of-way. See **Appendix B: Corridor Matrix Annotation Document** for more information on required widths in different circumstances.

[2] Travel lane width does not include the shy distance and curb or curb and gutter pan.

[3] Section 5.3.2.1 of the 2018 AASHTO Green Book discusses considerations for lane widths on local streets in urban areas. Lanes should preferably be 10 to 11 ft wide. Where the available or attainable width of right-of-way imposes severe limitations, 9-ft lanes can be used in residential areas.

[4] The NACTO Urban Street Design Guide indicates 11-foot lanes are only appropriate on designated truck or bus routes, and limited to one 11-foot lane in each direction. The NACTO USDG indicates 10-foot lanes are appropriate in all other instances.

CORRIDOR MATRIX

Multimodal System Design Guidelines - 2020 Update

Corridor Element Key													
	Corridor Type ⇨	**Multimodal Through Corridor**											
	Intensity ⇨	**T-6**		**T-5**		**T-4**		**T-3**		**T-2**		**T-1**	
⇩	**Context Zones & Corridor Elements** ⇩	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM
	Building Context Zone												
A	BUILDING FRONTAGE ELEMENT	15 to 25 ft	10 ft	15 to 25 ft	10 ft	20 to 35 ft	15 ft	25 to 35 ft	15 ft	30 to 45 ft	20 ft	30 to 45 ft	20 ft
	Location of off street parking	rear	front	rear	front	rear	front	rear	front	rear	front	rear	front
	Typical building entry locations	front/side	rear	front/side	rear	front/side	rear	front/side	rear	front/side	rear	front/side	rear
	Roadway Edge Zone												
B	SIDEWALK THROUGH ELEMENT	14 ft shared use path	5 ft sidewalk	14 ft shared use path	5 ft sidewalk	12 ft shared use path	5 ft sidewalk	12 ft shared use path	5 ft sidewalk	10 ft shared use path	5 ft sidewalk	10 ft shared use path	5 ft sidewalk
C	AMENITY ELEMENT	A minimum of 8 feet width is necessary between the face of the curb and the edge of the shared use path. Physical barriers, such as dense shrubbery, railings, or fencing may be placed between travel lanes and shared use path.								Shoulder and drainage ditch recommended instead of curb and gutter. Width between travel lanes and shared use path varies depending on speed. 20 to 28 ft for 60 mph design speed. 14 to 22 ft for 50 mph design speed.			
	Surface Treatment for Amenity Element												
	Roadway Zone												
D	CURBSIDE ACTIVITY ELEMENT												
	PARALLEL PARKING ONLY	On Street Parking Prohibited	On Street Parking Prohibited	On Street Parking Prohibited	On Street Parking Prohibited	On Street Parking Prohibited	On Street Parking Prohibited	On Street Parking Prohibited	On Street Parking Prohibited	On Street Parking Prohibited	On Street Parking Prohibited	On Street Parking Prohibited	On Street Parking Prohibited
	FLEX ZONE: variable parallel parking, pick-up + drop-off, light delivery	Flex zone not permitted		Flex zone not permitted		Flex zone not permitted		Flex zone not permitted		Flex zone not permitted		On Street Parking Prohibited	
E	BICYCLE ELEMENT*												
	Non-Separated Conventional Bike Lane	5 - 8 ft [1]	4 - 5 ft [1]	5 - 8 ft [1]	4 - 5 ft [1]	5 - 8 ft [1]	4 - 5 ft [1]	5 - 8 ft [1]	4 - 5 ft [1]	5 - 8 ft [1]	4 - 5 ft [1]	5 - 8 ft [1]	4 - 5 ft [1]
	Non-Separated Buffered Bike Lane	9 - 10 ft [1]	6 - 8 ft [1]	9 - 10 ft [1]	6 - 8 ft [1]	9 - 10 ft [1]	6 - 8 ft [1]	9 - 10 ft [1]	6 - 8 ft [1]	9 - 10 ft [1]	6 - 8 ft [1]	9 - 10 ft [1]	6 - 8 ft [1]
	Further Guidance for Non-Separated Facilities	NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide		NACTO Urban Bikeway Design Guide	
	Separated Bike Lane (one-way)	10 ft [1]	6.5 - 8 ft [1]	10 ft [1]	6.5 - 8 ft [1]	10 ft [1]	6.5 - 8 ft [1]	10 ft [1]	6.5 - 8 ft [1]	10 ft [1]	6.5 - 8 ft [1]	10 ft [1]	6.5 - 8 ft [1]
	Separated Bike Lane (two-way)	15 ft [1]	9.5 - 11 ft [1]	15 ft [1]	9.5 - 11 ft [1]	15 ft [1]	9.5 - 11 ft [1]	15 ft [1]	9.5 - 11 ft [1]	15 ft [1]	9.5 - 11 ft [1]	15 ft [1]	9.5 - 11 ft [1]
	Further Guidance for Separated Facilities	FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide		FHWA Separated Bike Lane Planning and Design Guide	
F	TRANSIT ELEMENT												
	Shared Transit Lane	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft
	Considerations	Low congestion		Low congestion		Low congestion		Low congestion		Low congestion		Low congestion	
	Dedicated Transit Lane	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft	12 ft	11 ft
	Considerations	High congestion		High congestion		High congestion		High congestion		High congestion		High congestion	
	Further Guidance	NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide		NACTO Transit Street Design Guide	

CORRIDOR MATRIX

Multimodal System Design Guidelines - 2020 Update

Corridor Element Key	Corridor Type ⇨	Multimodal Through Corridor											
	Intensity ⇨	T-6		T-5		T-4		T-3		T-2		T-1	
⇩	Context Zones & Corridor Elements ⇩	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM	OPTIMAL	MINIMUM
	TRAVEL LANE ELEMENT	12 ft [2]	11 ft [2]	12 ft [2]	11 ft [2]	12 ft [2]	11 ft [2]	12 ft [2]	11 ft [2]	12 ft [2]	12 ft [2]	12 ft [2]	12 ft [2]
G	Design Speed	35 - 45 mph		35 - 45 mph		35 - 45 mph		35 - 55 mph		45 - 55 mph		45 - 55 mph	
G	Number of Through Lanes	4 to 6		4 to 6		4 to 6		2 to 4		2 to 4		2 to 4	
G	Typical Traffic Volume Range (vehicles per day)	20,000 to 60,000		20,000 to 50,000		15,000 to 40,000		10,000 to 30,000		5,000 to 20,000		2,000 to 20,000	
G		*The following rows provide guidance on design speeds, lane widths, and number of though lanes from other guidebooks. This guidance was considered and incorporated in the values above, and is provided here for additional reference.*											
G	*2020 VDOT Road Design Manual***												
G	*Lane Widths*	12 ft [2]	11 ft [2]	12 ft [2]	11 ft [2]	12 ft [2]	11 ft [2]	12 ft [2]	11 ft [2]	12 ft [2]	12 ft [2]	12 ft [2]	12 ft [2]
G	*Design Speeds*	30 - 70 mph		30 - 70 mph		30 - 70 mph		30 - 70 mph		30 - 70 mph		30 - 70 mph	
G	*2018 AASHTO Green Book*												
G	*Lane Widths*	12 ft [5]	10 ft [6]	12 ft [5]	10 ft [6]	12 ft [5]	10 ft [6]	12 ft [5]	10 ft [6]	12 ft [5]	10 ft [6]	12 ft	12 ft
G	*Design Speeds*	30 mph OR LESS		30 mph OR LESS		25 - 45 mph		25 - 45 mph		30 - 55 mph		40 - 75 mph	
G	*Number of Through Lanes*	4 to 8		4 to 8		4 to 6		4 to 6		2 to 4		2 to 4	
G	*2013 NACTO Urban Street Design Guide*							NACTO Urban Street Design Guidance is not applicable.		NACTO Urban Street Design Guidance is not applicable.		NACTO Urban Street Design Guidance is not applicable.	
G	*Lane Widths*	11 ft [7]	10 ft	11 ft [7]	10 ft	11 ft [7]	10 ft						
G	*Design Speeds*	35 mph or less		35 mph or less		35 mph or less							
H	MEDIAN ELEMENT	18 ft [3,4]	17 Ft [3,4]	18 ft [3,4]	17 Ft [3,4]	18 ft [3,4]	17 Ft [3,4]	18 ft [3,4]	None	40 ft [4]	None	40 ft [4]	None

*The bicycle element treatments listed here are discussed in more detail in **Appendix B: Corridor Matrix Annotation Document**. Shared lane markings and bicycle boulevard features are other potential treatments appropriate for corridors with Bicycle Modal Emphasis. Refer to the NACTO Urban Bikeway Design Guide and the AASHTO Guide for the Development of Bicycle Facilities for design guidance on shared lane markings and bicycle boulevard features.

**The 2020 VDOT Road Design Manual is in concurrence with the 2011 AASHTO Green Book.

[1] **Optimal and minimum values for the Bicycle Element are subject to other criteria including type of curb and gutter, on-street parking, posted/design speeds, average daily traffic volumes, bicycle volumes, frequency of parking turnover, and percentage of heavy vehicles.** These values represent general ranges of potentially feasible widths to determine if a facility might possibly fit within the available right-of-way. See **Appendix B: Corridor Matrix Annotation Document** for more information on required widths in different circumstances.

[2] Travel lane width does not include the shy distance and curb or curb and gutter pan.

[3] Median element widths are measured from back of curb to back of curb. Median element widths do not include the width of the curb and shy distance.

[4] Median width does not include accommodation for transit in the median. If transit runs in the median, the width will vary based upon detailed design.

[5] Section 7.3.3.2 of the 2018 AASHTO Green Book discusses considerations for lane widths on arterials in urban areas. Lane widths may vary from 10 to 12 ft. The 12-ft lane widths are desirable, where practical on high-speed, free-flowing, principal arterials. However, Section 7.3.2.1 indicates design speeds for arterials are generally 30 mph or less in the urban core context, 25 to 45 mph in the urban context, and 30 to 55 mph in the suburban context.

[6] 10-ft widths may be used if speeds are less than 35 mph and truck and bus volumes are relatively low. (Section 7.3.3.2 in 2018 AASHTO Green Book)

[7] The NACTO Urban Street Design Guide indicates 11-foot lanes are only appropriate on designated truck or bus routes, and limited to one 11-foot lane in each direction. The NACTO USDG indicates 10-foot lanes are appropriate in all other instances.

APPENDIX B.

CORRIDOR MATRIX ANNOTATION DOCUMENT

The following Appendix contains the Corridor Matrix Annotation Document. This is an accompanying document to the Corridor Matrix and explains the sources, justification, and additional considerations for each of the recommended standards in the Corridor Matrix.

CORRIDOR MATRIX ANNOTATION DOCUMENT

This Corridor Matrix Annotation Document is an accompanying document to the Corridor Matrix and gives additional information on the sources, rationale, and additional considerations for each of the recommended standards in the Corridor Matrix. This document starts with a narrative explaining the overall approach to Multimodal Corridor design that is recommended in the Multimodal System Design Guidelines ("the Guidelines" or "these Guidelines"). Although some of this repeats information in Chapter 5 of the Guidelines, it is included in this document for ease of reference.

Places are defined in large part by the character and scale of the streets that traverse them. The Multimodal Corridor types are organized according to a composite of features that include their scale, capacity, function and context zone, characteristics. All of these are detailed in the Corridor Matrix. These features are customized to the Virginia context and correlated with the Virginia Department of Transportation's (VDOT) functional classification hierarchy, Access Management Standards, and Road Design Manual.

The Multimodal Corridor types and corridor element dimensions used in these Guidelines are based on industry-standard manuals and current best practice guidebooks. The original 2013 Multimodal System Design Guidelines drew heavily from *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach* published by the Institute of Transportation Engineers (ITE) and the Congress for the New Urbansim (CNU). The ITE/CNU Guidebook was, at the time of original development, a commonly cited industry standard, and it defined thoroughfare types that correspond to the Transect Zones from CNU's *SmartCode* and to traditional functional classifications for roadways.

Since 2013, a wealth of new corridor design guidebooks and manuals have been published. The Corridor Matrix has been revised been revised as part of the 2020 Update to these Guidelines to reflect the new guidance. The following resources played a major role in the update to the Corridor Matrix.

- *A Policy on Geometric Design of Highways and Streets, **7th Edition***, published by the American Association of State Highway and Transportation Officials (AASHTO) in 2018
- *Urban Street Design Guide*, published by the National Association of City Transportation Officials

(NACTO) in 2013

- *Bikeway Selection Guide*, published by the Federal Highway Administration (FHWA) in 2019
- *Separated Bike Lane Planning and Design Guide*, published by FHWA in 2015
- *Transit Street Design Guide*, published by NACTO in 2016
- *Urban Bikeway Design Guide*, published by NACTO in 2012[1]

This Corridor Matrix Annotation Document references specific pages and tables within the ITE/CNU Guidebook; readers will need a copy of the ITE/CNU Guidebook to refer to as a reference. This document also refers to the other resources for further information.

This Corridor Matrix Annotation Document serves as the detailed reference for the Corridor Matrix, which provides standards for each Multimodal Corridor type within each Transect Zone.

Corridor Matrix References and Resources

The Corridor Matrix and this Annotation Document refer to several key references and resources. The most frequently cited resources are summarized below. A full list of guidance documents for multimodal corridor planning and design is provided in Appendix G.

Road Design Manual

Virginia Department of Transportation, Revised January 2020

The VDOT Road Design Manual is the informational and procedural guide for engineers, designers, and technicians involved in the development of plans for Virginia's highways. It provides the standards for road design, and is used in conjunction with publications from AASHTO. VDOT regularly updates the Road Design Manual every six months.

All standards provided in the Corridor Matrix meet the minimum standards as specified in the VDOT Road Design Manual unless noted otherwise, ensuring that the multimodal recommendations from these Guidelines are consistent with the VDOT Road Design Manual for constructability.

This Annotation Document explains how each corridor standard meets or exceeds the specifications within the VDOT Road Design Manual.

At the time of the 2020 Update to the Guidelines, the VDOT Road Design Manual was consistent with the 6th Edition of AASHTO's *A Policy on Geometric Design of Highways and Streets* ("Green Book"), published in 2011. AASHTO released the 7th Edition of the Green Book in 2018, which, among other changes, expands the formerly binary urban and rural context classes into five new roadway context classes. At the time of the 2020 Update to these Guidelines, FHWA had not yet incorporated the 7th Edition of the Green Book into its regulations governing construction, reconstruction, and resurfacing of the National

[1] Although the NACTO Urban Bikeway Design Guide was published during the development of the original 2013 Multimodal System Design Guidelines, this 2020 Update to the Guidelines more fully incorporates the different bicycle facility treatments into the Corridor Matrix.

Highway System. VDOT is expected to update its Road Design Manual to incorporate the 7th Edition Green Book once FHWA does. Select differences between the 6th and 7th Editions of the Green Book relevant to the Corridor Matrix are noted and explained in this Annotation Document.

Designing Walkable Urban Thoroughfares: A Context Sensitive Approach

Institute of Transportation Engineers and Congress for the New Urbanism, 2010

This ITE/CNU report provides guidance for the design of walkable urban thoroughfares in places that currently support the mode of walking or in places where the community desires to provide a more walkable thoroughfare in the future. It focuses primarily on arterials and collectors. This document is a key industry best practice for Context Sensitive Solutions (CSS) and walkable thoroughfare design. It includes many details related to corridor design and process. Application is generally limited to low speed urban arterials and collectors - streets that require tradeoffs between pedestrian and vehicle priority. Separate sections highlight various elements of the planning and design process.

The ITE/CNU Guidebook was used as a key resource in the original development of the corridor standards in the Corridor Matrix. All of the recommended metrics in the ITE/CNU Guidebook meet VDOT standards; some exceed the VDOT Standards. Generally, where the ITE/CNU parameters exceed VDOT standards, the ITE/CNU parameters are used. For example, VDOT requires a minimum sidewalk width of five feet, whereas the ITE/CNU Guidebook recommends a minimum sidewalk width of six feet in commercial areas. The ITE/CNU parameters were incorporated as appropriate, as further explained in this Annotation Document.

Implementing Context Sensitive Design on Multimodal Thoroughfares

Institute of Transportation Engineers, 2017

In 2017, ITE released *Implementing Context Sensitive Design on Multimodal Thoroughfares*, a follow-up publication to the 2010 *Designing Walkable Urban Thoroughfares* document. The 2017 publication updates some of the concepts in the 2010 document and provides more specific guidance for redesigning arterial and collector roadways in suburban communities, urban edges, and small towns that are transitioning to more walkable communities. The publication provides design concepts and countermeasures for tackling common street design challenges.

Separated Bike Lane Planning and Design Guide

Federal Highway Administration, 2015

A separated bike lane is an exclusive bike lane that is separated from motor vehicle traffic by a vertical element. This treatment is sometimes referred to as a cycle track or protected bike lane. FHWA published the Separated Bike Lane Planning and Design Guide in 2015 to provide a menu of design options for typical one and two-way separated bike lane scenarios. Although the VDOT Road Design Manual does not contain design standards for separated bike lanes, it does include some information about this treatment type and cites FHWA's guide.

Urban Bikeway Design Guide

National Association of City Transportation Officials, 2nd Edition, 2012

NACTO published the original Urban Bikeway Design Guide in 2011 and released a 2nd Edition in 2012. This guide presents global best practices for bikeway design in an urban context. Most of the design guidance in NACTO's bikeway guide are not referenced in the relevant AASHTO guidance. However, FHWA issued a memo in 2013 supporting the use of NACTO's guide. In 2019, NACTO released *Don't Give up at the Intersection,* a supplement to the *Urban Bikeway Design Guide*. This supplement provides guidance on intersection bikeway design to support safe, comfortable biking for users of all ages and abilities.

Transit Street Design Guide

National Association of City Transportation Officials, 2016

This guide provides recommendations for designing transit streets that also function as great placemaking corridors. Published in 2016, this guide lays out standards for a variety of bus-priority street elements, including bus lanes, bus boulevards, and transit signals. NACTO's membership is primarily composed of transportation departments of medium and large cities and this guide is most-relevant to urban contexts.

Guide for Geometric Design of Transit Facilities on Highways and Streets

American Association of State Highway and Transportation Officials. 2014

This guide provides a comprehensive overview of transit facilities across a wide range of contexts. It contains design guidance for light rail and bus facilities on limited access highways and streets and includes topics such as station location and design, pedestrian and bicycle access, and transitway design.

General Corridor Types and Correlation

The Corridor Matrix specifies five different Multimodal Corridor types: Boulevard, Major Avenue, Avenue, Local Street, and Multimodal Through Corridor.[2,3] The five Multimodal Corridor types are further subdivided by Transect Zone. The 29 detailed Multimodal Corridor types are variations of the five basic Multimodal Corridor types described below. The first four basic Multimodal Corridor types are based primarily on the ITE/CNU typology, are located usually within Multimodal Centers, and are referred to as Placemaking Corridors. For this reason, the Multimodal Through Corridor is included as a fifth Multimodal

[2] The original 2013 Guidelines included a Transit Boulevard placemaking corridor type – a boulevard with a dedicated right-of-way for transit. The 2020 Update eliminated this as a separate corridor type and added a Transit Element to the Corridor Matrix that is applicable for all multimodal corridor types, not just the Boulevard.

[3] A sixth Multimodal Corridor type was added in the 2020 Update to the Multimodal System Design Guidelines – the Slow Street. A Slow Street is a special kind of Local Street that is designed for extremely low vehicle speeds – with maximum speeds of 20 to 25 mph and the majority of motorists going slower. Chapter 5 in the Guidelines explains the Slow Street corridor type in more detail. The Slow Street corridor type is not included in the Corridor Matrix.

Corridor type, and generally describes the corridors and segments of corridors outside Multimodal Centers.

This fundamental distinction – between Multimodal Through Corridors and Placemaking Corridors is a key concept in these Guidelines. All Multimodal Corridors within a Multimodal Center, and often many of the corridors in a Multimodal District are considered to be Placemaking Corridors; these corridors facilitate movement to destinations within a Multimodal Center or District. The higher speed Multimodal Corridors that connect Multimodal Centers within a Multimodal District, or connect between Districts, are considered to be Multimodal Through Corridors. Multimodal Through Corridors and Placemaking Corridors work together in a region by getting people quickly from one Multimodal District or Multimodal Center to another and ultimately to activities within a Multimodal District or Multimodal Center. Multimodal Through Corridors will typically transition to Placemaking Corridors as they enter a Multimodal Center. Ideally, though, they are located at the edge of Multimodal Centers, remaining as higher-speed facilities to which Placemaking Corridors provide access from the core of the Multimodal Center. This relationship is shown in **Figure B-1**.

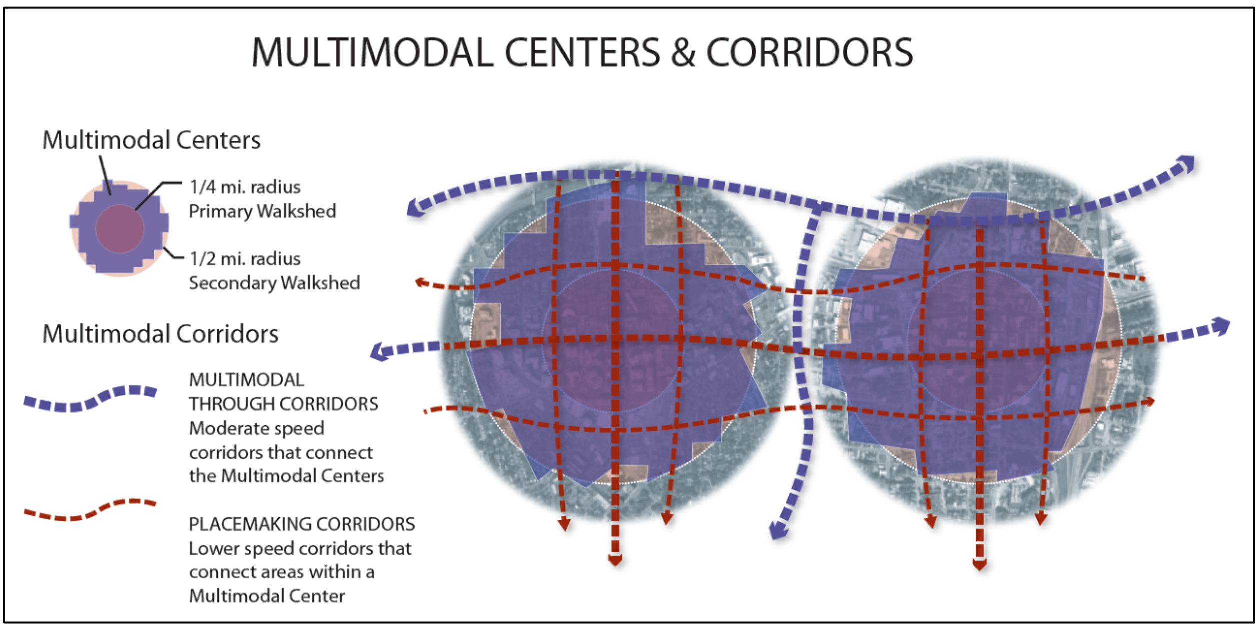


Figure B-1 – Multimodal Through and Placemaking Corridors. This diagram distinguishes Placemaking Corridors from Multimodal Through Corridors – the two general categories of multimodal corridors that together comprise a true multimodal transportation system in a region.

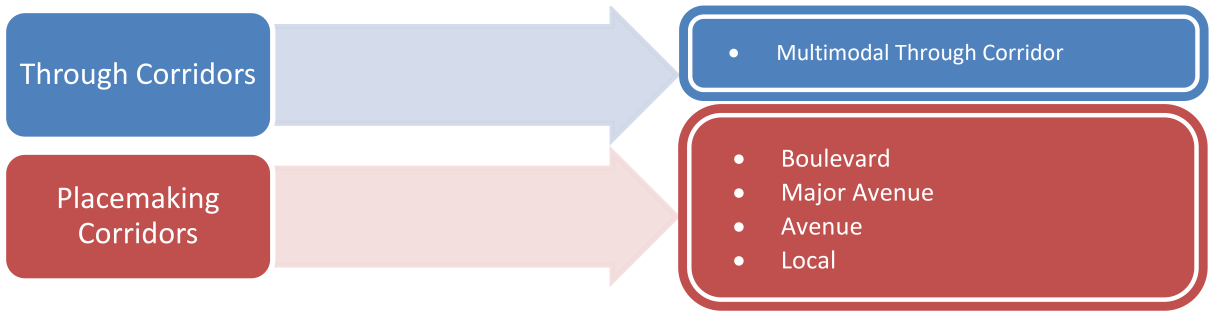
Placemaking Corridors are usually located within Multimodal Centers, but can extend outward beyond the Multimodal Center boundaries into a Multimodal District. Any street that communities desire to make into a lively, pedestrian-oriented street may be designated as a Placemaking Corridor, regardless of location. Because of the concentration and diversity of land uses within Multimodal Centers, the streets within Multimodal Centers should be designated as Placemaking Corridors.

Multimodal Through Corridors are located exclusively outside of Multimodal Centers, but may traverse Multimodal Districts. If possible, Multimodal Centers should be located such that Multimodal Through

Corridors skirt the edges of a Multimodal Center. Alternatively, Multimodal Through Corridors must transition to Placemaking Corridors if they go through a Multimodal Center. Once they have passed through the Multimodal Center, they may transition back to Multimodal Through Corridors.

Multimodal Corridor Types

Each Multimodal Corridor type has a unique function relative to access, mobility, and multimodal features; this is similar, but more detailed than the VDOT roadway functional classes. The five Multimodal Corridor types used in these Guidelines are listed and individually described below.



Through Corridors

Multimodal Through Corridor

The Multimodal Through Corridor is a higher speed corridor that connects multiple activity centers. It is intended for longer distance, higher speed automobile, bus, or rail travel and ideally has limited at-grade intersections with other roadway types. Multimodal Through Corridors are good candidates for high speed commuter transit having few impediments to traffic flow. High speeds limit pedestrian and bicycle modes and hence the corridor design should provide separated facilities for these modes. The design of the adjacent buildings should be oriented away from Multimodal Through Corridors and towards Placemaking Corridors on the other side of the buildings, providing more desirable pedestrian facilities and pedestrian-oriented land uses on the Placemaking Corridors, while still accommodating pedestrian travel along the Multimodal Through Corridors. Design speeds for Multimodal Through Corridors range from 35 to 55 mph.

Placemaking Corridors

Boulevard

A Boulevard is the corridor type of highest multimodal capacity that accommodates multiple motorized and non-motorized modes. Boulevards allow for higher traffic volumes and greater efficiency of vehicular movements than Major Avenues, Avenues, and Local Streets, and typically have four to six lanes of traffic but may grow to eight in particularly dense centers such as Tysons Corner. Boulevards provide safe and convenient pedestrian and bicycle access to adjacent land uses. Boulevards feature a median, landscaped amenity elements, street trees, and wider sidewalks. Design speeds for Boulevards range from 25 to 35 mph.

Major Avenue

Major Avenues contain the highest density of destinations, intensity of activity, and mix of modes. Because of the close proximity of destinations, pedestrians and street activity are common on Major

Avenues. Major Avenues have wide sidewalks to accommodate high numbers of pedestrians and a variety of outdoor activities, including sidewalk cafes, kiosks, vendors, and other street activities. Major Avenues can be areas of high transit ridership for local bus routes. Traffic is low speed and localized. Due to the intensity of destinations, longer regional trips do not use Major Avenues; rather they would typically be on Boulevards or Multimodal Through Corridors. Autos and buses on Major Avenues travel at slow speeds because pedestrian crossings and on-road bicyclists are frequent. Major Avenues typically have four or fewer lanes for motor vehicle travel while providing adequate facilities for bicycling and typically providing roadway space dedicated to on-street parking. Design speeds for Major Avenues range from 25 to 35 mph.

Avenue

Avenues provide a balance between access to the businesses and residences that front upon them and the collection of vehicular and pedestrian traffic. While having fewer destinations than Major Avenues, pedestrian and bicycle activity is very common, as Avenues serve as critical links in the non-motorized network. Avenues are low speed roadways that facilitate shorter trips, but still contain a fair amount of destinations. Avenues typically have three travel lanes or fewer, and do not exceed four lanes. Avenues may have roadway space dedicated for on-street parking and provide adequate bicycle facilities. Design speeds for Avenues range from 25 to 30 mph.

Local Street

Local Streets see a low amount of activity and have slow speeds and high access. Bicyclists typically can share the road with autos, because speeds are slow and auto traffic is sparse, although they have separate sidewalks and trails for pedestrian accommodation. Local Streets are primarily in more residential areas and are intended to serve only trips that originate or end along them. They connect to Avenues, Boulevards or Major Avenues, funneling longer trips to these higher capacity corridor types. Local Streets are characterized by slow design speeds, wider setbacks; they may not have lane striping, and they emphasize on-street parking. Local Streets have a 25 mph design speed.

Corridor Intensity Zones

Just as the Transect Zones were used to define intensity zones in the Multimodal Centers, they are also used to define intensity levels among Multimodal Corridors. Within each Multimodal Corridor type, there is a spectrum of intensity levels ranging from T-1 to T-6. The intensity levels directly correspond to the Transect Zones.

Not all intensity levels exist in all Multimodal Corridor types. For example, the intensity levels for a Boulevard range from T-6 to T-2, since a very low intensity Boulevard is not practical. In the least dense Multimodal Center (P-1), roads that provide a high level of mobility will not correspond with the description and function of a Boulevard. In these cases, a Major Avenue or Avenue will serve as the primary Multimodal Corridor within the Multimodal Center and will provide the facilities for multimodal transportation scaled to their less dense context. The Multimodal System Design Guidelines are designed to address urban and rural areas of many scales and intensities. A Rural or Village Center may be a village crossroads through which two regional routes (or a regional route and a smaller road) intersect. For example, in the small town of Palmyra in Fluvanna County, US 15 intersects with Courthouse Road.

Outside of this local center, US 15 has a posted speed limit of 55 mph with no sidewalks and is used for high speed regional auto travel. But within the primary walkshed of the center, the road serves a different function. It becomes more like a Major Avenue as described above, although it is located within what could be described as a P-2 (Small Town or Suburban Center) context. In this example, in particular, the Transect Zones differentiate the intensity levels of similar Multimodal Corridor types. For example, a Major Avenue in downtown Richmond looks and feels different from the Major Avenue just described in Palmyra, but the functions of the two roads are similar. They both serve more localized traffic, contain destinations for pedestrians, have slower speeds to allow safe pedestrian crossings, and are more focused on destinations and access than mobility. The T-Zones, however, help differentiate the intensities and characteristic features of the two examples of Major Avenue corridors – one rural and one urban. **Table B-1** specifies which of the Multimodal Corridor types exist within each Transect Zone.

Table B-1 – Multimodal Corridor Types and Transect Zones. Not all Multimodal Corridor types apply to all Transect Zones. Transit Boulevards and Boulevards only apply to the moderate and high intensity Transect Zones. Major Avenues, Avenues, Local Streets and Multimodal Through Corridors can be found in any of the Transect Zones.

<table>
<tr><th></th><th colspan="6">Transect Zone (Intensity Zone)</th></tr>
<tr><th></th><th>T-6
High Intensity</th><th>T-5
Medium High Intensity</th><th>T-4
Medium Intensity</th><th>T-3
Medium Low Intensity</th><th>T-2
Low Intensity</th><th>T-1
Very Low Intensity</th></tr>
<tr><th rowspan="5">Multimodal Corridor Types</th><td colspan="5">Boulevard</td><td></td></tr>
<tr><td colspan="6">Major Avenue</td></tr>
<tr><td colspan="6">Avenue</td></tr>
<tr><td colspan="6">Local Street</td></tr>
<tr><td colspan="6">Multimodal Through Corridor</td></tr>
</table>

AASHTO Context Classification for Geometric Design

The 7th Edition of the AASHTO Green Book, published in 2018, expands the binary urban and rural context classes into five context classes for geometric design. This expansion more closely aligns with the more nuanced approach to Multimodal Center types in these Guidelines. AASHTO's five roadway context classes are listed below and defined in Section 1.5 of the 2018 AASHTO Green Book:

Rural areas:

- Rural context
- Rural town context

Urban areas:

- Suburban context
- Urban context
- Urban core context

The 2018 Green Book indicates the five context classes do not replace the functional classification system but are intended to assist designers in making choices that appropriately balance the needs of multiple modes and that use a street. The context classes are based on development intensity, land use, and the physical context of the roadway. AASHTO's introduction of context classification is a recognition that appropriate geometric design varies widely depending on the context. There is no single design type that is appropriate for all contexts. The 2018 Green Book provides preliminary guidance for each context zone. Future editions will include more comprehensive guidance for each functional class by context zone.

Table B-2 shows the general correlation between the Multimodal Corridor Types, Transect Zones, and five roadway Context Classes from the 2018 AASHTO Green Book.

Table B-2 – 2018 AASHTO Green Book Roadway Context Classes, Multimodal Corridor Types, and Transect Zones.

<table>
<tr><th rowspan="2">Multimodal Corridor Types</th><th colspan="6">Transect Zone (Intensity Zone)</th></tr>
<tr><th>T-6 High Intensity</th><th>T-5 Medium High Intensity</th><th>T-4 Medium Intensity</th><th>T-3 Medium Low Intensity</th><th>T-2 Low Intensity</th><th>T-1 Very Low Intensity</th></tr>
<tr><td>Boulevard</td><td colspan="2" rowspan="5">Urban Core Context</td><td colspan="2" rowspan="5">Urban Context</td><td rowspan="4">Rural Town Context</td><td></td></tr>
<tr><td>Major Avenue</td><td rowspan="3">Rural Town Context</td></tr>
<tr><td>Avenue</td></tr>
<tr><td>Local Street</td></tr>
<tr><td>Multimodal Through Corridor</td><td>Suburban Context</td><td>Rural Context</td></tr>
</table>

Correlation to VDOT Functional Classes

The VDOT Transportation and Mobility Planning Division maintains an official functional classification system for all roads within the Commonwealth. A road's functional classification is determined by criteria including trip types, traffic volumes, system connections, and mileage percentage thresholds.[4]

[4] More information about VDOT's functional classification criteria and process can be found on VDOT's website at http://www.virginiadot.org/projects/fxn_class/home.asp.

VDOT classifies roads as either urban or rural based on whether they are located within an urbanized area. Urban roads are those roads located within an urbanized area or urban cluster; rural roads are those outside of urbanized areas and urban clusters.[5] Roads are further classified based on the ability to access land and the mobility through an area. Local facilities emphasize the land-access function. Arterials emphasize a high level of mobility for through traffic. Collectors offer a compromise between the two functions. **Figure B-2** shows the VDOT functional classification types as applied to the downtown area of Richmond.

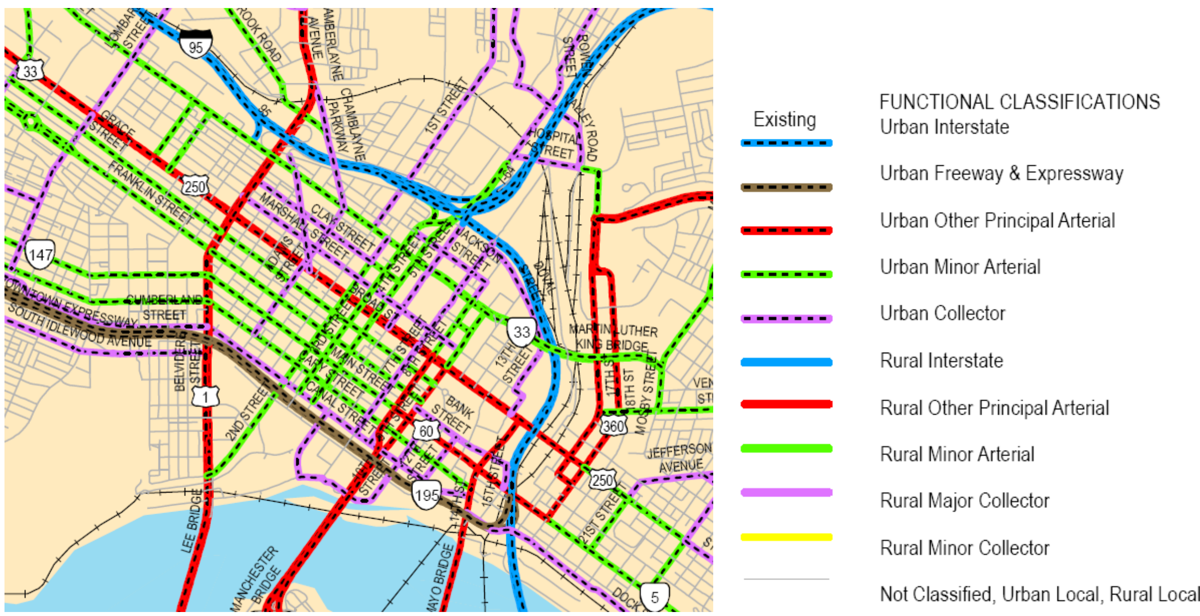
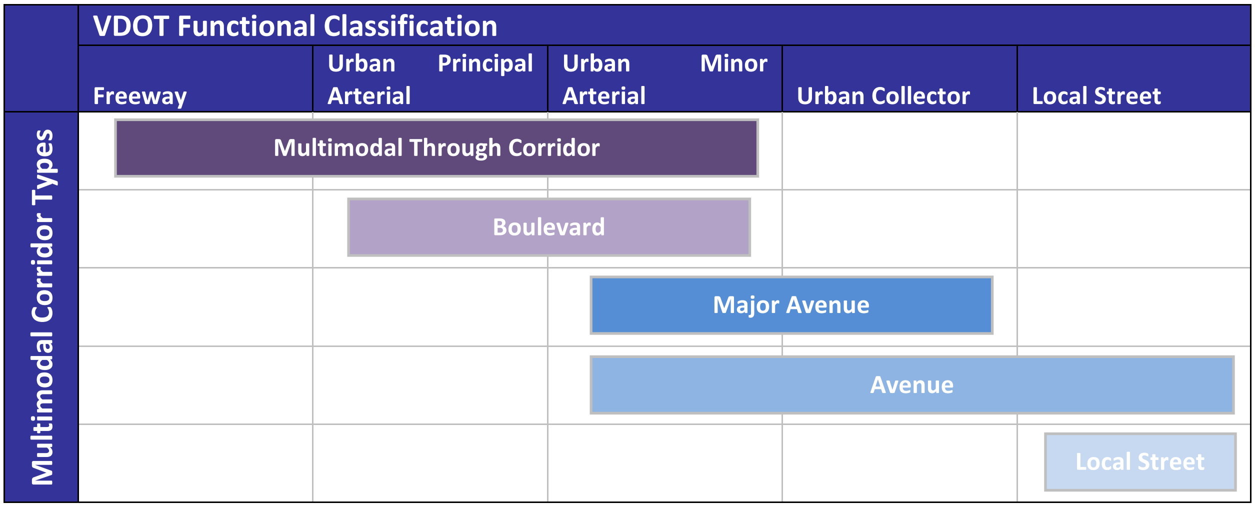


Figure B-2 – VDOT Functional Classification Example. This functional classification map of downtown Richmond illustrates that different roads are designated into different functional classes depending on the ability to provide mobility and access land. The functional classes work together as a system.

The Multimodal Corridor types within the Multimodal System Design Guidelines generally correlate to the VDOT functional classification types as illustrated in **Table B-3**.

[5] Urbanized areas are defined as areas designated by the U.S. Census Bureau having a population of 50,000 or more. Urban clusters are areas having a population of 5,000 or more and are not part of an urbanized area.

Table B-3 – Correlation of Multimodal Corridor Types and VDOT Functional Classes. The Multimodal Corridor types are similar, but not identical to VDOT functional classes. Local planners will designate Multimodal Corridor types as part of the Multimodal System Plan, to establish each corridor's multimodal role in the overall region.



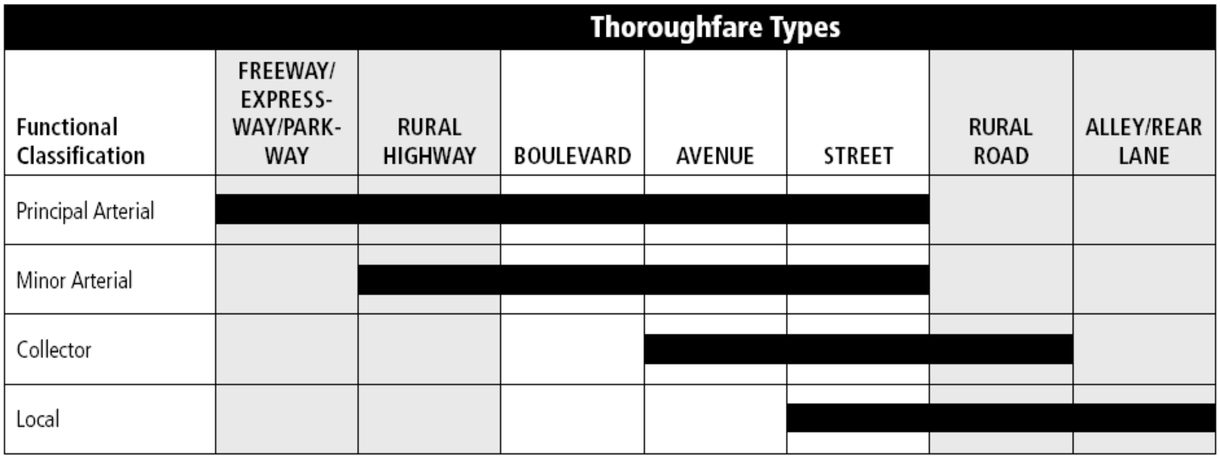
Each individual locality will determine the Multimodal Corridor type designation through the development of a Multimodal System Plan, a holistic multimodal planning process involving Multimodal Centers and Multimodal Districts as described in the Guidelines. As such, the Multimodal Corridor type correlation to the VDOT functional class is not a perfect one-to-one relationship.

VDOT uses functional classification for a variety of applications; the most relevant to the Multimodal System Design Guidelines is to determine road design and access management features. As mentioned previously, the recommended standards within the Corridor Matrix meet or exceed the VDOT Road Design standards for each corridor type and functional class.

Correlation to ITE/CNU Guidebook Corridor Types

The ITE/CNU Guidebook provides the foundation of thoroughfare types on which the Multimodal Corridor types in these Multimodal System Design Guidelines are based. These Guidelines expand upon and delve deeper into general thoroughfare typology established by ITE and CNU.

The ITE/CNU Guidebook establishes seven thoroughfare types, of which three are considered to be within walkable urban areas and thus are the focus of the ITE/CNU Guidebook. The following chart from the ITE/CNU Guidebook shows a similar relationship between thoroughfare type and functional classification, and highlights the three thoroughfare types applicable to the urban walkable thoroughfare concept (Boulevards, Avenues, and Streets).



Shaded cells represent thoroughfare types that are not addressed in this report.

Figure B-3 – ITE/CNU Thoroughfare Types & Relationship to Functional Class. The three walkable urban thoroughfare types in the ITE/CNU Guidebook are the foundational basis for the Multimodal Corridor types in these Multimodal System Design Guidelines. The Multimodal Corridor types in these Guidelines expand upon the corridor type concept to offer a more robust and flexible system for designing Multimodal Corridors. Image source: Institute of Transportation Engineers and Congress for the New Urbanism. *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach.*

The Multimodal Corridor types in these Multimodal System Design Guidelines are more expansive than the three focus thoroughfare types of the ITE/CNU Guidebook. The ITE/CNU Guidebook focuses only on medium to higher intensity context zones (Transect Zones T-3 and higher), and it specifies different parameters for areas with primarily commercial or primarily residential land uses. The Multimodal System Design Guidelines provide a larger range of Multimodal Corridor types and applicable Transect Zones, as previously discussed in the Corridor Intensity Zones section.

All Multimodal Centers should ideally have a mix of residential and commercial uses. This mix of land uses is what makes multimodal transportation viable. Origins and destinations need to be within walking distance to support walking and bicycling as viable means of transportation, even if only for a small portion of trips within a rural place. It is this mix of uses that is a key feature of a Multimodal Center. Based on this assumption, the recommended metrics in the Corridor Matrix are not dependent upon the prevailing type of land use.

Places do not need to be urban or even moderately dense to have Multimodal Centers. The *closeness* of destinations, not the *number* of destinations, is what creates a Multimodal Center. Thus even in very low density rural places, Multimodal Centers can be identified. Walkability and bikability within these low density Multimodal Centers is still possible. The Corridor Matrix includes standards for Multimodal Corridors within a broad spectrum of Transect Zones, which are applicable to all Multimodal Centers, from Urban Cores to Rural Centers.

Other Typologies of Multimodal Corridors

Since the original Multimodal System Design Guidelines were adopted in 2013, NACTO and Sidewalk Labs have developed several other corridor typologies, each unique.

- The NACTO *Urban Street Design Guide* outlines 13 different street types including Downtown Thoroughfares, Neighborhood Main Streets, Residential Shared Streets, and Green Alleys.
- The NACTO *Transit Street Design Guide* provides a typology of streets with different types of transit facilities in a variety of contexts including Downtown Shared Transitways, Offset Bus Lane Streets, Edgefront Transit Streets, Contraflow Transit Streets, and Parallel Paired Transitways, among others.
- The NACTO *Global Street Design Guide* encourages practitioners to identify a range of street typologies. It presents a list of 21 different street types ranging from Pedestrian-Only Streets to Grand Streets to Streets in Informal Areas.
- Sidewalk Labs, Alphabet Inc.'s urban innovation organization, outlines four street types – Laneways, Accessways, Transitways, and Boulevards – in *Street Design Principles*. These street types prioritize different modes, separate streets by speed, and take advantage of technological advancements to make streets narrower and safer while still getting people "where they need to go."

These new street typologies are more nuanced than the corridor types presented in these Multimodal System Design Guidelines, and they generally apply only in urban areas. The corridor types in these Guidelines span a full spectrum of context types, including suburban areas and small rural towns. The purpose of these Guidelines is to provide an overarching framework for multimodal corridor design that applies to the full range of contexts in Virginia. Practitioners working in urban contexts may find the additional street types in the NACTO guidebooks useful for a variety of different functions and contexts that only apply in urban areas.

Recommended Corridor Metrics by Context Zone

The elements of corridor design are organized into three distinct Context Zones, each of which has a unique purpose and specific design considerations. **Figure B-4** illustrates the three distinct Context Zones for these Multimodal System Design Guidelines:

1. Building Context Zone
2. Roadway Edge Zone
3. Roadway Zone

The Roadway Zone describes the space between the edges of curb, or between the edges of pavement if curb and gutter is not present. Autos, buses, and bicycles move within the Roadway Zone, and it includes on-street parking. The Roadway Edge Zone includes space for pedestrian travel, and it includes amenities for pedestrians such as buffer space, lighting, bus shelters, benches, etc. Signage, utility poles, and other features will be located within the Roadway Edge Zone. The Building Context Zone generally describes the space between the pedestrian travel way (sidewalk or shared use path) and the buildings along the street.

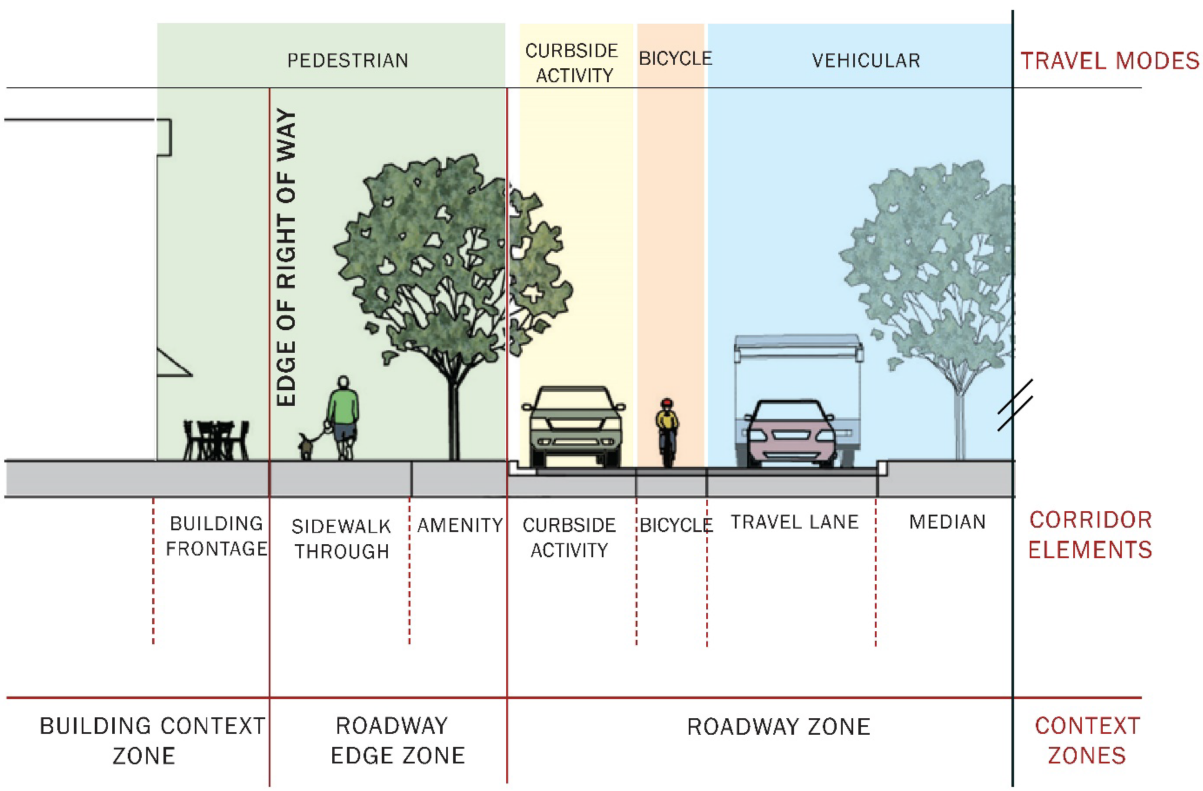


Figure B-4 – Multimodal Corridor Context Zones & Corridor Elements. The different Corridor Elements are organized into three Context Zones. Each Corridor Element can be optimized or minimized, depending on which travel modes are emphasized.

Building Context Zone

The Corridor Elements within the Building Context Zone affect how adjacent buildings 'interact' with pedestrians, bicyclists, and motorists. When this zone is small, pedestrians interact with the buildings more easily. Buildings that are closer to the sidewalk are simply easier to enter. Windows close to the sidewalk invite pedestrians to look in. Front lot parking can create conflicts between motorists who are parking and pedestrians who are entering the building or just walking by, and is therefore discouraged. This zone can include space for street activities like café tables, sidewalk sales, and other extensions of building activity. These activities should be kept within the Building Context Zone and should not encroach upon the space for the clear pedestrian travel way in the Roadway Edge Zone.

All of the elements in the Building Context Zone are usually outside of the roadway right-of-way. VDOT road design standards do not address these elements; local planners and site plan reviewers should review local ordinances for these metrics during development review. The building owner would generally be responsible for maintenance for these elements.

Table 6.4 on pages 70 to 71 in the ITE/CNU Guidebook guided the recommended metrics within the Building Context Zone portion of the Corridor Matrix. However, in some T-Zones, these setbacks were increased since the ITE/CNU standards are not clear on where the public right-of-way is located within the Building Context Zone.

A: Building Frontage Element

The Building Frontage Element is the typical width of the setback between the wall, porch, patio, or outdoor stairs of a building and the Sidewalk Through Element. Setbacks are typically specified in a locality's zoning ordinance with intention to fit within a desired streetscape design and sense of place. As such, the typical front building setbacks shown in the Corridor Matrix are simply advisory. They will vary by locality and can vary by building type.

Generally buildings in more urban multimodal areas will have retail or other non-residential uses on the first floor. Minimal setbacks provide a sense of enclosure within the streetscape and are desirable to encourage street life. Large windows next to the sidewalk draw interest from pedestrians and maintain a sense of security with 'eyes on the street'. In less intense areas, larger setbacks are suitable, especially when residential uses are on the first floor. Generally, as explained in the Off-Street Parking Location section, parking should be located in the back of buildings, not between the right-of-way and the building.

VDOT & Other Guidance

VDOT gives no guidance on building setback, as localities generally provide their own setback standards in the local zoning code. The ITE/CNU Guidebook provides maximum setbacks ranging from 0 feet to 20 feet, as shown in Table 6.4 on pages 70-71. These values do not include pedestrian lateral or shoulder clearance; that is the space needed between the edge of the clear pedestrian travelway and the edge of the building. Pedestrian lateral clearance should be a minimum of 18 inches when the edge of the building meets the sidewalk (pg. 123 in ITE/CNU). Pedestrian lateral clearance can be zero if the remaining setback includes lawn or groundcover between the sidewalk and the building edge. Twelve inches will suffice along low walls and fences and hedges; and 18 inches is necessary along facades and tall walls and fences. The ITE/CNU Guidebook includes the pedestrian lateral (shoulder) clearance in the frontage zone.

The ITE/CNU values for setbacks vary depending on whether the area is primarily commercial or primarily residential. Setbacks in commercial areas vary from 0 to 5 feet; in residential areas from 10 to 20 feet. These maximum setback values are exclusive of sidewalk frontage zone, which has a minimum of 18 inches for lateral or shoulder clearance. Table 8.1 on page 124 specifies frontage zone widths (where frontage zone is the recommended lateral or shoulder clearance) by transect. As previously mentioned, the ITE/CNU Guidebook is limited to Transect Zones T-3 and above. No guidance is provided for T-2 or T-1 zones.

Optimal Recommendations

The Building Frontage Element is most important for pedestrians; it is also beneficial for transit and for landscaping (such as for the 'Green' Modal Emphasis). Designers should use the optimal recommendations when a corridor has Pedestrian Modal Emphasis. If sufficient right-of-way exists, the optimal values for this element should also be used with Transit or Green Modal Emphasis, but not to the detriment of other Primary and Secondary Elements.

The optimal values used for the Building Frontage Element are slightly larger than the recommended values from ITE/CNU because the values in this Corridor Matrix include pedestrian lateral or shoulder clearance, and because the ITE/CNU standards are not clear on where the public right-of-way is located within the Building Context Zone. The recommended Corridor Matrix values for the Building Frontage Element represent the recommended pedestrian lateral clearance (frontage zone) plus the building setback. The minimum total setback is five feet to account for ease of construction. However, if existing buildings are built at the zero lot line, the setback for future construction should be continuous to keep a consistent line at which the building meets the sidewalk.

Minimum Recommendations & Potential Modifications

Corridors that do not have Pedestrian, Transit or Green Modal Emphasis may use the minimum recommendations for the Building Frontage Element.

In general, setbacks within the primary walk-shed (e.g. T-6 in a P-6) would be smaller than setbacks in the secondary walk-shed (e.g. T-5 in a P-6). The setback metrics may be taken as relative values. Designers may increase setbacks in secondary walk-sheds or decrease setbacks in primary walk-sheds. These values may also be modified depending on local ordinances.

Additionally, communities may wish to increase setbacks particularly in the more intense Transect Zones to allow space for café tables, retail sidewalk sale clearance racks, and other streetside items.

Location of Off-Street Parking

Generally off-street parking should be located behind or beside buildings. Building facades that open directly onto the sidewalk without parking in front are more inviting to pedestrians and have more aesthetic quality. Parking spaces in front of buildings create conflicts between pedestrians and parking vehicles, and require curb cuts which are dangerous for on-road bicyclists.

VDOT & Other Guidance

The ITE/CNU Guidebook recommends rear parking for all walkable urban thoroughfares, and allows side parking for slower streets and in less intense areas. Front parking is not recommended.

Optimal Recommendations

The Corridor Matrix recommends rear parking for all street types, including Multimodal Through Corridors. Side parking is appropriate for all Local Streets and for Major Avenues and Avenues in T-Zones T-1 through T-4. Front parking is discouraged in all circumstances.

Minimum Recommendations & Potential Modifications

Rear parking is preferable to side parking in all areas. Front parking is discouraged in all circumstances.

Typical Building Entry Locations

Buildings with front doors that face the street create a better environment for pedestrians.

VDOT & Other Guidance

The ITE/CNU guidebook recommends front access for all walkable urban thoroughfares, and allows side access for slower streets and in less intense areas.

Optimal Recommendations

The Corridor Matrix recommends front entry for all Multimodal Corridor types, including Multimodal Through Corridors. Side entry is appropriate for all Local Streets and for Major Avenues and Avenues in T-Zones T-1 through T-4. This is consistent with the recommendations for off-street parking location.

Minimum Recommendations & Potential Modifications

Front entry is preferable to side entry in all areas. Rear entry may be convenient for automobiles when parking is in the back and may be provided as a secondary entrance location. The main entry point should be along the street in front of the building.

Roadway Edge Zone

The Roadway Edge Zone describes the space between the travelway of on-road vehicles and the Building Context Zone, see **Figure B-4** shown previously on page B-14. This space is generally designed to maximize pedestrian safety and comfort. It includes the pedestrian travelway (Sidewalk Through Element) and space for streetside amenities like benches, trashcans, and newspaper boxes (Amenity Element). It also includes space where lighting fixtures and signs are placed, and provides buffer space between traveling vehicles and streetside activity.

The Roadway Edge Zone is measured from the back of curb to the outside edge of the Sidewalk Through Element (the space kept clear of obstructions for pedestrian travel). For roads without curb and gutter, the Roadway Edge Zone is typically measured from the edge of pavement.

B: Sidewalk Through Element

The Sidewalk Through Element is the space where pedestrians walk. It should be kept clear of any obstructions like utility poles, signage, trash cans, and other streetside amenities. These objects should be placed in the Amenity Element.

VDOT & Other Guidance

The Geometric Design Standards in Appendix A of the VDOT Road Design Manual specify a minimum sidewalk width of five feet for all roads with curb and gutter, and footnotes that a width of eight feet or more may be needed in commercial areas. The VDOT Road Design Manual also states that a minimum of eight feet of sidewalk is necessary when the sidewalk is placed adjacent to the curb (i.e. no buffer space) and on-street parking exists to allow vehicle doors to open and people to exit from parked vehicles without blocking the pedestrian access route (see SIDEWALKS section in Appendix A-5).

The ITE/CNU Guidebook is generally consistent with the VDOT Road Design Manual. It recommends an absolute minimum width of five feet for the pedestrian travel way in residential areas, and six feet in commercial areas (see Table 5.2 on pg. 65 in ITE/CNU Guidebook). In more intense context zones, the minimum sidewalk width increases. Avenues need more sidewalk width than Local Streets, and Boulevards need more sidewalk width than Avenues. The optimal and minimum recommendations in the Corridor Matrix are also consistent with the NACTO Urban Street Design Guide.

Optimal Recommendations

The Sidewalk Through Element is a Primary Element for Pedestrian Modal Emphasis, and a Secondary Element for Transit Modal Emphasis. This element has the highest priority in Pedestrian Modal Emphasis; optimal values should be used in corridors with Pedestrian Modal Emphasis and if possible, in corridors with Transit Modal Emphasis.

The Corridor Matrix recommends 10 feet for Boulevards and Transit Boulevards in T-6 and T-5, with widths generally decreasing to 5 feet for Local Streets in T-2 and T-1.

Shared use paths are recommended for Multimodal Through Corridors. These streets have generally higher speeds, and a shared use path will allow bicyclists to ride off-street. A shared use path is typically accompanied by wider buffer space, which will increase pedestrian comfort and safety.

Minimum Recommendations & Potential Modifications

The Corridor Matrix generally reflects the recommendations from the ITE/CNU Guidebook, and specifies an absolute minimum sidewalk width of five feet for Local Streets and Avenues, and six feet for Major Avenues and Boulevards. Major Avenues in T-1 or T-2 have a minimum width of five feet as these are in very low intense Multimodal Centers.

Multimodal Through Corridors with design speeds of 45 mph or less may use a sidewalk instead of a shared use path.

The Corridor Matrix standards for the Sidewalk Through Element may be increased wherever possible to provide more space for pedestrians. This is especially relevant for corridors within the primary walk-sheds in the more intense Multimodal Centers, as these places typically see more pedestrian travelers than in the less intense Multimodal Centers and secondary walk-sheds. This space may also be increased for plaza or other public space uses.

C: Amenity Element

The Amenity Element describes the space between the back of curb and the edge of the pedestrian travel way (Sidewalk Through Element). This space separates pedestrians from moving vehicles, and can be referred to as the buffer or planting strip. It does not include the curb, gutter pan, parked cars, bicycle lanes, or other items within the roadway. The Amenity Element is the ideal place for streetside amenities and lateral obstructions including street trees, transit stops, bicycle racks, food carts, fire hydrants, street lights, parking meters, signal control boxes, signs, and utility poles. These objects are outside of the clear pedestrian travel way and serve as a physical barrier between pedestrians and moving vehicles. Ideally the Amenity Element includes landscaping to add aesthetic quality to the streetscape and prevent pedestrians from jaywalking.

VDOT & Other Guidance

For curb and gutter urban roadways with design speeds less than or equal to 45 mph, VDOT requires a minimum of four feet of buffer space between the back of curb and the sidewalk (see Road Design Manual, Appendix A, Figure A-2-1).

VDOT does have several options to the four foot minimum for the buffer space (refer to the discussion of buffer width in the Road Design Manual, Appendix A(1)). Three feet may be appropriate when using smaller signs. If trees are to be planted in the buffer strip, it shall be a minimum of six feet wide and the trees should be planted so that the center of the trees are three feet minimum behind the back of curb. It is also important to make sure that trees will not block road signs once they reach a mature height.

Appendix B(1) Subdivision Street Design Guide in the VDOT Road Design Manual restates the six-foot minimum buffer from the back of curb for trees. Buffers without trees may be four feet wide measured from the back of curb, and for streets with a posted speed of 25 mph or slower, a three-foot buffer zone measured from the back of curb may be appropriate for smaller signs (see Figure 6 and Figure 10 in Appendix B(1).)

At intersections and driveway openings, VDOT requires a minimum lateral offset of three feet between the face of curb and obstructions to provide sufficient clearance for truck overhangs (Road Design Manual, Appendix A(1)).

The ITE/CNU Guidebook defines the space of the Amenity Element into two separate zones: the Edge Zone and the Furnishings Zone (these two terms should not be confused with the terminology of the Corridor Elements in the Multimodal System Design Guidelines Corridor Matrix). The ITE/CNU Guidebook's Edge Zone is the lateral offset, the distance between the face of curb and any lateral obstructions. The ITE/CNU Guidebook recommends a minimum of 1.5 feet for the Edge Zone, and recommends widening the Edge Zone to a minimum of 4 feet at transit stops with bus shelters to allow people with wheelchairs to maneuver in front of the shelter (see pg. 122 in the ITE/CNU Guidebook). The ITE/CNU Guidebook's recommended widths for the Furnishings Zone vary between six to eight feet; wider widths are recommended for Boulevards and narrower widths for Local Streets. The ITE/CNU Guidebook also recommends tree wells in more intense areas and areas with predominantly commercial ground floor use. Landscape strips with trees and grasses or groundcovers are recommended in more residential areas.

For shared use paths that are adjacent to roads with curb, the VDOT Road Design Manual requires a minimum separation of eight feet between the face of curb and the edge of the shared use path. The necessary separation between a shared use path and a road with shoulder and ditch (instead of curb) varies depending on travel speed. Shared use paths should be placed behind the ditch.

The optimal and minimum recommendations in the Corridor Matrix are also consistent with the NACTO Urban Street Design Guide.

Optimal Recommendations

The Amenity Element is a Primary Element for Green Modal Emphasis, and a Secondary Element for Pedestrian Modal Emphasis. It is a Contributing Element for Bicycle and Transit Modal Emphasis. Corridors with Green Modal Emphasis should always use the optimal recommendations. If possible, optimal values should be used for Pedestrian, Bicycle and Transit Modal Emphasis.

Optimal values range from nine feet to six feet for the five Placemaking corridors, to be consistent with the recommendations in the ITE/CNU Guidebook. Optimal widths for the Amenity Elements in T-Zones T-2 and T-1 are slightly wider than those in T-Zones T-6 through T3 to reflect the change in context.

The surface treatment for the Amenity Element for Placemaking Corridors in T-Zones T-6 through T-3 should typically be tree wells that provide a continuous walking surface between the Sidewalk Through Element and the back of curb. The surface treatment for Placemaking Corridors in T-Zones T-2 and T-1 should be landscaped grass, or other natural surfaces. Corridors with a Green Modal Emphasis in the higher intensity T-Zones (and no Pedestrian Modal Emphasis) may incorporate bioswales or have a landscaped surface (either grass, dirt, or such surface to treat the stormwater runoff). Corridors in the lower intensity T-Zones with a Pedestrian Modal Emphasis may have a hard surface like tree grates that pedestrians can walk on.

Multimodal Through Corridors typically have higher traffic volumes and higher speeds than Placemaking Corridors. Ideally, shared use paths would be provided on Multimodal Through Corridors to provide a safe facility for pedestrians and bicyclists that is set back from the roadway. The recommendations for the Amenity Element for Multimodal Through Corridors follow the VDOT Road Design Manual requirements and recommendations for shared use paths.

Minimum Recommendations & Potential Modifications

The minimum recommendations for the Amenity Element are six feet for all Placemaking Corridors, as this is the minimum width VDOT allows for trees. Six feet with trees (in tree wells for T-6 through T-3 and with grass for T-2 and T-1) is recommended as the minimum element because trees are desired on all Placemaking Corridors.

If trees cannot be planted because of funding or other constraints, six feet is still recommended as the minimum because communities may decide to plant trees in the future as part of a streetscaping initiative, and six feet would allow them to do so without needing additional right-of-way.

In cases of severely constrained right-of-way, designers can use the absolute minimums in the VDOT Road Design Manual, Appendix A(1). Appendix A(1) in the VDOT Road Design Manual allows a minimum buffer width of four feet for posted speeds of 25 mph or greater, and a minimum of three feet with smaller signs and posted speeds of 25 mph or less. Please note these absolute minimum buffer widths do not allow trees to be planted.

The optimal values should be used wherever possible when Green, Pedestrian, Bicycle, or Transit modal emphasis is applied. The lateral offset of the Amenity Element should be increased at transit shelters for adequate wheelchair access between the transit shelter and the back of curb. In low intensity Transect Zones like T-1 and T-2, the minimum widths may be further reduced if adequate space exists between the far edge of the pedestrian way and the property line. However, this is not recommended as buffer space for pedestrians should always be at least four feet, or three feet if the posted speed is 25 mph or less and smaller signs are used.

In instances of severely constrained right-of-way for Multimodal Through Corridors, a shared use path may not be feasible. If a sidewalk is provided, the maximum amount of buffer space should be provided between the sidewalk and the edge of road. The minimum buffer distance for Multimodal Through Corridors with sidewalk and curb is four feet. If a sidewalk is used on a Multimodal Through Corridor with shoulder and ditch, the sidewalk shall be placed behind the ditch (see VDOT Road Design Manual Appendix A(1)).

Roadway Zone

The Roadway Zone can be defined as the space from face of curb to face of curb (or between the edges of asphalt pavement if there is no curb). It includes the vehicle travel lanes, bus only lanes, bike lanes, on-street parking spaces, medians, and gutter pans. This space is where higher speed travel occurs and is usually separated from the Roadway Edge Zone by the curb.

The Placemaking Corridors within these Guidelines are assumed to have a curb and gutter design (VDOT urban road design). A shoulder design is highly discouraged for corridors within Multimodal Centers and Multimodal Districts. Drivers on curb and gutter roadways are likely to travel at slower speeds and be aware of the possible presence of pedestrians and bicyclists. A shoulder design may be appropriate only for a Multimodal Through Corridors in T-2 and T-1 transect zones, and if used should have enough buffer space between the pedestrian travel way (sidewalk or shared use path) and the vehicle travel lanes to meet VDOT's clear zone requirements.

The following sections describe the Corridor Elements within the Roadway Zone. **Figures B-5 through B-7** illustrate how the Corridor Elements fit together in a typical cross-section, and show where each Corridor Element is measured from and to. **Figure B-5** shows a cross-section with bicycle lanes and on-street parallel parking in both directions. **Figure B-6** shows bicycle lanes with no on-street parking. **Figure B-7** shows a cross-section with no bicycle lanes and no on-street parking.

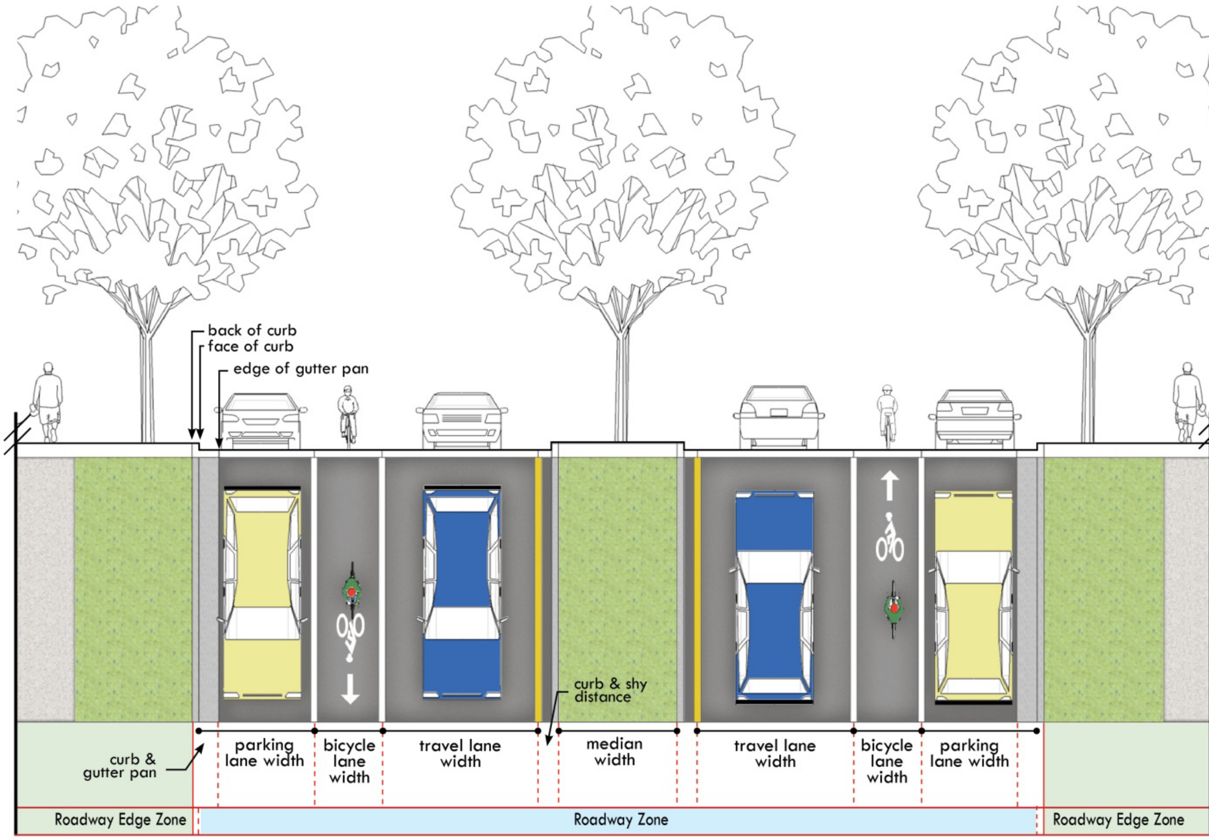


Figure B-5 - Roadway Zone Cross-Section with Bicycle Lanes and On-Street Parallel Parking. On-street parking lane widths include the width of the gutter pan.

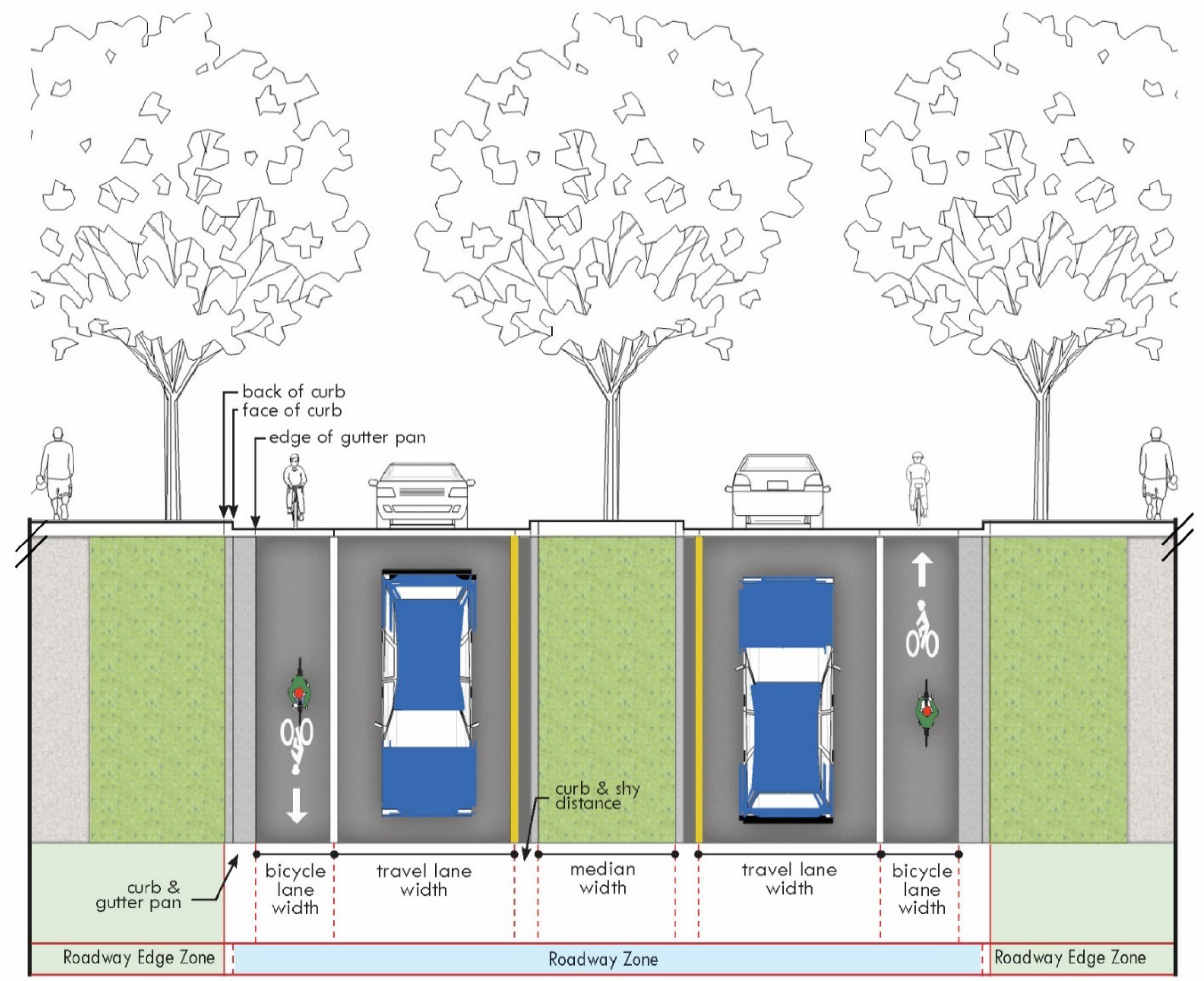


Figure B-6 – Roadway Zone Cross-Section with Bicycle Lanes and No On-Street Parking. When the bicycle lane is adjacent to the curb and gutter, the width of the bicycle lane does not include the gutter pan.

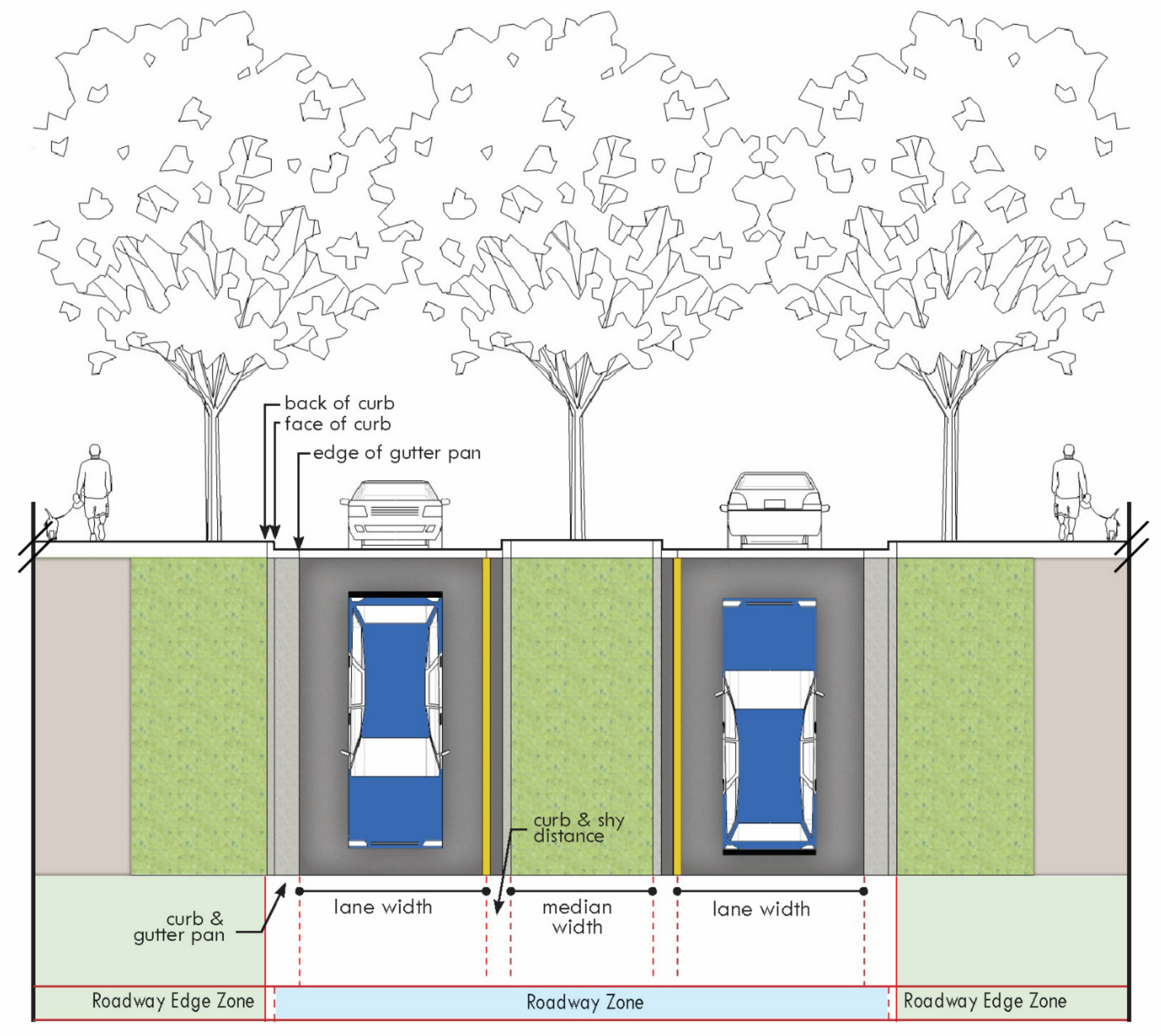


Figure B-7 – Roadway Zone Cross-Section with No Bicycle Lanes and No On-Street Parking. When the travel lane is adjacent to the curb and gutter, the travel lane width does not include the width of the gutter pan.

D: Curbside Activity Element

The Curbside Activity Element describes the space dedicated to on-street vehicle parking, bike and scooter parking, pick up and drop off, loading, and other activities at the curb. Curbside activity can contribute to a vibrant street life for a neighborhood corridor.

Curbside activity is usually desirable on lower speed roads (35 mph or less) for a variety of reasons. Local businesses prefer active use of the curb space to attract customers and facilitate smooth deliveries. Parked cars serve as a physical buffer between moving vehicles and pedestrians, increasing pedestrian safety and comfort. The most common form of curbside activity is on-street parallel parking. Other forms of curbside activity include passenger car pick-up and drop-off, bus stops, and freight delivery. In areas with a high density of activities, multiple activities may compete for limited curb space. Flex zones are a tool that allow localities to actively manage curb access to balance a variety of demands throughout the day. For example, a flex zone on a dense urban corridor can be programmed to allow loading during delivery windows, pick up and drop off during peak activity hours, and parking overnight.

Curbside activity is typically located between the curb and the vehicle travel lanes. Streets with on-street bicycle lanes can have curbside activity occurring between the bicycle lane and the curb. In this configuration, the bicycle lanes are located between the vehicle travel lanes and the curbside activity. Alternatively, parallel parking may be located in a floating lane between an on-street bike lane and a vehicle travel lane to serve as the vertical separation for a separated bike lane.

The Curbside Activity Element of the Corridor Matrix has two options:

1. Parallel Parking Only
2. Flex Zone

The optimal and minimum dimensions of the Parallel Parking Only option are appropriate in dense urban areas where other types of curbside activity (e.g. freight deliveries and passenger pick-up/drop-off) are prohibited and in less dense areas where other types of curbside activity are uncommon. The dimensions for the Flex Zone option are appropriate where a mix of curbside activities are expected and allowed to occur.

Curbside activity may not be appropriate on all streets. Opening parked car doors on the driver's side can create serious safety conflicts for on-road bicyclists in conventional bike lanes. Parking maneuvers also create conflicts for moving vehicles. On-street parking reduces the capacity of the adjacent travel lane, anywhere from three to 30 percent depending on the frequency of parking maneuvers.[6]

VDOT & Other Guidance

The Subdivision Street Design Guide (SSAR) in Appendix B(1) of the VDOT Road Design Manual specifies on-street parking should be seven feet wide on residential and mixed-use local streets, and eight feet wide on commercial and industrial streets. These values include the width of the gutter pan (see **Figure**

[6] ITE/CNU Guidebook. Pg. 146.

B-5, shown previously on page B-23). When combined with a bicycle lane, 12 feet of combined bicycle travel and parking should be the minimum for this type of shared use (see Figure A-5-1 in SHARED ROADWAYS section of Appendix A(1) in the VDOT Road Design Manual). The SSAR states that the use of curb and gutter anticipates on-street parking, and parking along streets with shoulder and ditch design is not desirable.

The ITE/CNU Guidebook recommends against providing parking for streets with speeds greater than 35 mph due to potential hazards associated with maneuvering in and out of spaces. In developing and redeveloping areas, provide the amount of on-street parking for planned, rather than existing, land use densities. Table 6.4 in the ITE/CNU Guidebook recommends a range of widths for on-street parking ranging from seven feet in less intense areas and eight feet in more dense areas.

Flexible zones are best accommodated within a 10 ft wide lane for frequent drop-off and-or delivery activities completed by a variety of different vehicle types, including trucks and shuttle buses. These activities can be accommodated within an 8-foot wide lane in cases where an existing roadway is not being reconstructed or where adjoining land use, roadway geometry, traffic volumes and or lane widths are deemed accommodating to a narrower flex zone width.[7] Successful flexible zones require data-driven planning in order to understand the range of curb demands, prioritize the right uses at the right time of day, and evaluate performance. See NACTO's white paper Curb Appeal: Curbside Management Strategies for Improving Transit Reliability for more guidance on planning flexible zones.[8]

Optimal Recommendations

The optimal recommendations are most important for corridors that have a Parking Modal Emphasis. Optimal values are also encouraged for corridors with Pedestrian Modal Emphasis as a Contributing Element.

The recommended parallel on-street parking lane widths are consistent with the VDOT and ITE/CNU guidance. Eight-foot widths are recommended for Boulevards. Major Avenues may have seven- to eight-foot widths. Seven-foot widths are appropriate for all Local Streets and for Avenues in lower intensity areas. These widths include the width of the gutter pan. The Corridor Matrix values for Transit Boulevards assume that the dedicated right-of-way for transit is located in the median, allowing space for on-street parking next to the curb without conflicting with the transit right-of-way.

Minimum Recommendations & Potential Modifications

In all cases, no on-street parking is an option in instances with constrained rights-of-way. On-street parking is appropriate for Transit Boulevards if the dedicated right of way for transit is in the median and the parking is located on the outside lanes. On-street parking is not recommended for Transit Boulevards where the dedicated right-of-way is curbside. On-street parking is also not recommended for Multimodal

[7] AASHTO, A Policy on Geometric Design of Highways and Streets, 7th edition, 2018, 4.20 On-Street Parking
[8] NACTO Curb Appeal: Curbside Management Strategies for Improving Transit Reliability, https://nacto.org/tsdg/curb-appeal-whitepaper/

Through Corridors, as the safety hazards of parking maneuvers become too great at speeds higher than 35 mph.

E: Bicycle Element

Effective bicycle networks create routes that are safe, comfortable, and easy to use. Bike facility design is a part of a broader planning process that considers a variety of factors, including traffic volume and speed, land use characteristics, and community goals. Bicycle facility design should not begin at the detailed corridor scale. As with other travel modes, planning at the **system** level is a critical first step. Cities, counties and towns usually prepare regional bicycle or greenway trail plans that provide connections throughout a region or city. When these plans are prepared, planners usually have specific facilities in mind for each corridor. The recommendations for the Bicycle Element in these Guidelines are intended to supplement, not replace, regional bicycle planning efforts.

Localities can choose from an extensive array of bicycle facilities and treatments to implement. Typical facilities for bicyclists can range from an on-street bicycle lane, separated bicycle lane, to an off-road shared use path that may or may not run parallel to a roadway. Some low speed low volume streets may be appropriate for bicycle travel without any special pavement treatment or signage. Cities across the U.S. and abroad are implementing newer and more innovative bicycle features such as bicycle boulevards, cycle tracks, contra-flow bike lanes, and shared bicycle and bus facilities. Although it is desirable to provide bicycle facilities on all streets, it is not always practical or appropriate to.

In the years following the publication of the original Multimodal System Design Guidelines, bicycle street design has significantly evolved and several new (to the United States) facility types have been implemented, evaluated, and added to design manuals. In general, bicycle design standards have become more conservative with a stronger emphasis on creating physically-separated bicycle networks that are appealing to riders of many skill levels. While older design guidance emphasized planning for different types of bicycle riders, new guidance recommends designing facilities to all bicyclists by designing for the least confident riders.[9]

NACTO published the Urban Bikeway Design Guide[10] in 2011, and updated it in 2012. It provides comprehensive guidance on where bicycle facilities might be appropriate and provides important design guidance. In 2017, NACTO published *Designing for All Ages and Abilities: Contextual Guidance for High-Comfort Bicycle Facilities*. This document provides guidance on selecting the appropriate facility type for a variety of contexts with an emphasis on design for the most vulnerable and least confident bicycle riders. In 2019, NACTO followed up this document with *Don't Give Up at the Intersection: Designing All Ages and Abilities Bicycle Crossings*, which focuses on designing intersection treatments for high-comfort bicycle lanes.

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[9] See NACTO's *Designing for all Ages and Abilities* published in 2017. https://nacto.org/wp-content/uploads/2017/12/NACTO_Designing-for-All-Ages-Abilities.pdf

[10] http://nacto.org/cities-for-cycling/design-guide/

FHWA has also released new bicycle guides in recent years. 2015's *Separated Bike Lane Planning and Design Guide* provides planning and design guidance for physically-separated bike lanes and 2019's *Bikeway Selection Guide* discusses context-appropriate bicycle facility selection. Although the NACTO and FHWA publications are not identical, the design standards and facility-selection principles set forth in both organizations' publications are overwhelmingly in agreement. The facility types and dimensions included in the Bicycle Element of the Corridor Matrix are based on the VDOT Road Design Manual as well as NACTO and FHWA bicycle design publications.

Bicycle Element Treatments in the Corridor Matrix

The 2020 update to these Guidelines features significant revisions to the Bicycle Element of the Corridor Matrix. The Bicycle Element now includes four types of facilities that provide a dedicated space for bicyclists within the roadway typical section. These four types of facilities are further defined in on the next page.

1. Non-Separated Conventional Bike Lane
2. Non-Separated Buffered Bike Lane
3. Separated Bike Lane (one-way)
4. Separated Bike Lane (two-way)

The bicycle facilities included in the Corridor Matrix are categorized into two general types of facilities, **separated bike facilities** and **non-separated bike facilities**.

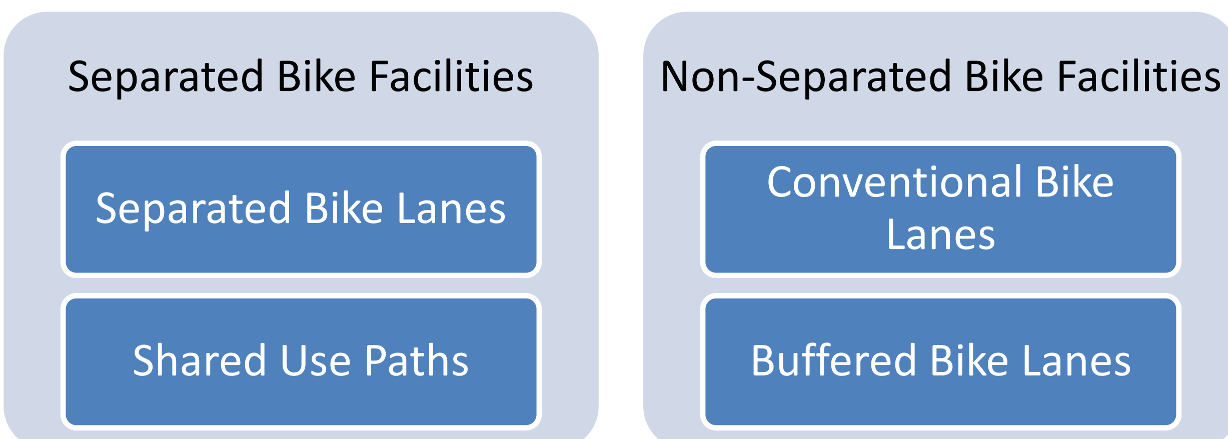

Figure B-E-8: Types of Bicycle Facilities. The Multimodal System Design Guidelines classify bicycle facilities into two general types – separated and non-separated facilities – consistent with the latest guidance from NACTO and FHWA.

<u>Separated Bike Facilities</u>

Separated bike facilities are located within or adjacent to the roadway and have both horizontal separation (i.e., additional pavement markings such as a painted buffer) and vertical separation (e.g.

flexible delineators, bollards,[11] planter boxes, raised medians, and parked vehicles) between the bike lane and the vehicle travel lane. Separated bike facilities can be located at either roadway level, sidewalk level, or at an intermediate level.

Separated bike facilities can be further classified into two subcategories:

- Separated Bike Lanes
- Shared Use Paths

Separated bike lanes (aka "cycle tracks" or "protected bike lanes") are differentiated from shared use paths by their more-proximate relationship to the adjacent roadway and the fact that they are bike-only facilities.

Non-Separated Bike Facilities

Non-separated bike facilities do not have vertical separation between the bike lane and the vehicle travel lane. Non-separated bike facilities can be further classified into two subcategories:

- Conventional Bike Lanes
- Buffered Bike Lanes

Both facility types have horizontal separation from the vehicle travel lane but do not have vertical separation. Conventional bike lanes are horizontally separated from the vehicle travel lane and/or parking lane by a 4" or 6" solid white line. Buffered bike lanes have additional horizontal separation, such as a painted buffer.

[11] VDOT does not allow planter boxes and bollards on state highways as vertical separation for bicycle facilities. Vertical elements such as planter boxes and bollards shall not be located within the clear zone of a VDOT-owned and maintained roadways.

Selecting the Appropriate Bicycle Facility Type

The optimal and minimal dimensions listed in the Matrix are intended to help practitioners quickly understand if a facility type might be feasible within a given cross section. The Matrix does not recommend one facility type over another but refers practitioners to the most-relevant guidance documents where they can learn more about facility selection and design. Facility selection is a complex planning exercise and requires a thorough understanding of physical conditions, area context, and traffic conditions. There are no hard-and-fast rules for selecting the appropriate facility type. NACTO and FHWA provide similar recommendations for facility types based on the volume and speed of vehicle traffic. Both organizations stress that this guidance is intended to be applied with flexibility alongside a robust analysis of local conditions. For more detailed guidance on bicycle facility selection, refer to the FHWA Bikeway Selection Guide and NACTO's Designing for All Ages and Abilities.

The following sections provide more information on each of the four bicycle facility types included in the Corridor Matrix.

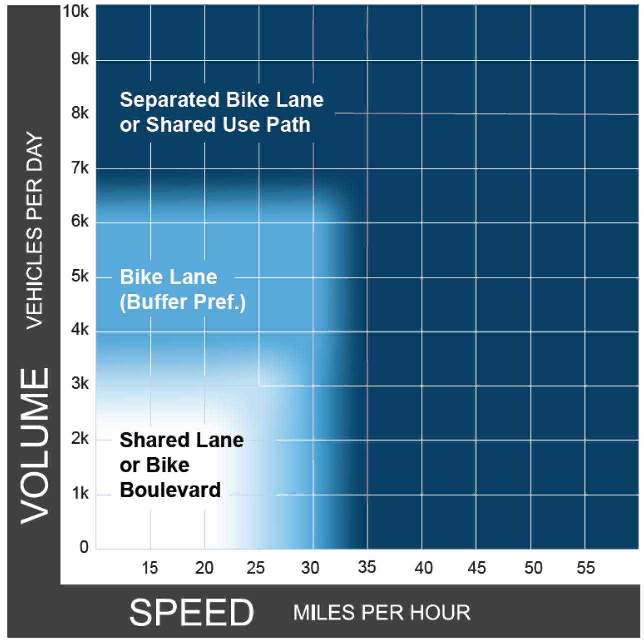

Figure B-E-9: Preferred Bikeway Types for Urban, Urban Core, Suburban and Rural Town Contexts. Image Source: FHWA Bikeway Selection Guide, 2019

Non-Separated Conventional Bike Lane

A conventional bike lane is defined as a bike lane with horizontal separation (i.e. pavement markings, such as a 4" or 6" solid white line), but no vertical separation from the vehicle travel lane and/or parking lane.

A conventional bike lane is located either:

1) adjacent to the curb with no on-street parking, or
2) in between on-street parking and a vehicular travel lane.

Figure B-E-10: Illustration of Conventional Bike Lanes. They can be located adjacent to the curb if there is no on-street parking, or adjacent to on-street parking. Image Source: NACTO Urban Bikeway Design Guide.

A bike lane located between the curb and on-street parking is not a conventional bike lane; it is a separated bike lane.

Optimal Dimensions

Without On-Street Parking

The AASHTO Bike Guide states that in most circumstances with no on-street parking, the recommended width of a conventional bike lane is 5 ft. In areas with high bicycle volumes, a width of 6 ft to 8 ft allows for bicyclists to ride side-by-side or pass each other.[12] The NACTO Bike Guide states the desirable bike lane width adjacent to a curbface is 6 ft.[13] The VDOT Road Design Manual recommends 6 ft bike lanes for streets with posted speeds of 30 to 35 mph and over 6,000 vehicles per day for roadways without on-street parking.[14]

In general, the optimal width of a conventional bike lane is 6 ft. A width of 6 to 8 feet makes it possible for bicyclists to ride side-by-side or pass each other without leaving the lane. A 5 ft wide bike lane is acceptable as an optimal condition on roads without on-street parking. However, a conventional bike lane is typically not appropriate for roads over 35 mph. The FHWA Bikeway Selection Guide indicates separated bike lanes are more appropriate facilities for roads with posted speeds above 35 mph than bike lanes without vertical separation.

With On-Street Parking

On streets where there is parallel on-street parking, conventional bike lanes are located between the vehicle travel lane and the parking lane. The proximity of the bike lane to parked vehicles introduces the risk of dooring, where a person riding a bike is struck by an opening vehicle door. Because of the potential interaction between bicyclists and drivers using the parking lane, the bicycle design guidance recommends dimensions for both the parking and bicycle lane. NACTO defines a desired "reach" from the face of the curb to the outside edge of the bike lane of 14.5 ft.[15] This translates to a 6 ft bike lane and an 8.5 ft parking lane. Similarly, the AASHTO Bike Guide recommends a 14 ft distance from curb to the outside edge of the bike lane with a 6 ft bike lane and 8 ft parking lane.[16] On streets with a narrow parking lane (7 ft) and high volume of parking movements, AASHTO recommends a 6 to 7 ft wide bike lane.

The VDOT Road Design Manual recommends 6 ft bike lanes for streets with on-street parking with posted speeds of 30 to 35 mph and 3,000 to 6,000 vehicles per day. [17] For roadways that have more than 6,000 vehicles per day and on-street parking, the VDOT Road Design Manual recommends a separated bike lane or shared use path.[18] This recommendation is consistent with the recommendations in FHWA's Bikeway Selection Guide. Separated bike lanes and shared use paths are discussed later in this document.

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[12] AASHTO Guide for the Development of Bicycle Facilities (2012), pg. 4-14
[13] NACTO Urban Bikeway Design Guide. Conventional Bike Lanes, Required Features. https://nacto.org/publication/urban-bikeway-design-guide/bike-lanes/conventional-bike-lanes/
[14] VDOT Road Design Manual, Appendix A(1) (Updated March 2020). Table A(1)-1-1
[15] NACTO Urban Bikeway Design Guide. Conventional Bike Lanes, Required Features. https://nacto.org/publication/urban-bikeway-design-guide/bike-lanes/conventional-bike-lanes/
[16] AASHTO Guide for the Development of Bicycle Facilities (2012), pg. 4-14
[17] VDOT Road Design Manual, Appendix A(1) (Updated March 2020). Table A(1)-1-1
[18] VDOT Road Design Manual, Appendix A(1) (Updated March 2020). Table A(1)-1-1

When a conventional bike lane is located between an on-street parallel parking lane and a vehicle travel lane, the optimal configuration is a 6 ft wide bike lane next to an 8 ft wide parking lane for a total reach (distance from the curb face to the edge of the bike lane adjacent to the travel lane) of 14 ft. The bike lane may be wider than 6 ft if space allows to provide more operating space for bicyclists to ride out of the area of opening vehicle doors.

The Corridor Matrix recommends an optimal bike lane width of 5 to 8 ft in order to account for a range of scenarios with and without on-street parking.

Minimum Dimensions

Without On-Street Parking

The NACTO Bike Guide states the desirable minimum rideable surface of a bike lane adjacent to a curb or longitudinal joint is 4 ft.[19] The rideable surface does not include the gutter pan. The AASHTO Bike Guide indicates a 4 ft wide bike lane can be used on extremely constrained, low-speed (45 mph or less) roadways with curbs but no gutter.[20]

When a conventional bike lane is located adjacent to the curb (i.e. there is no on-street parking between the bike lane and the curb), the minimum allowable bike lane width is 5 ft on roadways with curb and no gutter pan. On roadways with curb and gutter, a minimum of 4 ft (not including the gutter pan width) is allowed when the bike lane is adjacent to the curb and gutter pan, as illustrated in **Figures B-E-4 and B-E-5**.

[19] NACTO Urban Bikeway Design Guide. Conventional Bike Lanes, Required Features. https://nacto.org/publication/urban-bikeway-design-guide/bike-lanes/conventional-bike-lanes/

[20] AASHTO Guide for the Development of Bicycle Facilities (2012), pg. 4-15

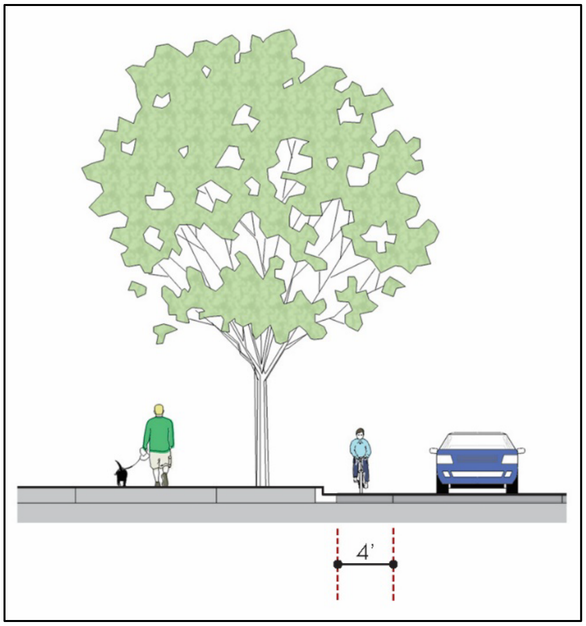

Figure B-E-4: Minimum Conventional Bike Lane Width on Roadways with Curb and Gutter, No Parking. On roadways with curb and gutter, a minimum bike lane width of 4 ft (not including the gutter pan width) is allowed when the bike lane is adjacent to the curb and gutter pan and when there is no on-street parking.

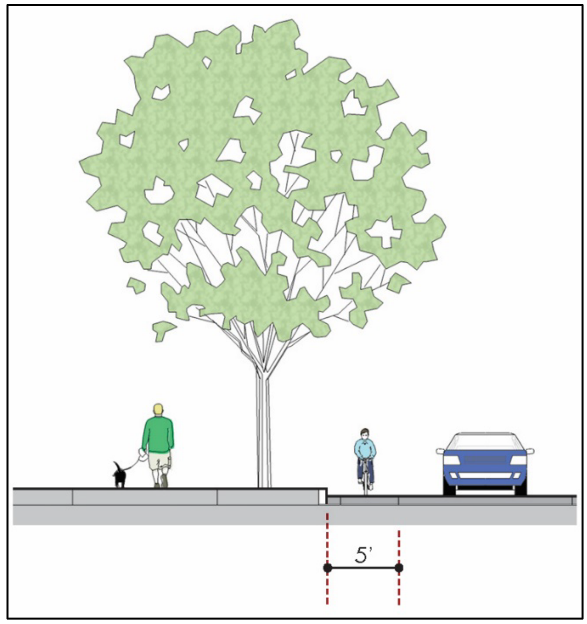

Figure B-E-11: Minimum Conventional Bike Lane Width on Roadways with Curb and No Gutter, No Parking. When a conventional bike lane is located adjacent to the curb (i.e. there is no on-street parking between the bike lane and the curb), the minimum allowable bike lane width is 5 feet on roadways with curb and no gutter pan.

With On-Street Parking

The NACTO Bike Guide recommends a minimum reach (from the curb to the outside edge of the bike lane) of 12 ft, which translates to a 5 ft wide bike lane and a 7 ft wide parking lane.[21] AASHTO states that where on-street parking is permitted, the minimum bike lane width is 5 ft and the minimum parking lane width is 7 ft for a total of 12 ft from curb to the outside of the bike lane.[22]

When a conventional bike lane is located between an on-street parallel parking lane and a vehicle travel lane, the minimum allowable configuration is a 5 ft wide bike lane next to a 7 ft wide parking lane for a minimum total reach of 12 ft. VDOT allows 7 ft wide parking lanes on residential streets, and requires 8 ft parking lanes on streets with commercial and mixed uses. **Figures B-E-6 and B-E-7** illustrate these minimum configurations with on-street parking.

[21] NACTO Urban Bikeway Design Guide. Conventional Bike Lanes, Required Features. https://nacto.org/publication/urban-bikeway-design-guide/bike-lanes/conventional-bike-lanes/

[22] AASHTO Guide for the Development of Bicycle Facilities (2012), pg. 4-16

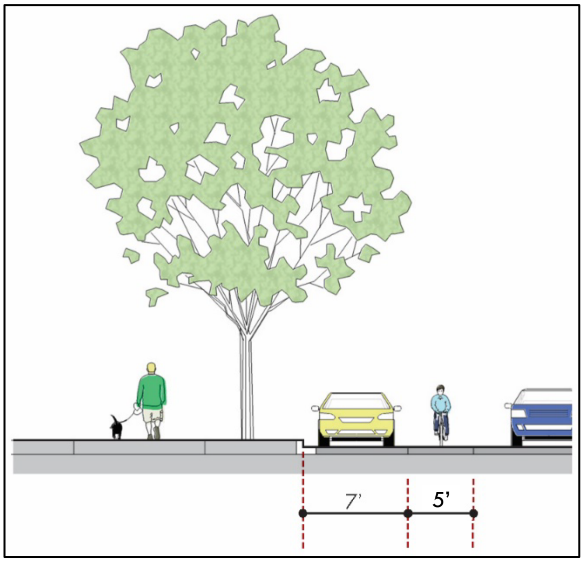

Figure B-E-12: Minimum Conventional Bike Lane Width with On-Street Parking, Residential Streets. When a conventional bike lane is located between an on-street parallel parking lane and a vehicle travel lane, the minimum allowable configuration is a 5 ft wide bike lane next to a 7 ft wide parking lane for a minimum total reach of 12 ft on residential streets.

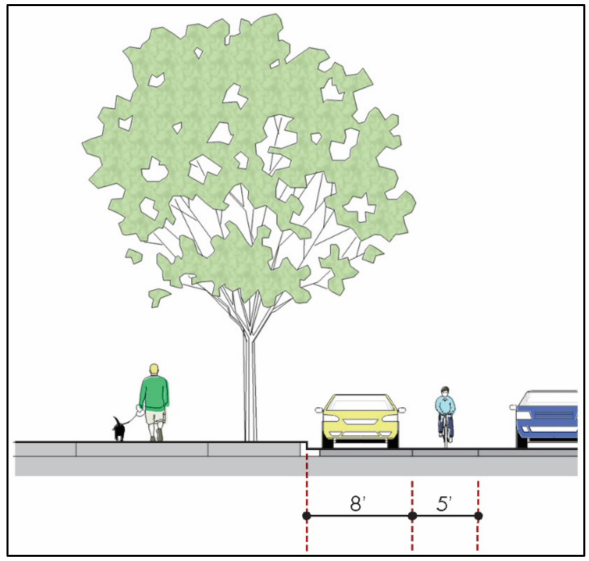

Figure B-E-7: Minimum Conventional Bike Lane Width with On-Street Parking, Commercial and Mixed-Use Streets. When a conventional bike lane is located between an on-street parallel parking lane and a vehicle travel lane, the minimum allowable configuration is a 5 ft wide bike lane next to a 8 ft wide parking lane for a minimum total reach of 13 ft on streets with commercial and mixed uses.

The Corridor Matrix recommends a minimum conventional bike lane width of 4 to 5 ft in order to account for scenarios with and without on-street parking.

Non-Separated Buffered Bike Lane

A buffered bike lane is a bike lane with additional horizontal separation between the bike lane and travel lane or parking lane. Pavement markings, such as a painted buffer, create the additional horizontal space between the bike lane and adjacent lane(s).

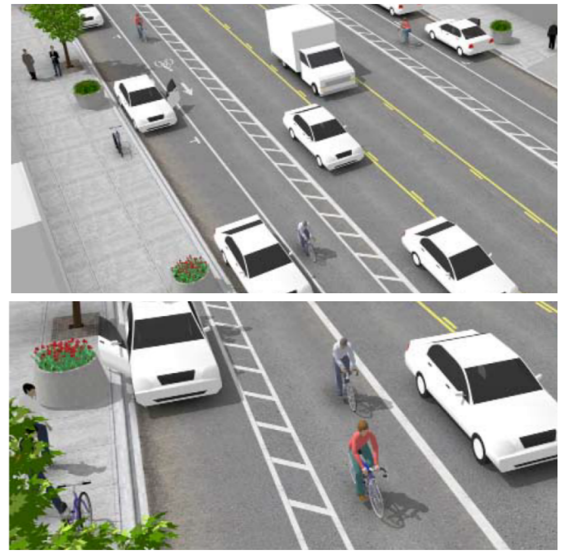

Figure B-E-8: Illustrations of Buffered Bike Lanes. Buffered Bike Lanes have additional painted buffer space between the travel lane and/or parking lane, but do not contain physical (i.e. vertical) separation from the vehicular travel lane. Image Source: NACTO UBDG.

A buffered bike lane can be located:

- adjacent to the curb with no on-street parking, or
- in between on-street parking and a vehicular travel lane.

When a buffered bike lane is adjacent to on-street parking, the buffer can be located either between the bike lane and parking lane or between the bike lane and travel lane.

A bike lane with vertical separation (e.g. bollards, flexible delineators, curbing, or on-street parking) from the vehicular travel lane is not a buffered bike lane; it is a separated bike lane.

Optimal Dimensions

Although the AASHTO Bike Guide does not provide guidance on buffered bike lanes, the NACTO Bike Guide states that the desirable width of a bike lane buffer is 3 ft.[23] Combined with NACTO's recommended bike lane width of 6 to 7 ft, the optimal width of a buffered bike lane is 9 to 10 ft.

Minimal Dimensions

The NACTO Bike Guide recommends a minimum buffer width of at least 18 inches because it is impractical to mark a zone narrower than that. For buffered bike lanes adjacent to parking, NACTO recommends a minimum bike lane width of 5 ft (not counting the buffer width) to encourage bicyclists to ride outside of the door zone.[24] To account for scenarios with and without on-street parking, the Corridor Matrix recommends a minimum buffered bike lane width of 6 to 8 ft, including the bike lane and the buffer.

[23] NACTO Urban Bikeway Design Guide. Buffered Bike Lanes, Required Features. https://nacto.org/publication/urban-bikeway-design-guide/bike-lanes/buffered-bike-lanes/

[24] NACTO Urban Bikeway Design Guide. Buffered Bike Lanes, Recommended Features. https://nacto.org/publication/urban-bikeway-design-guide/bike-lanes/buffered-bike-lanes/

Separated Bike Lane (one-way) and (two-way)

A separated bike lane is an exclusive bike facility that has both horizontal separation (i.e. additional pavement markings, such as a painted buffer) and vertical separation between the bike lane and a travel lane. Vertical separation could include flexible delineators, bollards,[25] planter boxes, raised medians, and parked vehicles.

Figure B-E-9: Illustration of a Separated Bike Lane. A bike lane located between on-street parking and the curb is a Separated Bike Lane. Image Source: NACTO Urban Bikeway Design Guide.

Separated bike lanes are exclusive bicycle facilities that combine the user experience of a separated path with the on-street infrastructure of a conventional bike lane. A separated bike lane is physically vertically separated from motor traffic and distinct from the sidewalk.

Separated bike lanes are also called "cycle tracks" or "protected bike lanes" which are different from non-separated buffered bike lanes.

When on-street parking is located between the bike lane and the curb, this arrangement is not a separated bike lane; it is either a conventional bike lane or a buffered bike lane.

A separated bike lane can be located at roadway level, sidewalk level, or in-between. A separated bike lane is composed of two parts: the bike lane where people on bikes are expected to ride, and a buffer space that either separates the bike lane from parked cars or provides a place to install vertical separation such as flexible delineators or bollards.

Separated bike lanes can operate as one-way or two-way facilities.

[25] VDOT does not allow planter boxes and bollards on state highways as vertical separation for bicycle facilities. Vertical elements such as planter boxes and bollards shall not be located within the clear zone of a VDOT-owned and maintained roadways.

Optimal Dimensions

The NACTO Bike Guide states that the desired width of a one-way cycle track (not including the buffer) is 7 ft,[26] and the recommended width of a two-way cycle track is 12 ft.[27] NACTO recommends a 3 ft wide buffer between a cycle track and on-street parking in order to prevent door collisions.[28] This translates to a total recommended width of 10 ft (7 ft lane + 3 ft buffer) for a one-way track and 15 ft (12 ft lane + 3 ft buffer) for a two-way cycle track. FHWA's Separated Bike Lane Planning and Design Guide specifies cycle track dimensions that are identical to NACTO's dimensions.

The Corridor Matrix recommends an optimal width of 10 ft (7 ft lane + 3 ft buffer) for one-way separated bike lanes and 15 ft (12 ft lane + 3 ft buffer) for two-way separated bike lanes.

Minimum Dimensions

The NACTO Bike Guide specifies a minimum one-way cycle track width of 5 ft, with a minimum buffer width of 3 ft for a total of 8 ft.[29] For two-way cycle tracks, NACTO recommends a desired minimum width of 12 ft but allows for 8 ft in constrained locations, combined with a minimum 3 ft buffer for a total of 15 ft (12 ft lane + 3 ft buffer) desired minimum and allowing a total of 11 ft (8 ft lane + 3 ft buffer) in constrained locations.[30]

The FHWA Separated Bike Lane Guide recommends the same minimum cycle track widths as NACTO but provides additional options for the separation element (i.e., the buffer space). Most types of vertical separation require a minimum 3 ft wide buffer. However, the FHWA Guide allows a minimum width of 1.5 feet if rigid bollards are used for vertical separation,[31] and 16 inches if a raised median is used for vertical separation.[32] VDOT does not allow fixed bollards on state highways for vertical separation. Fixed bollards are only an option for non-VDOT roads. On non-VDOT roads, the minimum width of a one-way cycle track is 6.5 ft (5 ft lane + 1.5 ft separation) if fixed bollards are used.

The minimum configuration for a one-way separated bike lane in most cases is a 5 ft wide bike lane with a 3 ft wide separation area for a minimum total facility width of 8 ft. On non-VDOT roads, the minimum width of a one-way separated bike lane may be 6.5 ft (5 ft bike lane + 1.5 ft separation area) if fixed bollards are used.

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[26] NACTO Urban Bikeway Design Guide. One-Way Protected Cycle Tracks, Recommended Features. https://nacto.org/publication/urban-bikeway-design-guide/cycle-tracks/one-way-protected-cycle-tracks/

[27] NACTO Urban Bikeway Design Guide. Two-Way Cycle Tracks, Recommended Features. https://nacto.org/publication/urban-bikeway-design-guide/cycle-tracks/two-way-cycle-tracks/

[28] NACTO Urban Bikeway Design Guide. One-Way Protected Cycle Tracks, Recommended Features. https://nacto.org/publication/urban-bikeway-design-guide/cycle-tracks/one-way-protected-cycle-tracks/

[29] NACTO Urban Bikeway Design Guide. One-Way Protected Cycle Tracks, Recommended Features. https://nacto.org/publication/urban-bikeway-design-guide/cycle-tracks/one-way-protected-cycle-tracks/

[30] NACTO Urban Bikeway Design Guide. Two-Way Cycle Tracks, Recommended Features. https://nacto.org/publication/urban-bikeway-design-guide/cycle-tracks/two-way-cycle-tracks/

[31] FHWA Separated Bike Lane Planning and Design Guide (2015), pg. 84

[32] FHWA Separated Bike Lane Planning and Design Guide (2015), pg. 85

The minimum configuration for a two-way separated bike lane in most cases is an 8 ft wide bike lane with a 3 ft wide separation area for a minimum total facility width of 11 ft. On non-VDOT roads, the minimum width of a two-way separated bike lane may be 9.5 ft (8 ft bike lane + 1.5 ft separation area) if fixed bollards are used.

The Corridor Matrix recommends a minimum width of 6.5 ft (5 ft lane + 1.5 ft separation if fixed bollards are used) to 8 ft (5 ft lane + 3 ft separation) for one way separated bike lanes. It recommends a minimum width of 9.5 ft (8 ft lane + 1.5 ft separation if fixed bollards are used) to 11 ft (8 ft lane + 3 ft separation) for two-way separated bike lanes. The actual minimum dimensions depend on the presence of on-street parking and the type of vertical object used to separate the bike lane from the adjacent lane.

Other Potential Bicycle Treatments Not Included in the Bicycle Element of the Corridor Matrix

Shared Lane Markings and Bicycle Boulevards

Shared lane markings and bicycle boulevard features are not included in the Corridor Matrix as bicycle facilities. Shared lane markings (aka "sharrows") are not a facility type; they are a pavement marking with a variety of uses to support a complete bikeway network.[33]

A bicycle boulevard is a local street or series of contiguous street segments that have been modified to function as a through street for bicyclists, while discouraging through automobile travel.[34] Bicycle boulevard features include pavement markings, signage, and intersection treatments often used on streets where bicyclists and motorized vehicles share a travel lane. A bicycle boulevard may have a dedicated bike lane for all or some portion of the bicycle boulevard, but many bicycle boulevards do not provide distinct vehicle lanes and bike lanes.

Shared lane markings and bicycle boulevard features may be appropriate treatment options for streets with bicycle modal emphasis discussed in the Guidelines, but these treatments are not included as separate rows in the Corridor Matrix. Readers interested in these treatments can refer to the NACTO Urban Bikeway Design Guide and the AASHTO Guide for the Development of Bicycle Facilities for design guidance.

Shared Use Paths

A shared use path is a paved surface for bicyclists and pedestrians that is physically separated from motorized vehicular traffic by a buffer strip of grass and sometimes other vegetation. Shared use paths are located beyond the edge of curb in the Roadway Edge Zone, outside of the Roadway Zone. Shared use paths are not included in the Bicycle Element of the Corridor Matrix. They are included in the Sidewalk Through Element in the Roadway Edge Zone.

[33] NACTO Urban Bikeway Design Guide. Bikeway Signing & Marking – Shared Lane Markings. https://nacto.org/publication/urban-bikeway-design-guide/bikeway-signing-marking/shared-lane-markings/

[34] AASHTO Guide for the Development of Bicycle Facilities (2012) pg. 4-33

F: Transit Element

The Transit Element describes options for accommodating and prioritizing transit vehicles within the street right of way. The accommodations range from a shared travel lane with general traffic to dedicated transit-only lanes. Street designers should consider transit performance, traffic characteristics, and street context when choosing the appropriate transit treatment. The VDOT Road Design Manual provides standards for the design of bus turnouts, bus loading zones, and bus stops. In 2016, NACTO published the Transit Street Design Guide, which provides design recommendations for a broad range of transit street elements on urban streets, including bus stops and stations, bus-only lanes, intersection treatments, and signal strategies. An additional resource for designing transit street design is the AASHTO Guide for Geometric Design of Transit Facilities on Highways and Streets. The design recommendations in both guides are largely compatible but the NACTO guide focuses primarily on urban streets while the AASHTO guide deals with streets in suburban and rural contexts.

Bus stop location and design affects bus performance and pedestrian access to the bus. Bus stops should be located near major trip generators and spaced in a way that balances bus speed (fewer stops) with passenger access (more stops). In most locations, it is best to place bus stops on the far side of an intersection to minimize conflicts with right-turning vehicles and reduce bus signal delay. Locating stops at intersections is typically preferred to mid-block because this gives bus riders more routing options to access the bus. Buses can stop at the curb, a bus bulb or island, or a bus bay (sometimes called a lay-by). Curbside stops are the most common type of bus stop, but bus bulbs and islands can enhance pedestrian access to the bus as well as bus performance. Some localities have begun installing temporary bus bulbs and islands which can be designed and installed on a shorter time frame and at a lower cost than concrete bus bulbs. Bus bays should be avoided in most cases but can be appropriate on certain higher-speed streets. See the AASHTO Guide for Geometric Design of Transit Facilities on Highways and Streets page 5-9 for more guidance on bus stop design.

Some multimodal corridors in dense urban areas attract relatively high bike and bus volumes. In recent years, there has been an increase in interest in combined bus-bike facilities. The NACTO Transit Street Design Guide cautions practitioners considering this treatment as a bus-bike lane is not considered a high-comfort bike facility and is not appropriate at high bus volumes.[35] Another potential point of conflict between buses and bikes is bus stops. The FHWA Separated Bike Lane Guide provides several bus-stop design options that maximize pedestrian access to the bus and bicyclist safety and comfort.[36]

[35] See NACTO Transit Street Design Guide, Shared Bus-Bike Lane, https://nacto.org/publication/transit-street-design-guide/transit-lanes-transitways/transit-lanes/shared-bus-bike-lane/

[36] FHWA Separated Bike Lane Planning and Design Guide, Pg. 93-96

VDOT & Other Guidance

Transit vehicles can operate in a shared lane with general traffic or a dedicated transit lane that is allocated to the exclusive use of transit. Shared transit lanes are appropriate on streets with low to moderate traffic congestion where transit can operate reliably with minimal delay. Planners may consider dedicated transit lanes on streets where traffic conditions degrade transit performance leading to slow and unreliable transit service. NACTO's Transit Street Design Guide describes a variety of dedicated transit lane types, including a curb-side lane, offset lane, center lane, and exclusive transit way.[37] Although transit lane design is highly dependent on context, NACTO generally recommends a minimum lane width of 10 ft and an optimal width of 11 to 12 ft (up to 13 ft if providing a physical barrier between the dedicated transit lane and general travel lane). The Corridor Matrix adopts VDOT's minimum lane width of 11 ft for a shared or dedicated transit lane, but a 10 ft dedicated transit lane may be acceptable on roads that are not owned and maintained by VDOT. The Corridor Matrix provides general guidance on the right of way width required to accommodate shared and dedicated transit lanes as well as issues to consider when choosing between shared and dedicated lanes but does not recommend an optimal transit lane type as the ideal design varies depending on local variables.

[37] See NACTO Transit Street Design Guide, Transit Lanes & Transitways, https://nacto.org/publication/transit-street-design-guide/transit-lanes-transitways/

G: Travel Lane Element

The Travel Lane Element in the Corridor Matrix contains more information than the other corridor elements. Optimal and minimum lane widths are provided for each Multimodal Corridor type and Transect Zone, as well as a range of appropriate design speeds, number of through lanes, and typical daily traffic volumes.

The first four rows of the Travel Lane Element have a white background – these are the recommendations for each Multimodal Corridor Type and Transect Zone in the Multimodal System Design Guidelines.

Subsequent rows have a grey background. These rows compare the guidance on optimal and minimum lane widths, design speeds, and number of through lanes from three sources:

1. The VDOT Road Design Manual, revised in July 2019
2. The 7th Edition of the AASHTO Green Book, published in 2018
3. the NACTO Urban Street Design Guide, published in 2013

These three resources have different ranges for lane widths, design speeds, and number of through lanes. This guidance was considered and incorporated into the recommendations, and it is provided separately for additional reference.

Lane Width

The Travel Lane Element describes the width of each travel lane for motorized vehicles. Lane width influences the speed at which vehicles will drive. Typically lane width is determined by the design speed of a roadway. Traditionally, designers and engineers consider wider lanes to be safer, as vehicles have more room to self-correct before going outside of the travel lane. However, this 'overdesign' results in vehicles driving faster, which creates more severe safety problems when crashes do occur.

VDOT & Other Guidance

The VDOT Road Design Manual Appendix A contains minimum lane widths for each functional class based on minimum design speed. The minimum lane width for urban arterials and collectors is 12 feet if the design speed is 50 mph or greater and 11 feet if the design speed is 45 mph or lower. If heavy truck traffic is anticipated, 12-foot widths are recommended even if the design speed is 45 mph or lower. Similarly roads with design speeds of 50 mph or greater may have 11-foot widths if there are restrictions on truck traffic. Urban local streets have a minimum lane width of 10 feet. Urban collector streets may have 10 foot lane widths under the following conditions (see Table 6-5 in AASHTO's *A Policy on Geometric Design of Highways and Streets*, 7th Edition, published in 2018):

a) Design speed is 50 mph or less and traffic volumes are less than 400 vehicles per day
b) Design speed is 30 mph or less and traffic volumes are less than 2,000 vehicles per day

Lane widths in the VDOT Road Design Manual do not include the curb and gutter (See VDOT Road Design Manual Appendix A).

The 2018 AASHTO Green Book provides ranges of allowable lane widths for each functional class and context class. These elements are different for roads in rural and urban areas.

- For Urban Arterials (Section 7.3.3.2 in the 2018 AASHTO Green Book):
  - Lane widths of 10 ft may be used in more constrained areas where truck and bus volumes are relatively low and speeds are less than 35 mph.
  - Lane widths of 11 ft are used extensively for urban arterial street designs.
  - Lane widths of 12 ft are desirable on high-speed free-flowing principal arterials.
  - Under interrupted-flow operating conditions at low speeds (45 mph or less), narrower [than 12 ft] lane widths are normally adequate and have some advantages. An 11-ft lane width is often adequate for through lanes.
  - If substantial truck or bus traffic is anticipated, additional lane width may be desirable.

- For Urban Collectors (Section 6.3.2.1 in the 2018 AASHTO Green Book):
  - Lanes should range from 10 to 12 ft in width.
  - Lanes may be 12 ft wide in industrial areas, and 11 ft wide in cases where space within the right-of-way is limited.

- For Urban Local Streets (Section 5.3.2.1 in the 2018 AASHTO Green Book):
  - Lanes for moving traffic should be 10 to 11 ft wide, and 12 ft wide in industrial areas.
  - In areas where right-of-way is severely limited, 9-ft lanes can be used in residential areas, and 11-ft lanes can be used in industrial areas.
- For Arterials in Rural Areas (Section 7.2.3.1 in the 2018 AASHTO Green Book):
  - Lane widths are not explicitly provided, but Table 7-3 indicates the minimum widt of the traveled way (assuming one lane in each direction)

The discussion of roadway width for rural arterials does not address arterials in the rural town context. It assumes arterials in rural areas have shoulders, not curb. The Matrix recommends 11-10 ft lanes for Boulevards in all transect zones, based on the guidance from Section 7.3.3.2.

The NACTO Urban Street Design Guide indicates lane widths of 10 feet are appropriate for all street types in urban areas and have a positive impact on a street's safety without impacting traffic operations. The NACTO Guide recommends lanes greater than 11 feet should not be used as they may cause unintended speeding and assume valuable right-of-way at the expense of other modes. The NACTO Guide indicates cities may choose to use 11-foot lanes on designated truck and bus routes, but this is limited to one lane 11-foot lane per direction. Lane widths of 10 feet are recommended in all other instances.

The NACTO Urban Street Design Guide is specific to urban contexts and most closely aligns with the T-6, T-5, and T-4 transect zones. The degree of urbanism displayed in the NACTO Urban Street Design Guide is not closely consistent with the T-3 transect zone densities. While the T-3 transect zone is correlated to the AASHTO urban context, it is considered to be on the edge of the urban/suburban divide. The descriptions and photo example of the urban context in the 2018 AASHTO Green Book indicate a lesser urban environment than the illustrations provided in the NACTO Urban Street Design Guide.

The ITE/CNU Guidebook acknowledges that lane width will vary and provides a number of useful design considerations (see pg. 137 in ITE/CNU Guidebook). Most thoroughfare types can effectively operate with 10- to 11-foot wide lanes, with 12-foot lanes desirable on higher speed transit and freight facilities. The

ITE/CNU Guidebook recommends 10- to 11-foot lane widths for all corridor types in all areas, except in C3 and C4 commercial boulevards, where 10- to 12-foot lane widths are recommended.

Optimal Recommendations

The Travel Lane Element is a Primary Element for Transit Modal Emphasis. For all other modes, it is a Non-Contributing Element. 12-foot lanes are appropriate for corridors with transit routes or heavy truck traffic. Twelve-foot lanes should *only* be used when a corridor has a Transit Modal Emphasis, or serves as a major freight route. All other Multimodal Corridors should use the minimum recommended lanes widths, as specified in the Corridor Matrix.

Minimum Recommendations & Potential Modifications

The recommended lane widths in the Corridor Matrix meet VDOT guidelines and comply with the AASHTO standards. The Corridor Matrix recommends 10 to 11 feet for Local Streets and 11 feet for Avenues, Major Avenues, and Boulevards. The Corridor Matrix recommends 11 feet for Multimodal Through Corridors in transect zones T-6 through T-3, and 12 feet in T-2 and T-1 zones.

Readers are encouraged to refer to the relevant sections of the 2018 AASHTO Green Book provided on the previous page for more guidance on lane widths.

Design Speed

Vehicle speed is the most influential factor in roadway design. In the conventional road design process, designers select a minimum design speed. The minimum design speed determines most of a roadway's physical characteristics including horizontal and vertical curvature, stopping sight distance, lane width, buffer (or shoulder) width, slope, bridge widths and vertical clearances, etc. Design speed is a function of roadway classification (rural or urban; arterial, collector, or local) and terrain (level, rolling, or mountainous). In traditional roadway design, designers will design the road for the minimum design speed and post the speed limit at usually five to ten miles per hour slower than the minimum design speed. Designers are traditionally encouraged to select the minimum design speed to be as high as practical. This conventional approach leads to 'overdesigning' roadways to be able to go faster than the posted speed. While it reduces the crash rate for vehicles going over the posted speed, it also encourages more vehicles to drive faster than the posted speed.

Target speed is the anticipated operating speed of a roadway, and the basis for the selection of the design speed. In the traditional road design process, target speed and design speed are assumed to be the same without much if any discussion, and usually set to five miles per hour higher than the expected posted speed limit. Recent developments in the road design process, particularly in Context Sensitive Solutions[38] projects, have included the determination of target speed as a discussion amongst all involved stakeholders including community members to ensure that the anticipated operating speed is appropriate

[38] Context Sensitive Solutions (CSS) is a type of design process that is more collaborative and interdisciplinary than the traditional road design processes. CSS involves all stakeholders in providing a transportation facility that fits its setting to encourage all community members early and continuously throughout the process.

for the land use context and safe for pedestrians and bicyclists. The term 'target speed' simply implies that the selection of this speed has been agreed upon by stakeholders and not just assumed. For the purposes of selecting the physical design elements of the roadway, target speed is equal to design speed.

Posted speeds for newly constructed high speed roads are typically set to five miles per hour below the design speed. Occasionally, communities may perform a speed study to see if the current posted speed is appropriate, and change the posted speed to match the 85th percentile speed from the speed study.

When designing slower speed roads (generally 45 mph or less), designers may assume the anticipated posted speed will be the same as the minimum design speed. Road design projects that involve the selection of target speed usually result in the purposeful selection of the same speed for the target speed, design speed, and posted speed. Once a road is constructed, communities may decide to post the speed limit lower than a roadway's design speed for a variety of safety and community benefits. Posted speeds may be lower than design speeds.

VDOT & Other Guidance

The Geometric Design Standards in the VDOT Road Design Manual Appendix A provide a range of appropriate design speeds for each functional classification and terrain type. Design speeds for Urban Arterials generally range from 40 to 60 mph and occasionally may be as low as 25 mph. The lower (40 mph and below) speeds apply in the central business district and intermediate areas. The higher speeds are more applicable to the outlying business and developing areas." Design speeds for Urban Collectors range from 25 mph to 50 mph. Urban local streets have design speeds ranging from 20 to 30 mph. Urban freeway design speeds range from 50 to 70 mph. In 2011, VDOT instituted IIM-LD-117 which allows the posted speed to equal the design speed on facilities with a minimum design speed of 45 mph or less, which is consistent with the target speed concept.

Table B-4 – Design Speeds & VDOT Functional Classes. The Geometric Design Standards in Appendix A of the VDOT Road Design Manual specify a range of design speeds for each functional class.

<table>
<tr><th rowspan="2"></th><th></th><th colspan="6">VDOT Design Speed Range</th></tr>
<tr><th>20 mph</th><th>25 mph</th><th>30 mph</th><th>40 mph</th><th>50 mph</th><th>60 mph</th><th>70 mph</th></tr>
<tr><td rowspan="5">VDOT Functional Classification</td><td colspan="3">Urban Local Street</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="4">Urban Collector</td><td></td><td></td></tr>
<tr><td></td><td colspan="5">Urban Minor Arterial</td><td></td></tr>
<tr><td></td><td colspan="5">Urban Other Principal Arterial</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="3">Urban Freeway</td></tr>
</table>

The 2018 AASHTO Green Book provides general ranges of design speeds for each functional class and context class. These elements are different for roads in rural and urban areas.

- For Urban Arterials (Section 7.3.2.1 in the 2018 AASHTO Green Book):
  - Design speeds in the urban core context are generally 30 mph or less.
  - Design speeds in the urban context typically range from 25 to 35 mph.
  - Design speeds in the suburban context generally range from 30 to 55 mph.
- For Urban Collectors (Section 6.3.1.1 in the 2018 AASHTO Green Book):
  - Design speeds in the urban core context should be in the range from 25 to 35 mph.
  - Design speeds in the urban context should be in the range from 30 to 40 mph.
  - Design speeds in the suburban context should generally be in the range from 35 to 50 mph.
- For Urban Local Streets (Section 5.3.1.1 in the 2018 AASHTO Green Book):
  - Design speeds ranging from 20 to 30 mph may be used.
- Within the Rural Town context:
  - Design speeds for arterials in the rural town context range from 20 to 45 mph (Section 7.2.2.1).
  - Design speeds of 45 mph and below are generally applicable to collectors in rural town contexts (Section 6.2.1.1)
  - Section 5.2.1.1 covers design speeds for local roads in rural areas, but the rural town context is not mentioned.

The NACTO Urban Street Design Guide[39] provides an extensive discussion on design speeds. It recommends the 85th percentile of observed target speeds should fall between 10-30 mph on most urban

[39] https://nacto.org/publication/urban-street-design-guide/design-controls/design-speed/

streets. It indicates the maximum target speed for urban arterial streets is 35 mph, and the maximum target speed for urban collector or local streets is 30 mph.

The ITE/CNU Guidebook recommends basing thoroughfare design on target speed. The ITE/CNU Guidebook recommends target speeds of 25 to 35 mph for the thoroughfare types it describes, which generally include all of the corridor types except the Multimodal Through Corridor. The ITE/CNU Guidebook recommends a 25 mph target speed for all local streets, a range of 25 to 30 mph for avenues generally, and a range of 25 to 35 mph for boulevards. Note, these recommendations from the ITE/CNU Guidebook are slightly different from the design speed recommendations in the Corridor Matrix in Appendix A of these Multimodal System Design Guidelines.

Recommended Metrics

The design speeds recommended in the Corridor Matrix are based on the theoretical approach of the ITE/CNU Guidebook and are consistent with the VDOT Road Design Manual, and generally consistent with the NACTO and AASHTO guidance. These speeds should be considered both the design speed and also the posted speed, although communities may choose to post speed limits lower than the design speeds. The values for design speed were based on the target speed recommendations in the ITE/CNU Guidebook. These are generally at the lower end of the design speeds from the VDOT Road Design Manual which says that roads in central business districts should have slower design speeds.

The ITE/CNU recommendation for the 25 mph lower end of the design speed range for Boulevards and Major Avenues is not consistent with the VDOT Road Design Manual, which states the lowest acceptable design speed for collectors and arterials is 30 mph. The design speeds in the Corridor Matrix have a smaller range but are acceptable to both the ITE/CNU Guidebook and the VDOT Road Design Manual.

Design speeds for Multimodal Through Corridors are higher than the other corridor types. The ITE/CNU Guidebook does not provide recommendations for this type of corridor. Because this corridor type is focused on moving higher volumes of traffic at higher speeds, the design speeds are higher than the other corridor types. In Transect Zones T-4 through T-6, 45 mph is recommended as the upper limit because of the higher number of pedestrians and bicyclists and the closeness of buildings to the street. However, pedestrian and bicycle travel can still be safely and comfortably accommodated on a 55 mph speed corridor in Transect Zones T-1 through T-3 with the recommended facilities in the Roadway Edge Zone Including a shared use path and wide buffer zone.

Table B-4 shows the design speeds for each Multimodal Corridor type and compares them to the design speeds of the VDOT functional classes for clarity.

Table B-5 – Comparison of VDOT Functional Classes to the Multimodal Corridor Types with Design Speeds. The design speeds for each Multimodal Corridor type fit within the range of appropriate design speeds of the VDOT functional classes. The design speeds of all five Placemaking Corridor types are 35 mph or slower.

<table>
<tr><th rowspan="2"></th><th colspan="5">VDOT Functional Classification (Design Speed)</th></tr>
<tr><th>Interstate, Freeway, or Expressway (50 – 70 mph)</th><th>Urban Other Principal Arterial (25 – 60 mph)</th><th>Urban Minor Arterial (25 – 60 mph)</th><th>Urban Collector (25 – 50 mph)</th><th>Local Street (20 – 30 mph)</th></tr>
<tr><td rowspan="5">Multimodal Corridor Types (Design Speed)</td><td colspan="2">Multimodal Through Corridor (35-55 mph)</td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="2">Boulevard (25-35 mph)</td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="2">Major Avenue (25-35 mph)</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Avenue (25-30 mph)</td></tr>
<tr><td></td><td></td><td></td><td></td><td>Local Street (25 mph)</td></tr>
</table>

See Road Design Manual, Appendix A for geometry design criteria based on Design Speed. Posted Speed = Design Speed when Design Speed is 45 mph or less. Roadway (Street) can be posted less than the Design Speed.

Potential Modifications

Exceptions to the design speeds are not recommended. The design speeds in the Corridor Matrix specifically represent reasonable vehicular speeds that balance the needs for all road users. Access management techniques are recommended to reduce delay rather than the selection of a higher design speed. By following the comprehensive multimodal planning process described in the Multimodal System Design Guidelines, communities will outline networks for each mode that ensure a balance of mobility for all travelers.

Number of Through Lanes

The number of through lanes has a large effect on the character of a corridor. Fewer through lanes are generally desirable for streetside activities, and are generally safer for pedestrians, bicyclists and vehicles. Roads with fewer lanes take less time for pedestrians to cross, and passing maneuvers are minimized. More lanes provide more vehicular capacity, but also increase noise and potential safety hazards.

VDOT & Other Guidance

According to the VDOT Road Design Manual, capacity analysis of traffic data will determine the number of through lanes necessary for operation at a satisfactory level of service.[40]

[40] VDOT Road Design Manual. Chapter 2B, Section 2B-3: Determination of Roadway Design.

The 2018 AASHTO Green Book indicates:

- For Urban Arterials, the typical range of number of lanes is four to eight through lanes in both directions of travel combined. (Section 7.3.3.4)
- For Urban Collectors, two traffic lanes are mostly sufficient. (Section 6.3.2.2)
- For Urban Local Streets, one unobstructed moving lane must be provided. The lack of two moving lanes causes remarkably low user inconvenience in areas with mostly single-family residential areas. In multi-family residential areas, a minimum of two moving traffic lanes to accommodate opposing traffic may be desirable. (Section 5.3.2.2)

The ITE/CNU Guidebook provides a range for each thoroughfare type. Four to six lanes are recommended for all Boulevards, two to four lanes are recommended for all Avenues, and two to four lanes are recommended for local streets in C6, C5, and C4 commercial areas, and two lanes are recommended for local streets in C4 residential and C3 areas.

The ITE/CNU Guidebook recommends weighing a number of different factors when determining the number of through lanes. These factors include community objectives, thoroughfare type, long-range transportation plans, and corridor-wide and network capacity analysis.

Recommended Metrics

The recommended number of through lanes in the Corridor Matrix includes both directions of travel. A road with four to six through lanes would have two to three lanes in each direction. These values do not include bus-only lanes, bike lanes, or parking lanes. The recommended values are consistent with the ITE/CNU Guidebook.

Typical Traffic Volume Range

Average annual daily traffic (AADT) volumes indicate how many vehicles use a road on a daily basis.

VDOT & Other Guidance

Table 6.4 in the ITE/CNU Guidebook provides a typical traffic volume range for each Multimodal Corridor type to help determine the characteristics of thoroughfares.

Recommended Metrics

The volume ranges provided in the Corridor Matrix are adapted from Table 6.4 in the ITE/CNU Guidebook, with a finer range to distinguish between the corridor types. This range is provided to give an idea of the typical usage of a facility and compare to other roadways with similar AADTs.

Potential Modifications

The AADT ranges provided are not intended to serve as upper or lower bounds for design. Instead they are simply provided for comparison. Traffic volumes widely vary on all Multimodal Corridor types.

G: Medians

Medians can be designed to enhance the aesthetic value of a corridor with landscaping and trees thereby increasing the urban green canopy, and provide a buffer between multiple travel lanes, and are especially important for pedestrians on high speed roads.

Medians can provide pedestrian refuge at intersections when crossing multiple travel lanes. However, medians also increase the distance a pedestrian must travel to cross from one side of the road to the other. Depending on the design of the signal phasing and timing, the increase in pedestrian crossing time can increase the green time for side-streets, which in turn may take away green time from the mainline movements at an intersection. Medians have both positive and negative tradeoffs and the effects for all travel modes should be considered when designing the corridor cross-section.

VDOT & ITE/CNU Guidance

Section 2E-3 Detailed Plan Design of the VDOT Road Design Manual discusses medians from the perspective of motor vehicle safety. Generally, wider medians are better in rural contexts and narrower medians are preferred in urban contexts. The VDOT Road Design Manual states that raised medians should have a minimum width of four feet, with one foot offset from the through lane edge in each direction, but four feet is not suitable for use as a pedestrian refuge. When the raised median's primary purpose is to provide space for left turn storage, the minimum width of the median is the required lane width plus four feet, with one foot on either side. Six feet from back-of-curb to back-of-curb is the minimum width for a median that is to be used as a pedestrian refuge. Six feet provides adequate space for two two-foot detectable warning surfaces (truncated domes) with two feet of flat surface in the middle where pedestrians who are visually impaired can detect that they are in a safe space (see **Figure B-G-1**). The minimum width for planting street trees is six feet. The VDOT Road and Bridge Standards provide more detailed specifications for median and refuge island applications (see Section 200: Curbs, Median, and Entrances).

The ITE/CNU Guidebook recommends that wherever medians are provided at intersections, they should be at least six feet wide to accommodate groups of pedestrians for refuge. Median width should not exceed 18 feet to keep streets compact and pedestrian-scaled. Table 6.4 in the ITE/CNU Guidebook recommends no medians on Local Streets, optional medians for Avenues, and medians with four to 18 foot widths for Boulevards. Continuous medians that narrow at intersections to provide left turn lanes should be 16 to 18 feet wide to allow for a turn lane (10 to 12 feet wide) plus a pedestrian refuge (six feet wide). Additionally, road designers must include one foot on either side of the median between the curb and the road stripe.

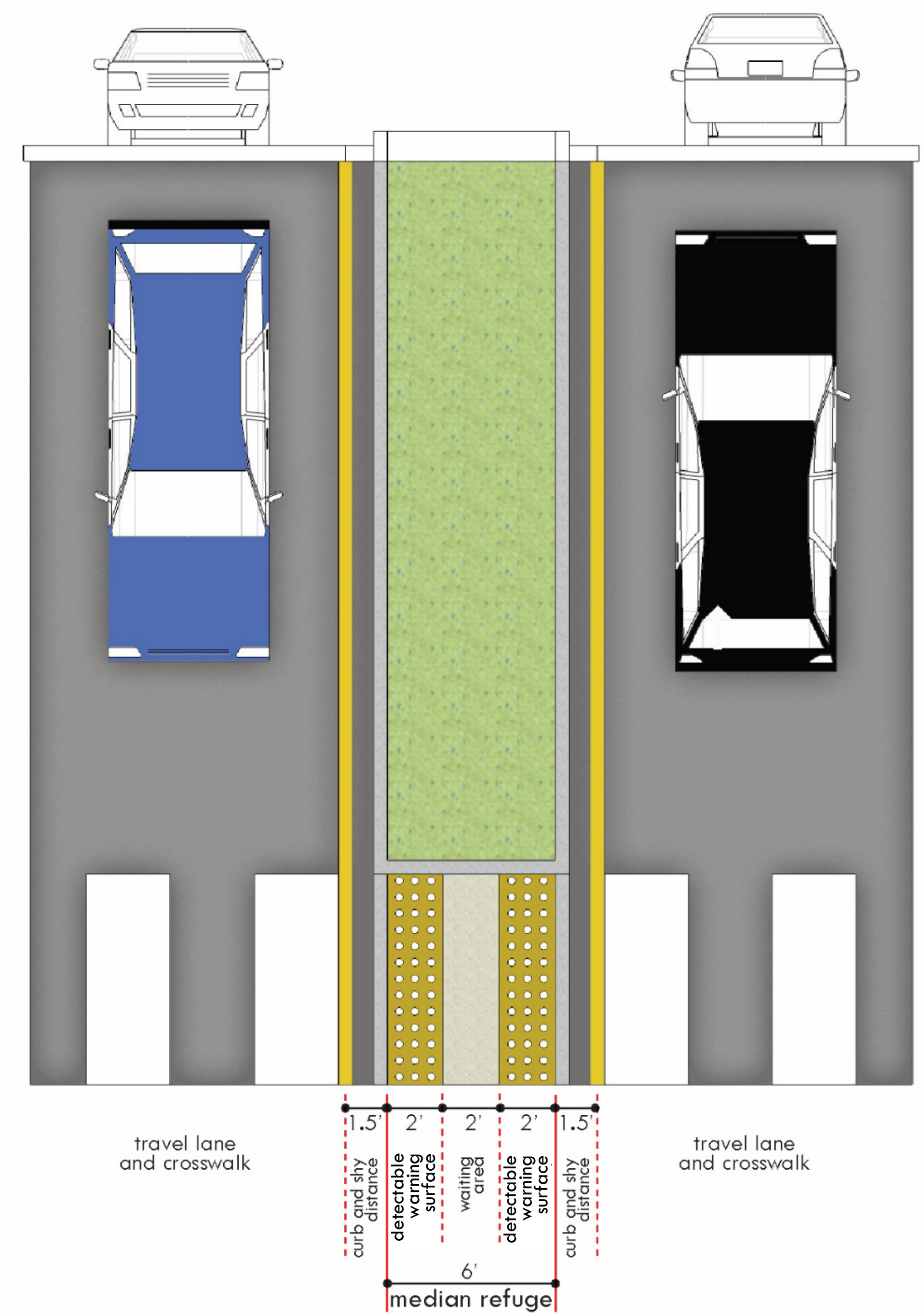


Figure B-G-1 – Detail of Six-Foot Wide Median Refuge. A median can serve as a pedestrian refuge if it is a minimum of six-feet wide from the back of curb to back of curb. This provides two feet of detectable warning surface ramps on either side of a two-foot wide smooth waiting area.

Optimal Recommendations

The Median Element is a Secondary Element for Green Modal Emphasis. At intersections, medians are very important for pedestrians, and thoughtful consideration should be given as to whether they would be more beneficial or detrimental to pedestrians at intersections. The values for Median Element width are measured from back of curb to back of curb. Median widths do not include the width of the curb and the one foot shy distance on either side between the road stripe and the median curb. The recommendations in the Corridor Matrix follow the ITE/CNU guidance very closely, where medians are recommended for Boulevards and Transit Boulevards and optional for Major Avenues and Avenues. Medians are inappropriate for Local Streets. Where medians are combined with left turn lanes, the recommended width is 18 feet to provide a 12-foot turn lane with a six-foot pedestrian refuge.

Optimal values for the Median Element assume optimal travel lane widths and include space for a left turn lane at intersections of the same width. If minimum travel lane width is used, reduce the optimal median with by the same width. I.e. if the optimal travel lane width is 12 feet, but the minimum lane width of 11 feet should be used, reduce the optimal median width by one foot (from 18 feet to 17 feet).

Medians are especially recommended for Multimodal Through Corridors. In T-1 and T-2 areas, 40 foot medians may be appropriate on Multimodal Through Corridors if future widening is anticipated. However, medians this wide substantially decrease walkability, and should be critically considered for alternatives.

If there is a dedicated transitway in the median, median widths will likely vary between 24 and 36 feet, depending on the design of the transit alignment and station location.

Minimum Recommendations & Potential Modifications

A six- foot minimum median is recommended for Transit Boulevards (with curbside transit) and Boulevards to provide the adequate width for a pedestrian refuge. Major Avenues and Avenues with limited right-of-way may choose to forgo a median for another element that is more beneficial for the corridor's modal emphasis.

Minimum recommendations for Multimodal Through Corridors depend on the number of lanes. T-1 and T-2 Multimodal Through Corridors may have no median if they are two lanes (one lane in each direction). Roads with four lanes should have a median.

APPENDIX C.

MULTIMODAL CENTERS CALCULATOR TOOL

The following pages show screenshots of a spreadsheet-based tool that computes typical building heights and floor-area-ratios for the Transect Zones, Multimodal Center Types, and TOD Nodes based on activity density and other assumptions. The yellow boxes indicate inputs to the tool, and reflect the assumptions for the Transect Zones and Multimodal Center types as presented in these Guidelines. The additional metrics of building heights and floor-area-ratios provide readers with a deeper understanding of the building and activity patterns within the Guidelines typology.

Planners may change the assumptions in the yellow boxes to better reflect the conditions within their locality, such as the percentage of activity units that are jobs or the square footage per dwelling unit. Revising these assumptions will change the floor-area-ratios and building heights. However, it is **not** recommended that planners change the values that describe the range of activity densities for each Transect Zone, as these were specifically calibrated for real places in Virginia to accurately span the range of contexts that exist in the Commonwealth.

Additional information about the Multimodal Center typology and recommended metrics is located in Chapter 3 of these Guidelines.

Calculations for Transect Zone and Place Type (Center Type) Activity Density, FAR, and other density metrics

Values in yellow boxes can be changed

Values in orange are calculated values

Values in grey are necessary for calculation.

TRANSECT DENSITIES

Transect Zone	ACTIVITY DENSITY by TRANSECT ZONE: Activity Density = (Jobs + Pop)/acre Low	High	BUILDING HEIGHT based on visual inspection (No. of stories): Average Building Height	Typical Maximum Bldg Height	TOTAL FLOOR-AREA-RATIO based on Activity Density (combined residential and commercial): Gross Building FAR (includes res + com) Low	High	Net Building FAR (includes res + com) Low	High
T1	-	1	1	2	-	0.01	-	0.02
T2	1	10	1.5	3	0.01	0.15	0.02	0.23
T3	10	25	3	5	0.15	0.37	0.23	0.57
T4	25	60	4	8	0.37	0.90	0.57	1.38
T5	60	100	6	12	0.90	1.49	1.38	2.30
T6	100	-	8	20	1.49	-	2.30	-

MULTIMODAL CENTER DENSITIES

Multi-modal Centers	Transect Zones Inner	Outer	MULTIMODAL CENTER GROSS ACTIVITY DENSITY: Activity Density = (Jobs + HH)/acre Low	High	TOTAL FLOOR-AREA-RATIO based on Activity Density (combined residential and commercial): Gross Building FAR (includes res + com) Low	High	Net Building FAR (includes res + com) Low	High	BUILDING HEIGHT based on visual inspection (No. of stories): Average Building Height	Typical Maximum Bldg Height
P1 Rural or Village Center	T2	T1	-	2.13	-	0.03	-	0.05	1	2
P2 Small Town or Suburban Ce	T2	T2	2.13	6.63	0.03	0.10	0.05	0.15	1.5	3
P3 Medium Town or Suburban	T3	T2	6.63	13.75	0.10	0.21	0.15	0.32	2	4
P4 Large Town or Suburban Ce	T4	T3	13.75	33.75	0.21	0.50	0.32	0.77	3	6
P5 Urban Center	T5	T4	33.75	70.00	0.50	1.04	0.77	1.61	5	9
P6 Urban Core	T6	T5	70.00	-	1.04	-	1.61	-	7	14

REVISE ASSUMPTIONS BELOW

ASSUMPTIONS	
50%	of activity units are jobs
50%	of activity units are population
500	sq. ft. = 1 job
2,000	sq. ft. = 1 dwelling unit
2.5	persons = 1 dwelling unit
0.65	Gross-to-Net Ratio
50%	of inner quarter-mile residential density concentrated to 1/8 mile TOD node
50%	of inner quarter-mile residential density located outside of 1/8 mile TOD node
50%	of inner quarter-mile employment density concentrated to 1/8 mile TOD node
50%	of inner quarter-mile employment density located outside of 1/8 mile TOD node

*The inner 1/8 mile circle contains 25% of the land area of the entire 1/4 mile circle.
A distribution of 25% within and 75% outside will result in equal densities in the inner circle and outer ring.

Create your own Center. Enter Inner and Outer T Zones.	Transect Zones Inner	Outer	MULTIMODAL CENTER GROSS ACTIVITY DENSITY: Activity Density = (Jobs + HH)/acre Low	High	TOTAL FLOOR-AREA-RATIO based on Activity Density (combined residential and commercial): Gross Building FAR (includes res + com) Low	High	Net Building FAR (includes res + com) Low	High
Custom MM Center A	T6	T4	31.25	-	0.47	-	0.72	-
Custom MM Center B	T5	T5	30.00	50.00	0.45	0.75	0.69	1.15
Custom MM Center C	T3	T1	-	6.50	-	0.10	-	0.15

TRANSIT-ORIENTED DEVELOPMENT NODE DENSITIES (Multimodal Centers P3 and Above)																				
	INSIDE TOD NODE (1/8 mile radius circle)									OUTSIDE TOD NODE (1/8 mile to 1/4 radius ring)										
	ACTIVITY DENSITY		TOTAL FLOOR-AREA-RATIO based on Activity Density (combined residential and commercial)				BUILDING HEIGHT based on visual inspection (No. of stories)			ACTIVITY DENSITY		TOTAL FLOOR-AREA-RATIO based on Activity Density (combined residential and commercial)				BUILDING HEIGHT based on visual inspection (No. of stories)				
Multimodal Center Types	Activity Density = (Jobs + HH)/acre		Gross Building FAR (includes res + com)		Net Building FAR (includes res + com)		Average Building Height	Typical Maximum Bldg Height		Activity Density = (Jobs + HH)/acre		Gross Building FAR (includes res + com)		Net Building FAR (includes res + com)		Average Building Height	Typical Maximum Bldg Height			
	Low	High	Low	High	Low	High				Low	High	Low	High	Low	High					
P3 Medium Town or Suburban Center	13.3	27.5	0.20	0.41	0.30	0.63	4	7		4.4	9.2	0.07	0.14	0.10	0.21	3	5			
P4 Large Town or Suburban Center	27.5	67.5	0.41	1.01	0.63	1.55	7	12		9.2	22.5	0.14	0.34	0.21	0.52	4	8			
P5 Urban Center	67.5	140.0	1.01	2.09	1.55	3.21	9	18		22.5	46.7	0.34	0.70	0.52	1.07	6	12			
P6 Urban Core	140.0	-	2.09	-	3.21	-	13	28		46.7	-	0.70	-	1.07	-	9	19			

APPENDIX D.

ACCESS MANAGEMENT CONSIDERATIONS FOR MODAL EMPHASIS

The following Appendix summarizes the recommended standards for access management by Multimodal Corridors in these Guidelines. The original matrix is in spreadsheet format and is laid out in individual page formats in this Appendix. Additional information about the Multimodal Center typology and recommended metrics is located in Chapter 3 of these Guidelines.

The frequency and spacing of intersections and driveways can affect how well a corridor accommodates different modes. Generally Placemaking Corridors, except for Local Streets, should have limited driveway access points to reduce conflict points for all modes. Automobile access to buildings is preferably oriented to the back of buildings, or along the side in some instances. Except for Local Streets in residential neighborhoods, access to properties should be provided in back of the buildings with a backage (or reverse frontage) road.

The following discussion examines the effects of intersection and driveway spacing on each modal emphasis. Table D-1 provides recommendations for spacing for each intersection and entrance type relative to the Minimum Spacing Standards in the VDOT Road Design Manual.

Access Management Effects on Modal Emphasis

Pedestrian

Pedestrians will typically walk anywhere they feel safe. They do not follow designated travel paths like automobiles and are more likely to ignore visual cues. They may walk in the street instead of on the sidewalk, cross the street where there is no crosswalk, cross the street outside of the pedestrian signal phase, and they may be less aware of their surroundings (texting, talking, etc). Pedestrians will usually take shortcuts to avoid going out of the way for a designated crosswalk. Providing frequent crossings minimizes the likelihood that pedestrians will cross midblock and helps motorists to stay alert to the possible presence of pedestrians.

The ITE/CNU Guidebook recommends providing smaller block lengths for walkable thoroughfares, with block lengths ranging from 200 to 660 feet.[1] Pedestrians generally need frequent crossings to access destinations on both sides of the street. This is especially important on major avenues where the traffic volumes may be high. Frequent driveway cuts and partial access intersections are discouraged on corridors with pedestrian emphasis. Midblock pedestrian crossings should not be necessary if block lengths are short enough.

At intersections, especially high-volume intersections, pedestrians need high-visibility crosswalks. Curb extensions are recommended when on street parking is provided; on street parking is generally beneficial with pedestrian emphasis. Median refuges are beneficial for roads with more than two travel lanes, and especially for unsignalized intersections for larger street types where there is moderate to heavy vehicular traffic, as they allow pedestrians to focus on crossing one direction at a time and provide a safe space to wait for a gap in oncoming traffic. At signalized intersections, pedestrian count-down signals, adequate crossing times, and shorter cycle lengths are strongly recommended. Small curb return radii are beneficial for pedestrians; channelized right turn lanes should be discouraged. Driveway cuts, if necessary, should be 24 feet wide or less.

[1] ITE/CNU's *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach*, Chapter 3 provides guidance on block length and street spacing.

Bicycle

Frequent driveway entrances can pose safety problems for bicyclists. Motorists pulling out of driveways may not be looking for bicyclists riding closer to the edge of the roadway, and especially if bicyclists are riding on the sidewalk. Motorists may attempt to pass a bicyclist and immediately turn off the road into a driveway, which creates a serious conflict. Bicyclists turning left to access a destination on the other side of the road may need to stop to wait for a gap in oncoming traffic. Even with proper hand signals, vehicles behind the bicyclist may not be expecting the cyclist to slow down or stop, and run the risk of collision, which is extremely dangerous for the cyclist.

Transit

There are advantages and disadvantages to access management for transit modal emphasis. For commuter and express bus service, frequent intersection and driveway spacing will create more conflict points and slow speeds. For local service, more frequent intersections will provide more opportunities for bus stops. More frequent stops slows transit travel speeds, but it makes it more convenient for transit riders to access their destinations. This is the classic mobility vs. accessibility dilemma of transit and transportation planning.

Green

Access management has little effect on green modal emphasis. Tree plantings, shrubbery and other landscaping elements are interrupted by driveway entrances. As with the other modal emphases, driveway access points should be limited.

Curbside Activity

Frequent driveway openings limit the number of on street parking spaces. Parallel-parked cars limit the sight distance of vehicles that pull out of driveways, creating potential safety hazards. Corridors with parking modal emphasis should consolidate driveway openings wherever possible. Backage (or reverse frontage) roads can provide access to properties without curb cuts. These backage roads would ideally connect to other roads that intersect the main road with a full-access intersection. This configuration provides continuous length for on street parking and minimizes conflicts between vehicles maneuvering into parking spaces and vehicles pulling out of driveways.

Spacing Recommendations by Modal Emphasis

The following table provides recommendations for intersection and entrance spacing for each Modal Emphasis relative to the Minimum Spacing Standards in the VDOT Design Manual.

A indicates that intersections of this type should be spaced as closely together as possible on corridors with this Modal Emphasis. The VDOT minimum spacing standards provide a baseline for minimum spacing. Operational analyses may indicate that more frequent (i.e. shorter) spacing may be appropriate. The shortest spacing for these types of intersections should be used whenever possible.

B indicates that the VDOT minimum spacing standards are likely the best option. Intersections of these types with these Modal Emphases may have mixed impacts. The VDOT minimum spacing standards will provide an adequate number of connections and crossings for each mode. Less frequent (i.e. longer) spacing will make accessing destinations for difficult, especially for pedestrians and bicyclists.

C indicates that these types of entrances should be minimized (i.e. less frequent or longer spacing between entrances). These types of entrances create conflict points and safety problems.

Table D-1 – Access Management Considerations for Modal Emphasis

ACCESS MANAGEMENT CONSIDERATIONS FOR MODAL EMPHASIS					
	Pedestrian	Bicycle	Transit	Green	Curbside Activity
Signalized Intersections	A	A	A	B	B
Unsignalized Intersections & Crossovers	B	A	B	B	B
Full Access Entrances	C	C	C	C	C
Partial Access Entrances	C	C	C	C	C

A = Use VDOT minimum. If possible, provide more frequently than VDOT minimum.

B = Use VDOT minimum. Neutral factor to Modal Emphasis, or contains both benefits and drawbacks.

C = Provide maximum possible distance between intersections or entrances.

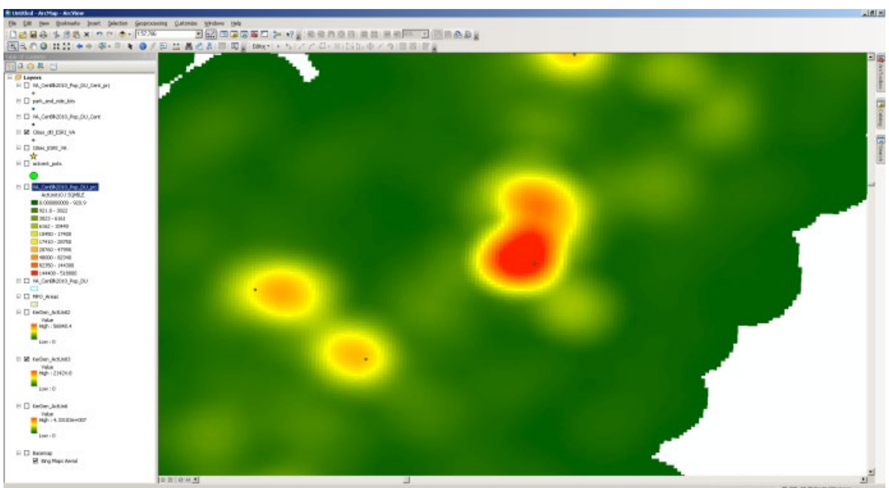
See VDOT Road Design Manual Appendix F for types of access points.

APPENDIX E.

ANALYSIS OF POTENTIAL MULTIMODAL CENTERS IN VIRGINIA

The following describes the methodology used for analyzing Potential Multimodal Centers in Virginia. This work was done as part of a contract with the Office of Intermodal Planning and Investment to study statewide accessibility in 2011. The results of that study were also used in the development of the Multimodal System Design Guidelines by classifying the activity density of each of the 319 centers in that study according to the Multimodal Center types (P-1 to P-6) used in the Multimodal System Design Guidelines.

A Potential Multimodal Center, as defined in this study, is a local concentration of population and/or employment. Potential Multimodal Centers throughout Virginia range from the downtowns of large cities to small town centers to concentrations of suburban employment or population. The geography used for testing in this study for Potential Multimodal Centers was a 1-mile wide (diameter) circle. Defining a statewide dataset of activity centers required a flexible methodology and multiple iterations of edits to refine what would become the final set of 319 one-mile diameter activity centers. Rather than only including the centers with the highest concentrations of population and jobs in the Commonwealth, it was decided to distribute the centers geographically and include all counties in the State, numerous villages, small towns and large cities, in order to span the full range of rural, suburban, and urban contexts in Virginia. What they share in common is a relative concentration of people and jobs, compared with their surrounding areas, suggesting their historic significance relative to their surrounding area or surrounding region.



To define activity centers, the first thing that was needed was an understanding of the spatial distribution of activity in the Commonwealth. For the purpose of this study, the definition of activity was the sum of population and jobs in an area. This was analyzed in several ways.

- First, ArcGIS was used to calculate the kernel density of jobs and population across the state. This resulted in a continuous surface of job or population density, interpolated from Census block centroids. From this, high activity values can be shown by themselves, making these "hotspots" readily apparent (see the "heat map" of activity density below).

- A cross check on this method of analyzing activity density was to use the density of the Census blocks themselves, color-coded to represent the level of density in each block. An industry-standard way to describe the density of a built environment is by use of a "Transect," which categorizes the spectrum of density from very rural (T1) to very urban (T6).
- A final way to verify activity centers was through the use of aerial imagery. Aerial imagery was overlaid with the previously described activity 'heat maps' to verify and confirm the specific center of density in each activity center.

After using this methodology for identifying potential activity centers, the next step was to compare it to Census data on major cities and Census Designated Places (CDP - both of which were layers available from the US Census) as starting points for identifying activity centers. Centroids were created from the CDP layer, as it was originally a polygon layer describing the CDP boundaries. These layers included a total of 452 points, some of which were located in centers of activity density, although most were not. The locations of these points were manually adjusted so that they were brought in alignment with the clusters of activity density. There were several criteria used for relocating these points:

- Maximize activity density (place the centroid so that it captures the maximum amount of activity units)
- If possible, place the point on a major street or intersection
- Do not move the centroid out of its boundary (either CDP or municipal boundary)

This methodology provided an initial set of candidate activity centers. Centers were also located in activity rich areas, like major commercial districts, universities, and Metro Rail stations in northern Virginia. Basic metrics for this first set of candidate activity centers were calculated to aid in the selection process, which was necessary due to the overrepresentation of activity-poor areas. This was particularly evident among the CDPs, an analysis of which showed that just because they are designated as a "place" does not mean that they are a center of activity.

As noted above, there were many small towns initially considered as potential activity centers due to their designation as CDPs. However, CDPs accounted for about 89 percent of the centers tagged for deletion in this round. During the deletion process, the geographic representation of the activity centers was paramount. If a center was the only one in a county or large area, it was kept as part of the activity center set. Also during this stage, centers were thinned out where there was excessive overlap. This was especially the case along some Metro Rail transit corridors as shown in the two images below – the one on the left before the deletion process and the one on the right after the deletion process.

Other centers were added or moved based on further analysis of aerial imagery, especially to identify suburban activity centers, where identifying distinct central locations can be difficult.

Data Used

The following is a listing of primary data sources used in this analysis:

- **Population.** US Census Blocks [1], with SF1 Summary data for population.
- **Employmen**t. US Census LED On the Map Tool[2], obtained statewide employment at the Census Block level for 2010, downloaded in March 2012.

A Summary table of the activity density by Multimodal Center type is shown on the following pages.

1 U.S. Census Bureau 2010 TIGER/Line® Shapefiles. http://www.census.gov/cgi-bin/geo/shapefiles2010/main
2 U.S. Census Bureau. 2012. OnTheMap Application. Longitudinal-Employer Household Dynamics Program. http://onthemap.ces.census.gov/

NAME	Activity Units (People + Jobs)	Activity Units/Acre	Multimodal Center Type
Tysons West	55,013	109.7	P6
Richmond	54,640	108.9	P6
Richmond South of River	54,640	108.9	P6
Rosslyn	44,791	89.3	P6
Backlick & Edsall	42,426	84.6	P6
Ballston - MU	42,372	84.5	P6
Norfolk	37,772	82.3	P6
Pentagon City/Crystal City	37,475	74.7	P6
Alexandria	27,176	54.2	P5
Reston Parkway	26,412	52.6	P5
Reston South Lakes	26,412	52.6	P5
Reston Lake Anne	26,412	52.6	P5
Clarendon	20,012	39.9	P5
Bailey's Crossroads	19,673	39.2	P5
Alexandria West	19,045	38.0	P5
University of Virginia	17,763	35.4	P5
Hampton	14,787	33.9	P5
Lake Monticello	16,134	33.3	P4
Tysons East	16,692	33.3	P4
Merrifield	16,645	33.2	P4
Herndon-Monroe	16,434	32.8	P4
Chantilly	16,297	32.5	P4
Richmond West	16,291	32.5	P4
Charlottesville	16,134	32.2	P4
Roanoke	15,953	31.8	P4
Van Dorn Street	15,319	30.5	P4
Chesterfield Court House	15,311	30.5	P4
Fair Oaks East	15,147	30.2	P4
Fair Oaks South	15,147	30.2	P4
Fairfax	15,043	30.0	P4
George Mason University	15,043	30.0	P4
Idylwood	14,313	28.5	P4
Lincolnia	14,224	28.4	P4
Fan District	13,408	26.7	P4
King St/Eisenhower Ave	13,326	26.6	P4
Staples Mill Rd	13,095	26.1	P4
Lynnhaven	13,085	26.1	P4
Hybla Valley	12,728	25.4	P4
Falls Church	12,715	25.3	P4
Alexandria Old Town North	11,587	25.3	P4
istopher Newport University	12,589	25.1	P4

NAME	Activity Units (People + Jobs)	Activity Units/Acre	Multimodal Center Type
Fair Oaks	12,578	25.1	P4
Chesapeake Great Bridge	12,559	25.0	P4
Columbia Pike	12,492	24.9	P4
Portsmouth Downtown	12,320	24.6	P4
Shirlington	12,145	24.2	P4
Lake Barcroft	11,727	23.4	P4
Alexandria North	11,587	23.1	P4
Manassas	11,542	23.0	P4
Bull Run	11,488	22.9	P4
Virginia Beach Town Center	11,322	22.6	P4
Seven Corners	10,719	21.4	P4
McLean	10,639	21.2	P4
Cox Rd & Nuckols Rd	10,616	21.2	P4
Wiehle Avenue	10,473	20.9	P4
Williamsburg	10,016	20.0	P4
Winchester	10,005	19.9	P4
Annandale	9,622	19.2	P4
Norfolk North Downtown	9,519	19.0	P4
Old Dominion University	9,519	19.0	P4
Chippenham	9,499	18.9	P4
Diamond Springs & Wesleyan	9,414	18.8	P4
Jefferson	9,204	18.3	P4
Harrisonburg	9,101	18.1	P4
James Madison University	9,101	18.1	P4
Vienna/Fairfax - GMU	9,072	18.1	P4
Centreville	9,019	18.0	P4
Newport News	8,983	17.9	P4
Route 28	8,641	17.2	P4
Chantilly East	8,615	17.2	P4
Virginia Beach Greenwich	8,607	17.1	P4
Thomas Corner	8,607	17.1	P4
Laurel	8,325	16.6	P4
Radford University	8,250	16.4	P4
Chesapeake Greenbriar	8,251	16.4	P4
Mount Vernon	7,993	15.9	P4
Farmville	7,873	15.7	P4
Warrenton	7,817	15.6	P4
Franconia	7,811	15.6	P4
Danville	7,767	15.5	P4
Burke	7,740	15.4	P4
Lynchburg	7,678	15.4	P4
Sherwood Forest	7,689	15.3	P4
Marumsco Woods	7,677	15.3	P4
Leesburg	7,671	15.3	P4

NAME	Activity Units (People + Jobs)	Activity Units/Acre	Multimodal Center Type
Leesburg Fort Evans	7,671	15.3	P4
Loch Lomond	7,441	14.8	P4
Portsmouth West	7,412	14.8	P4
Broad Street & Pemberton	7,366	14.7	P4
Fredericksburg	7,362	14.7	P4
Springfield	7,361	14.7	P4
S Sterling Blvd	7,350	14.7	P4
Acredale	7,300	14.5	P4
Blacksburg	7,252	14.5	P4
West Gate	7,242	14.4	P4
Newington	7,177	14.3	P4
Manassas Park	7,152	14.3	P4
Suffolk	7,087	14.1	P4
Peninsula Town Center	7,077	14.1	P4
Port of Newport News	6,917	14.0	P4
Bristol	6,961	13.9	P4
Newport News Shipyard	6,917	13.8	P4
Level Green	6,903	13.8	P4
Sudley	6,846	13.6	P3
Staunton	6,713	13.4	P3
Occoquan	6,659	13.3	P3
Vienna	6,609	13.2	P3
Groveton	6,551	13.1	P3
Ashburn	6,461	12.9	P3
Midlothian	6,430	12.8	P3
Hodges Manor	6,299	12.5	P3
Salem	6,251	12.5	P3
Lexington	6,236	12.4	P3
Tuckahoe	6,190	12.3	P3
Christiansburg	6,161	12.3	P3
Woodbridge	6,120	12.2	P3
Virginia Beach	6,038	12.0	P3
Quantico Station	5,517	12.0	P3
West Springfield	6,009	12.0	P3
Cascades	5,944	11.8	P3
Dulles Town Center	5,944	11.8	P3
Lake Ridge	5,697	11.4	P3
Gayton Centre	5,683	11.3	P3
Ashburn Farm & Claiborne	5,643	11.2	P3
Broad Street & 64	5,594	11.2	P3
University of Richmond	5,594	11.2	P3
Dumbarton	5,594	11.2	P3
Dumfries	5,517	11.0	P3
North Springfield	5,406	10.8	P3

NAME	Activity Units (People + Jobs)	Activity Units/Acre	Multimodal Center Type
Bloxoms Corner	5,407	10.8	P3
Front Royal	5,358	10.7	P3
Woodfield & Laurelwood	5,298	10.6	P3
Petersburg	5,272	10.5	P3
Fort Belvoir	5,244	10.5	P3
Lorton	5,244	10.5	P3
Hopewell	4,946	10.4	P3
and Rd & Independence Blvd	5,187	10.3	P3
Bedford	5,175	10.3	P3
Herndon	5,133	10.2	P3
Waynesboro	5,074	10.1	P3
Cave Spring	5,068	10.1	P3
Marion	5,060	10.1	P3
East Falls Church	5,019	10.0	P3
Dale City	4,999	10.0	P3
Spring Knoll Plaza	4,981	9.9	P3
Radford	4,859	9.7	P3
Ettrick	4,828	9.6	P3
Ashland	4,812	9.6	P3
Yorkshire	4,665	9.3	P3
Haymarket	4,613	9.2	P3
Vinton	4,583	9.1	P3
Five Mile Fork	4,574	9.1	P3
Culpeper	4,559	9.1	P3
Belle Haven	4,558	9.1	P3
Montrose	4,402	8.8	P3
Loxley Gardens	4,398	8.8	P3
Industrial Complex	4,393	8.8	P3
Galax	4,316	8.6	P3
Oakton	4,268	8.5	P3
Wise	4,196	8.4	P3
Colonial Heights	4,132	8.2	P3
Purcellville	4,125	8.2	P3
Round Hill	4,125	8.2	P3
Smithfield	3,720	8.2	P3
Martinsville	4,074	8.1	P3
Aquia Harbour	4,070	8.1	P3
Mechanicsville	4,065	8.1	P3
Grundy	3,995	8.0	P3
Berryville	3,956	7.9	P3
Highland Springs	3,952	7.9	P3
Emporia	3,954	7.9	P3
Linton Hall	3,926	7.8	P3

NAME	Activity Units (People + Jobs)	Activity Units/Acre	Multimodal Center Type
Pulaski	3,880	7.7	P3
Dunn Loring	3,825	7.6	P3
Rose Hill Dr	3,824	7.6	P3
Richlands	3,825	7.6	P3
Woodstock	3,776	7.5	P3
Lakeside	3,768	7.5	P3
Norton	3,741	7.5	P3
Short Pump	3,679	7.3	P3
Elkton	3,515	7.0	P3
Stephens City	3,510	7.0	P3
Hollymead	3,427	6.8	P3
Albemarle Square	3,427	6.8	P3
Clintwood	3,362	6.7	P3
Abingdon	3,356	6.7	P3
East Highland Park	3,345	6.7	P3
Covington	3,331	6.6	P3
Gloucester Courthouse	3,203	6.4	P2
Glen Allen	3,126	6.2	P2
Fort Hunt	3,121	6.2	P2
Route 772	3,043	6.1	P2
Wytheville	2,996	6.0	P2
West Falls Church -VT/UVA	2,968	5.9	P2
Jonesville	2,947	5.9	P2
Timberville	2,920	5.8	P2
Bridgewater	2,859	5.7	P2
Franklin	2,859	5.7	P2
Bensley	2,841	5.7	P2
Wyndham	2,824	5.6	P2
Broadway	2,705	5.4	P2
Bon Air	2,671	5.3	P2
Hillsville	2,643	5.3	P2
Buena Vista	2,589	5.2	P2
Montclair	2,417	5.0	P2
Bealeton	2,457	4.9	P2
Gate City	2,433	4.8	P2
Orange	2,428	4.8	P2
Appomattox	2,421	4.8	P2
Roanoke Mall	2,389	4.8	P2
Hollins	2,389	4.8	P2
Fort Lee	2,370	4.7	P2
Luray	2,362	4.7	P2
Sandston	2,342	4.7	P2
Monticello Marketplace	2,300	4.6	P2
Clifton Forge	2,238	4.5	P2

NAME	Activity Units (People + Jobs)	Activity Units/Acre	Multimodal Center Type
Lebanon	2,219	4.4	P2
Halifax	2,217	4.4	P2
Lawrenceville	2,183	4.3	P2
Strasburg	2,176	4.3	P2
South Hill	2,159	4.3	P2
Stuart	2,120	4.2	P2
Verona	2,100	4.2	P2
Bluefield	2,069	4.1	P2
Grafton Village	2,063	4.1	P2
Falmouth	2,063	4.1	P2
South Boston	2,057	4.1	P2
Shenandoah	1,973	3.9	P2
Grottoes	1,956	3.9	P2
Mantua	1,948	3.9	P2
Fishersville	1,947	3.9	P2
Timberlake	1,942	3.9	P2
Gloucester Point	1,896	3.9	P2
Accomac	1,914	3.8	P2
Colonial Beach	1,827	3.8	P2
Tappahannock	1,522	3.7	P2
Dublin	1,803	3.6	P2
Chase City	1,797	3.6	P2
Chamberlayne	1,752	3.5	P2
Big Stone Gap	1,726	3.4	P2
Gordonsville	1,701	3.4	P2
Bowling Green	1,698	3.4	P2
Glasgow	1,688	3.4	P2
Waverly	1,679	3.3	P2
Blackstone	1,673	3.3	P2
Madison Heights	1,671	3.3	P2
Lovettsville	1,662	3.3	P2
Chester	1,652	3.3	P2
Coeburn	1,607	3.2	P2
Crewe	1,572	3.1	P2
Cloverdale	1,570	3.1	P2
Mount Crawford	1,553	3.1	P2
Marshall	1,505	3.0	P2
Altavista	1,491	3.0	P2
Floyd	1,474	2.9	P2
West Point	1,215	2.9	P2
Kilmarnock	1,452	2.9	P2
Amherst	1,397	2.8	P2
Tazewell	1,382	2.8	P2
Chatham	1,376	2.7	P2

NAME	Activity Units (People + Jobs)	Activity Units/Acre	Multimodal Center Type
Pearisburg	1,320	2.6	P2
Narrows	1,320	2.6	P2
Gretna	1,318	2.6	P2
Dahlgren	1,148	2.5	P2
Exmore	1,265	2.5	P2
Chincoteague	1,240	2.5	P2
Collinsville	1,235	2.5	P2
Pennington Gap	1,233	2.5	P2
Goochland	1,193	2.4	P2
Woodlawn	1,166	2.3	P2
Louisa	1,164	2.3	P2
Clarksville	991	2.3	P2
Brookwoods Golf Club	1,122	2.2	P2
Victoria	1,112	2.2	P2
New Castle	1,111	2.2	P2
Elliston-Lafayette	1,088	2.2	P2
Cape Charles	948	2.1	P2
Spotsylvania Courthouse	1,036	2.1	P2
Poquoson	1,000	2.0	P1
Madison	980	2.0	P1
Kenbridge	959	1.9	P1
Warsaw	952	1.9	P1
Fincastle	947	1.9	P1
Independence	945	1.9	P1
Powhatan	934	1.9	P1
Boykins	910	1.8	P1
Stanardsville	905	1.8	P1
Crozet	903	1.8	P1
Ferrum College	885	1.8	P1
Rocky Mount	885	1.8	P1
Courtland	881	1.8	P1
Amelia Court House	792	1.6	P1
Urbanna	654	1.5	P1
Yorktown	621	1.4	P1
Keysville	623	1.2	P1
Rustburg	579	1.2	P1
Jarratt	562	1.1	P1
Washington	512	1.0	P1
Scottsville	486	1.0	P1
Surry	475	0.9	P1
McKenney	474	0.9	P1
Mineral	468	0.9	P1
Buchanan	464	0.9	P1
Rose Hill	455	0.9	P1

NAME	Activity Units (People + Jobs)	Activity Units/Acre	Multimodal Center Type
Lovingston	452	0.9	P1
Dryden	447	0.9	P1
Ivor	436	0.9	P1
Bland	382	0.8	P1
Forest	369	0.7	P1
Reedville	328	0.7	P1
Port Royal	273	0.7	P1
Monterey	241	0.5	P1
Mathews	236	0.5	P1
Dillwyn	233	0.5	P1
Dendron	193	0.4	P1
Warm Springs	99	0.2	P1
Cumberland	97	0.2	P1
Charles City	63	0.1	P1
King and Queen Courthouse	3	0.0	P1

MULTIMODAL CENTER INTENSITY			
Center Type	**Activity Density (Jobs + people/acre)**	**Gross Development FAR (residenial + non-residential)**	**Net Development FAR (residenial + non-residential)**
P1 Rural or Village Center	2.13 or less	0.03 or less	0.05 or less
P2 Small Town or Suburban Center	2.13 to 6.63	0.03 to 0.10	0.05 to 0.15
P3 Medium Town or Suburban Cente	6.63 to 13.75	0.10 to 0.21	0.15 to 0.3
P4 Large Town or Suburban Center	13.75 to 33.75	0.21 to 0.5	0.3 to 0.8
P5 Urban Center	33.75 to 70.0	0.5 to 1.0	0.8 to 1.6
P6 Urban Core	70.0 or more	1.0 or more	1.6 or more

APPENDIX F.

CONNECTIONS TO PUBLIC HEALTH

Multimodal Transportation Planning and Public Health

Public health is not just a measure of access to medical care. A variety of factors influence physical, mental and social health, most notably social and environmental circumstances. Where and how we live, work, learn and play has an enormous influence on how healthy we are. Different types of neighborhoods have differing levels of toxin exposure, access to affordable healthy food, connected social institutions, and other resources. Transportation planning decisions greatly influence access to these resources, and have direct implications on public health.

Transportation policies affect travel choices. Research has shown that policies that provide more opportunities for active transportation (bicycling, walking, and taking public transportation) provide numerous benefits for public health. When people walk or bike, they are more physically active, and statistically less likely to develop heart disease, cancer and diabetes, suffer strokes and negative effects from stress, and die young. Research also shows that these policies have resulted in a lower risk of pedestrian and bicyclist fatalities. Transportation decisions also affect air pollution, which in turn affect rates of asthma, lung disease, lung cancer and mortality, noise pollution, water quality, overall mental health, and the likelihood of injury or death from car crashes.[1,2] Decisions to provide more opportunities to walk, bike and take public transportation instead of driving alone can improve all of these aspects of public health.

Health Indicators in Virginia

The Virginia Department of Health (VDH) is committed to protecting and promoting the health of all Virginians and has been involved in the development of these Multimodal System Design Guidelines. VDH publishes an annual Health Equity Report which evaluates the health status of Virginia's residents, especially for disadvantaged populations. The 2012 report provides a Health Opportunity Index (HOI) by census tract across the Commonwealth. The HOI reflects the indirect factors that contribute to public health including education, environmental hazards, transportation and housing affordability, income, employment, population density, racial diversity, and commuting patterns, referred to as the social determinants of health. Social determinants essentially reflect the opportunities or lack thereof to live a physically, mentally and socially healthy lifestyle.

Figure F-1 shows the results of the HOI analysis across Virginia. Some large rural areas perform poorly, as do some mid-sized and specific areas of larger cities. This analysis shows that areas across the Commonwealth in both urban and rural contexts can benefit from increased opportunities for healthy living.

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[1] American Public Health Association. *At the Intersection of Public Health and Transportation: Promoting Healthy Transportation Policy.* http://www.apha.org/NR/rdonlyres/43F10382-FB68-4112-8C75-49DCB10F8ECF/0/TransportationBrief.pdf.

[2] Policy Link, Prevention Institute, and Convergence Partnership. *The Transportation Prescription: Bold New Ideas for Healthy, Equitable Transportation Reform in America.* http://www.policylink.org/atf/cf/%7B97C6D565-BB43-406D-A6D5-ECA3BBF35AF0%7D/transportationRX_final.pdf.

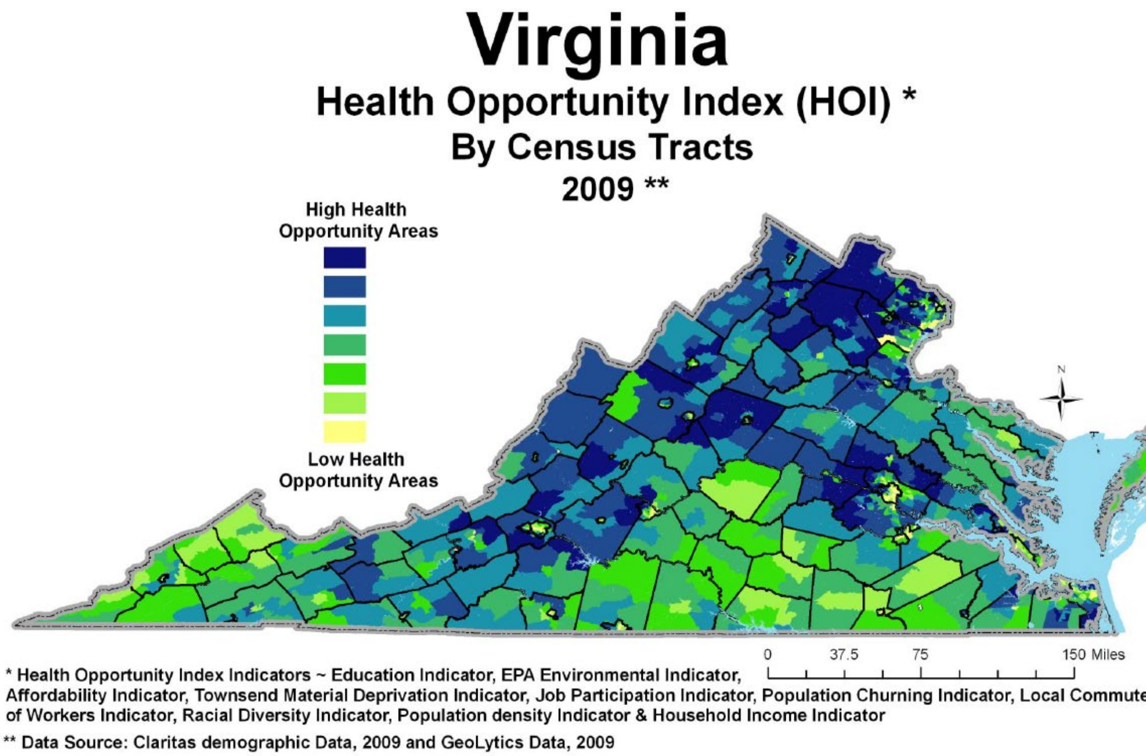

Figure F-1 - Health Opportunity Index Throughout Virginia

What is a Health Impact Assessment?

A Health Impact Assessment[3] (HIA) is a process that evaluates the potential effects of a community design plan or policy on public health. Through an HIA, communities can make more informed decisions about transportation, land use and other public policy concepts to ensure these decisions are providing benefits for public health. HIAs are particularly valuable for identifying and understanding potential health impacts that are not outwardly apparent and those that may disproportionately affect disadvantaged populations. HIAs are compared to other assessments like environmental impact assessments as a formal process to understand all potential implications of a policy or decision.

A Health Impact Assessment typically consists of the following steps[4]:

1. **Screening** determines whether a proposal is likely to have health effects and whether in the HIA will provide information useful to the stakeholders and decision-makers.
2. **Scoping** establishes the scope of health effects that will be included in the HIA, the populations affected, the HIA team, sources of data methods to be used, and alternatives to be considered.
3. **Assessment** describes the baseline health status of the affected population and assesses potential impacts.

[3] For more information on Health Impact Assessments, please visit the Centers for Disease Control and Prevention website at http://www.cdc.gov/healthyplaces/hia.htm.

[4] The National Research Council outlines and describes this six-step framework in *Improving Health in the United States: The Role of Health Impact Assessment* (2011). http://www.nap.edu/catalog.php?record_id=13229

4. **Recommendations** suggest alternatives that could improve health or actions that could be taken to manage the health effect, if any, that are identified.
5. **Reporting** documents and presents the findings and recommendations.
6. **Monitoring and Evaluation** can address adoption and implementation of HIA recommendations and changes in health or health determinants.

The steering committee for these Multimodal System Design Guidelines expressed interest in conducting an HIA for these guidelines. Should this be pursued, the following section provides an overview of other communities in the U.S. that have conducted HIAs on transportation planning initiatives.

Examples of Health Impact Assessments

Health Impact Assessments are commonly used internationally in Europe, Australia, New Zealand, and Canada, and are gaining momentum in the U.S. as a holistic approach to promoting health.

Health Impact Assessments in Virginia

Although few HIAs have been conducted in Virginia, interest in this field is rapidly growing. The academic community is pioneering several HIAs in Virginia.

The Center on Human Needs at Virginia Commonwealth University is currently conducting an HIA for a biomass facility that would convert poultry litter into an energy source in the Shenandoah Valley.[5] Participants in this HIA process are working through concerns regarding air quality, water quality, the local economy, employment, and social cohesion.

In 2008, students at the University of Virginia customized an HIA for the City of Charlottesville for future implementation by community leaders.[6]

Examples of Health Impact Assessments on Transportation Planning Initiatives

Several localities have applied the HIA process to transportation planning initiatives.

HIA on Transportation Policies in the Eugene Climate and Energy Action Plan (Eugene, OR)

In 2010, Upstream Public Health, a non-profit organization, conducted a collaborative six-step HIA process in Eugene, Oregon, to examine the potential health effects of transportation recommendations in the City's Climate and Energy Action Plan. It addressed health issues including injuries and chronic cardiovascular and respiratory diseases, crash rates, physical activity, and air pollution.[7]

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[5] More information about the Shenandoah Valley Poultry Litter to Energy HIA can be found online at http://humanneeds.vcu.edu/Page.aspx?nav=217.

[6] http://news.virginia.edu/content/students-take-community-goal-help-charlottesville-become-americas-healthiest-city.

[7] For more information on the HIA on the transportation recommendations from the Eugene Climate and Energy Action Plan, please visit http://www.upstreampublichealth.org/resources/eugene-climate-and-energy-action-plan-hia.

HIA on Transit-Oriented Development Policy (Saint Paul, MN)

The Twin Cities in Minnesota are planning four transit corridors for transit-oriented development (TOD), with the Central Corridor Light Rail Line under construction. The community expressed concern that the light rail line and subsequent land use changes may negatively affect the existing communities, which include some of the region's most diverse and low-income populations who have experienced disinvestment and historic discrimination.

A community collaborative of Policy Link (a national research and action institute for advancing economic and social equity), Take Action Minnesota (a statewide non-profit), and ISAIAH (a regional faith-based coalition) launched an HIA to better understand the potential impacts. The HIA focused on maintaining a healthy economy, affordable healthy housing, and safe and sustainable transportation. It resulted in five policy recommendations: starting a Community Equity Program, codifying a commitment to affordable housing, starting a density bonus program, relieving the lack of commercial parking, and requiring first source hiring.[8]

[8] For more information on the HIA on Saint Paul's Transit-Oriented Development Policy, please visit http://www.policylink.org/site/c.lkIXLbMNJrE/b.7841971/k.7BB/The_Healthy_Corridor_for_All_Health_Impact_Assessment.htm.

APPENDIX G.

NATIONAL INDUSTRY GUIDANCE AND BEST PRACTICES RESEARCH

The following Appendix summarizes research conducted as part of the 2020 Update to the Multimodal System Design Guidelines. This Appendix is organized into three components:

1. A summary table of national guidance documents published since the Multimodal System Design Guidelines were first published in 2013

2. A series of brief write-ups of examples of localities in Virginia who have implemented innovative multimodal treatments:

    a. City of Alexandria Contra-Flow Bike Lanes
    b. City of Charlottesville Contra-Flow Bike Lanes
    c. City of Richmond Bicycle Boulevards
    d. Arlington County Bicycle Boulevards
    e. Fairfax County Bike Boxes
    f. Charlottesville Bike Boxes
    g. City of Alexandria Pedestrian Hybrid Beacons
    h. Alexandria Rectangular Rapid Flash Beacons
    i. Loudoun County Rectangular Rapid Flash Beacons
    j. GRTC Pulse
    k. Virginia House Bill 2023 § 33.2-319

3. A series of summary reports documenting the experiences of four localities and organizations in implementing the 2013 Multimodal System Design Guidelines into transportation planning processes and efforts

    a. Roanoke Valley: Long Range Transportation Plan
    b. Fairfax County: Mixed Use Area Plans
    c. City of Lynchburg: Better Streets Design Handbook
    d. City of Norfolk: Downtown Multimodal Plan

DRPT Multimodal System Design Guidelines Update
Best Practices Research
Last Updated 10/23/19

ORGANIZATION/ AUTHOR	DOCUMENT TITLE	DESCRIPTION	WHEN/HOW TO USE IT	RELEVANT SECTIONS WITHIN MMSD	URL	STATUS
NATIONAL GUIDANCE DOCUMENTS PUBLISHED SINCE 2013						
National Association of City Transportation Officials	Urban Bikeway Design Guide	A comprehensive compendium of different types of facilities for bicyclists, including bike lanes, cycle tracks, intersection treatments, bicycle signals, bikeway signing and marking, and bicycle boulevards. Provides descriptions, photos, 3D renderings, typical applications, benefits, design guidance, and maintenance considerations for each type of facility. Design guidance includes required, recommended, and optional features like desirable lane widths, placement, signage and pavement markings.	Useful when considering facilities on roads with bicycle modal emphasis or in constrained right-of-way, and during corridor design. Provides options for different types of facilities and describes the necessary dimensions and other design details.	Chapter 5: Multimodal Corridors - Planning For Modal Emphasis Appendix A: Corridor Matrix Appendix B: Corridor Matrix Annotation Document	https://nacto.org/publication/urban-bikeway-design-guide	Released in 2011. 2nd Edition published in 2012.
National Association of City Transportation Officials	Don't Give Up at the Intersection: Designing All Ages and Abilities Bicycle Crossings	Don't Give Up at the Intersection expands the NACTO Urban Bikeway Design Guide, adding detailed guidance on intersection design treatments that reduce vehicle-bike and vehicle-pedestrian conflicts.	This guidance covers protected bike intersections, dedicated bike intersections, and minor street crossings, as well as signalization strategies to reduce conflicts and increase comfort and safety	Chapter 6: Intersections Appendix B: Corridor Matrix Annotation Document	https://nacto.org/publication/urban-bikeway-design-guide/dont-give-up-at-the-intersection/	2019
National Association of City Transportation Officials	Urban Street Design Guide	An overview of street design in an urban context, with considerations for high volumes of multi-modal users and constrained right-of-way. Provides example street treatments to enhance multi-modal mobility, connectivity, and safety.	Guidance for (re)designing streets in an urban context (high multi-modal volumes, limited right-of-way), including a range of design interventions at different scales.	Chapter 6	http://www.nyc.gov/html/dot/downloads/pdf/2012-nacto-urban-street-design-guide.pdf	2013

ORGANIZATION/ AUTHOR	DOCUMENT TITLE	DESCRIPTION	WHEN/HOW TO USE IT	RELEVANT SECTIONS WITHIN MMSD	URL	STATUS
National Association of City Transportation Officials	Transit Street Design Guide	This guide provides design guidance for the development of transit facilities on city street, and for the design and engineering of city streets to prioritize transit, improves ervice quality,and other goals.	This guide would be useful in amending any information related to transit model emphasis in the MSDG.	Chapter 5: Multimodal Corridors - Planning For Modal Emphasis Chapter 6: Intersections Appendix A: Corridor Matrix Appendix B: Corridor Matrix Annotation Document	https://nacto.org/publication/transit-street-design-guide/	2016 (Print version available in the office)
National Association of City Transportation Officials	Bike Share Station Siting Guide	The NACTO Bike Share Station Siting Guide provides high-level guidance on physical bike share station siting types and principles.	This guide highlights best practices in station siting from around the United States and provides guidance on bike share station typologies and principles.	Chapter 5: Multimodal Corridors - Planning For Modal Emphasis Appendix B: Corridor Matrix Annotation Document	https://nacto.org/publication/bike-share-station-siting-guide/	2016
National Association of City Transportation Officials	Global Street Design Guide	This guide sets out to provide a baseline for designing urban streets. This guide addresses a variety of street typologies and design elements found in various contexts around the world.	This guide is meant to inspire, guide, measure, and communicate change for street design. It is broken into 3 sections, (1) about streets, (2) street design guidance, (3) street transformations.	Chapter 5: Multimodal Corridors - Planning For Modal Emphasis Appendix A: Corridor Matrix Appendix B: Corridor	https://nacto.org/publication/global-street-design-guide/	Print version available in office
National Association of City Transportation Officials	Designing for All Ages & Abilities: Contextual Guidance for High-Comfort Bicycle Facilities	This guidance builds on NACTO's Urban Bikeway Design Guide and sets an All Ages & Abilities criteria for selecting and implementing bike facilities.	Useful when considering facilities on roads with bicycle modal emphasis, and during corridor design. A toolbox of strategies to make bike facilities safer.	Chapter 5: Multimodal Corridors - Planning For Modal Emphasis Chapter 6: Intersections Appendix A: Corridor Matrix Appendix B: Corridor	https://nacto.org/publication/urban-bikeway-design-guide/designing-ages-abilities-new/	2017

ORGANIZATION/ AUTHOR	DOCUMENT TITLE	DESCRIPTION	WHEN/HOW TO USE IT	RELEVANT SECTIONS WITHIN MMSD	URL	STATUS
National Association of City Transportation Officials	Guidelines for Regulating Shared Micromobility	This guidance outlines best practices for cities and public entities regulating and managing shared micromobility services on their streets.	NACTO's Guidelines for Regulating Shared Micromobility is divided into two broad sections: Best Practice Recommendations and Current State of the Practice.	Chapter 5: Multimodal Corridors - Planning For Modal Emphasis Appendix B: Corridor Matrix Annotation Document New Chapter on emerging	https://nacto.org/sharedmicromobilityguidelines/	Vol. 2, 2019
National Association of City Transportation Officials	Blueprint for Autonomous Urbanism	The Blueprint for Autonomous Urbanism is centered on people and restoring life to our streets—showing how to adapt new mobility technologies to our cities instead of the other way around.	It is organized into three parts, taking the reader through the (1) principles and political structures that underscore and shape our vision of the future, (2) key policy choices around transit, pricing, freight, and data that can reshape our cities, and finally, (3) exploring the sweeping vision for city streets of the future.	Chapter 5: Multimodal Corridors - Planning For Modal Emphasis Appendix B: Corridor Matrix Annotation Document New Chapter on emerging tech?	https://nacto.org/publication/bau2/	Vol. 2
Institute of Transportation Engineers	Implementing Context Sensitive Design on Multimodal Thoroughfares Handbook	Defines context sensitive solutions "CSS" and provides a framework to apply them to multimodal design, including process, considerations, and solutions. Focuses on redesigning roadways in suburban and rural areas to become more multimodal.	Good reference for redesigning auto-centric corridors.	Chapter 5 Multimodal Corridors	https://environment.transportation.org/pdf/context_sens_sol/ir-145-e.pdf	Published 2017

ORGANIZATION/ AUTHOR	DOCUMENT TITLE	DESCRIPTION	WHEN/HOW TO USE IT	RELEVANT SECTIONS WITHIN MMSD	URL	STATUS
Institute of Transportation Engineers	Recommended Guidelines to Accommodate Pedestrians and Bicycles at Interchanges	A report listing a range of bicycle and pedestrian facility designs for interchanges. Includes guiding design principles and lists other reports for reference. Design aspects cover crosswalks, road striping, traffic lights, conflict areas, off ramps, Single Point Diamond Interchanges (SPDI), and interchange retrofits. Report acknowledges most of these recommended facilities will not achieve Level of Traffic Stress (LTS) 1, the "child safe" standard, and some are high-stress, LTS 4. Diagrams are present for many descriptions.	It adds valuable information about interchanges that are not often considered an important focus. It would be useful in summarizing critical points of interchange retrofit/upgrading or new interchange design.	Chapter 6 as a type of intersection or a separate section regarding interchanges	Hard Copy Scan	published 2016
Institute of Transportation Engineers	Protected Bikeways Practitioners Guide	A concise guide for planning, designing, operating, and implementingprotected bikeways. includes sections of safety performance, mid-block design and operation, intersection design and operation, maintenace, and implementation. Provides evidence for bikeways as a smart investment and other documents of related material. Full scope of design elements including elevation, signage, buffers, staff training for maintenance, etc.	Guidance for practical implementation of bikeways and relevant needs such as maintenance and integration with street, other modes. Strong focus on design.	Chapter 5: Multimodal Corridors - Planning For Modal Emphasis.	Scan located in project folder (internal use only). For purchase: https://ecommerce.ite.org/IMIS/ItemDetail?iProductCode=IR-144	Published 07/17
Institute of Transportation Engineers	Curbside Management Practitioners Guide	"Provides best practices for curb space allocation policy and implementation. Presents a framework and toolbox for analyzing and optimizing curb space with the aim of prioritizing and maximizing community values and safety" Defines potential uses/users and provides example treatments and	Guidance to develop treatment selection process and measure performance. Good reference for types of treatments.	Chapter 5: Multimodal corridors	https://www.ite.org/pub/?id=C75A6B8B-E210-5EB3-F4A6-A2FDDA8AE4AA	Published 2018

ORGANIZATION/ AUTHOR	DOCUMENT TITLE	DESCRIPTION	WHEN/HOW TO USE IT	RELEVANT SECTIONS WITHIN MMSD	URL	STATUS
Federal Highway Administration	Achieving Multimodal Networks: Applying Design Flexibility and Reducing Conflicts	"The publication highlights ways that planners and designers can apply the design flexibility found in current national design guidance to address common roadway design challenges and barriers. It focuses on reducing multimodal conflicts and achieving connected networks so that walking and bicycling are safe, comfortable, and attractive options for people of all ages and abilities. This resource has topics within two themes: (1) design flexibility and (2) measures to reduce conflicts between modes. It addresses common concerns and perceived barriers among planning and design professionals and provides specific information about flexible design treatments and	To identify flexible design treatments within existing national guidelines. It identifies potential solutions to reconcile different needs of, and potential conflicts between modes. It identifies common concerns and perceptions that may act as a barrier to better design for all users.	Barriers/perceptions: not discussed in detail. May be worth mentioning in Chapter 1 Introduction & Benefits Alternatives/Flexible Design and Principles for Reducing conflicts: Chapters 5 & 6	http://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/multimodal_networks/fhwahep16055.pdf	Published August 2016
Federal Highway Administration	Separated Bike Lane Planning and Design Guide	A compendium of design options for separated bicycle facilities for a wide range of roadways and intersections. Considers costs, benefits, risks, maintenance, accessibility, and connectivity to other modes. Covers vehicle, cyclist, and transit turning movements, signalization, intersections and markings, and relative speeds. Provides concise description of above elements with photos, high-quality diagrams, and advice for practitioners, including site selection, design processes, funding, and contextual considerations.	Useful when considering installing facilities on roads, corridors, or intersections with bicycle modal emphasis and/or constrained ROW space. Provides technical guidelines for facility dimensions as well as contextual planning processes.	Chapter 5: Multimodal Corridors - Planning For Modal Emphasis. Diagrams useful for building on design standards. Chapter 9: Implementation and Funding Best Practices.	https://nacto.org/wp-content/uploads/2016/05/2-4_FHWA-Separated-Bike-Lane-Guide-ch-5_2014.pdf	Published May 2015
Federal Highway Administration	Road Diet Informational Guide	A comprehensive look into Road Diets with specific evidence including long-term scientific studies, diagrams, photos, and observations. Considers safety, collisions, costs and benefits, daily traffic, capacity, funding, decision processes, and other elements for various design options. Focuses on low- or no-cost resurfacing of roadway to reduce collisions and provide additional mobility improvements such as bike lanes, bus stops, on-street parking, and pedestrian islands.	Useful when considering resurfacing a roadway with conventional lane widths, two, four, or five existing lanes, or adding mobility options/improvements to the roadway. Provides technical design and planning guidelines.	Chapter 3: multimodal system plan, multimpodal emphasis, and multimodal corridors. Chapter 5: multimodal corridors, specifically the diagramming of corridors	https://safety.fhwa.dot.gov/road_diets/guidance/info_guide/rdig.pdf	Published November 2014

ORGANIZATION/ AUTHOR	DOCUMENT TITLE	DESCRIPTION	WHEN/HOW TO USE IT	RELEVANT SECTIONS WITHIN MMSD	URL	STATUS
Federal Highway Administration	Incorporating On-Road Bicycle Networks into Resurfacing Projects	Comprehensive overview of planning process for selecting, redesigning, and implementing bicycle facilities to coincide with resurfacing projects. The resurfacing process and scheduling are explained inclusive of inventory, data collection, procedure, development, and resurfacing. Practicing advice for avoiding common pitfalls and including flexibility in design for connectivity and cost savings in final result.	Useful for building on planning strategies for implementing bicycle networks, connecting routes, and providing cost savings for expanding facilities. Provides technical design and planning guidelines.	Chapter 2: Multimodal System Plan, public engagement and ongoing input. Chapter 5: multimodal corridors, diagramming and lane cross-sections Chapter 9: implementing and funding best practices	https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/resurfacing/resurfacing_workbook.pdf	Published March 2016
Federal Highway Administration	Accessible Shared Streets: Notable Practices and Considerations for Accommodating Pedestrians with Vision Disabilities	Overview of practices and considerations for accommodating pedestrians with vision disabilities on shared streets. The report describes the specific challenges pedestrians with vision disabilities face when navigating shared streets and the strategies they employ, and discusses ideas on how accessibility for pedestrians with vision disabilities can be addressed in the planning and design process.	Reference for designing shared streets to accommodate the most vulnerable users.	Chapter 6: Intersections (some existing references)	https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/accessible_shared_streets/fhwahep17096.pdf	Published October 2017
Federal Highway Administration	Guidebook for Measuring Multimodal Network Connectivity	"This resource focuses on pedestrian and bicycle network connectivity and provides information on incorporating connectivity measures into state, metropolitan, and local transportation planning processes." Outlines measures for practitioners to identify connectivity gaps, implement cost-effective solutions, optimize cost/benefit, measure long term impacts. Discusses factors in defining analysis network, including data sources, methods, metrics, and others to create connectivity measures. Some metrics include route directness, access to destinations, trip generators, network quality, Bicycle Level of Service (BLOS), and others.	Reference for identifying gaps in network connectivity and service through rigorous but practical analysis with descriptive examples and explainations.	Chapter 2: Multimodal System Plan, Step 5. Chapter 5: Multimodal Corridors, Multimodal through Corridors. Some emphasis of planning processes relevant to Chapter 9.	https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/multimodal_connectivity/fhwahep18032.pdf	Published February 2018

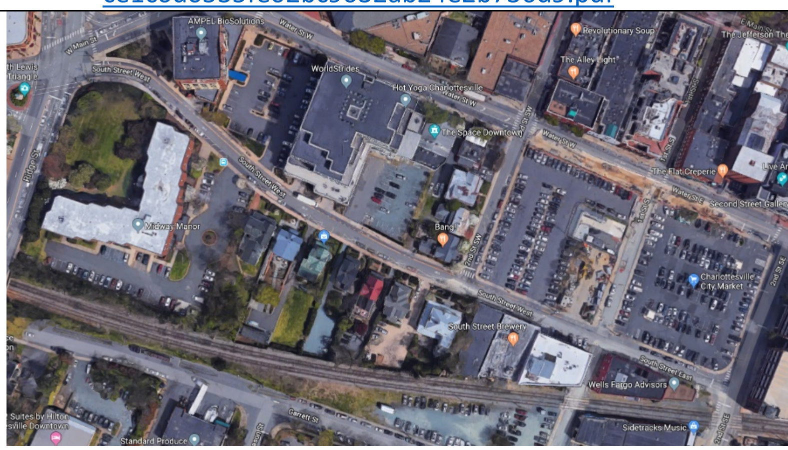
ORGANIZATION/ AUTHOR	DOCUMENT TITLE	DESCRIPTION	WHEN/HOW TO USE IT	RELEVANT SECTIONS WITHIN MMSD	URL	STATUS
Federal Highway Administration	Guide for Improving Pedestrian Safety at Uncontrolled Locations	"Provides guidance for installing countermeasures at uncontrolled pedestrian crossing locations. This guidance is aimed at agencies considering policies for installing safety measures at pedestrian crossings, and it includes recommended practices for each step involved in selecting countermeasures."	Good reference for how to conduct a ped crossing safety study. Provides study methodology, including guidance on post-study monitoring.	Chapter 6: Mid-block crossings Chapter 9: Implementation (maybe add to a new section on monitoring) Appendix: study methodology?	https://safety.fhwa.dot.gov/ped_bike/step/docs/STEP_Guide_for_Improving_Ped_Safety_at_Unsig_Loc_3-2018_07_17-508compliant.pdf	Updated release July 2018
Federal Highway Administration	Field Guide for Selecting Countermeasures at Uncontrolled Pedestrian Crossing Locations	Same guidelines as "Guide for Improving Pedestrian Safety at Uncontrolled Locations", but more focused on the specific criteria for countermeasures. Presented as a checklist of considerations and criteria.	Reference when considering various countermeasures at uncontrolled locations.	Chapter 6: Mid-block crossings	https://safety.fhwa.dot.gov/ped_bike/step/docs/pocket_version.pdf	
Federal Highway Administration	Bikeway Selection Guide	Intended to supplement planning and engineering judgement for placement of bikeways – a facility distinct from vehicle travel not including shared lanes, sidewalks, signed routes, but does include bike boulevards. Discusses goal setting, multimodal network integration, selecting metrics, planning and design considerations, flexible approach. Discussion urban, rural, etc. road categorization and context. Evaluates costs and benefits of various design possibilities over	Useful reference for deciding on and designing bikeways. opportunities are weighed such as speed, design, and planning process. Focused more on design elements, results, etc. than planning, but substantial planning processes discussed.	Chapter 5 and 9, designing and planning multimodal corridors.	https://safety.fhwa.dot.gov/ped_bike/tools_solve/docs/fhwasa18077.pdf	Published February 2019
American Association of State Highway and Transportation Officials	Guide for the Development of Bicycle Facilities, 2019	Guide that claims itself as national standard for bikeway design. Takes comprehensive approach to bicycle facilities design guidleines: "all ages and abilities."				
Federal Transit Administration	Manual on Pedestrian and Bicycle Connections to Transit	"Suggests improvements for pedestrians' and bicyclists' access to transit. Includes information on evaluating, planning, and implementing improvements to pedestrian and bicycle access to transit. Explains how to integrate bike sharing with transit and make both options more accessible.	Guidance on ped-bike access to transit, as well as facilities to accommodate this access mode.	Appendix G; not many references in main document.	https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/research-innovation/64496/ftareportno0111.pdf	Published August 2017

ORGANIZATION/ AUTHOR	DOCUMENT TITLE	DESCRIPTION	WHEN/HOW TO USE IT	RELEVANT SECTIONS WITHIN MMSD	URL	STATUS
Pedestrian Bicycle Information Center	Design Resource Index	An Excel spreadsheet identifying the specific location of information in key national design manuals for various pedestrian and bicycle facility designs. Useful for practitioners seeking quick and specific information.	Could be useful to identify supplemental design guidelines from various agencies/organizations for bicycle facilities, shared use paths, and pedestrian facilities. Likely most useful when looking for authoritative sources for substantiating design criteria	Chapters 5 and 6, very specific design information for wide range of facilities.	http://www.pedbikeinfo.org/resources/resources_details.cfm?id=4975	Updated Sept. 7, 2018
City of Boston	Boston Complete Streets Design Guidelines	Boston's Complete Streets initiative aims to improve the quality of life in Boston by creating streets that are both great places to live and sustainable transportation networks. The Complete Streets approach places pedestrians, bicyclists, and transit users on equal footing with motor vehicle users, and embraces innovative designs and technologies to address climate change and promote active healthy communities.	A comprehensive look at designing urban streets. A series of street types forms the basis of the guidelines. They have been developed to supplement the functional street classifications in Boston and to provide additional guidance during the selection of design elements. Also looks at principles for each zone of the street. (i.e. sidewalk activation, greenscape, features that reduce speed)	Chapter 5: Multimodal Corridors - Planning For Modal Emphasis Chapter 6: Intersections Appendix A: Corridor Matrix Appendix B: Corridor Matrix Annotation Document	https://bostoncompletestreets.org/	2013
Sidewalk Labs	Street Design Principles	Brief document on how cities can leverage new and emerging mobility technologies, such as connected and autonomous vehicles, to make their streets safer, more comfortable, and more efficient — for all modes.	This document builds on NACTO's Blueprint for Autonomous Urbanism by asking: "Instead of teaching new mobility services to operate on today's streets, can we take advantage of new technologies to fundamentally redesign the street?"	Chapter 5: Multimodal Corridors - Planning For Modal Emphasis Appendix B: Corridor Matrix Annotation Document New Chapter on emerging tech?	https://sidewalklabs.com/streetdesign/	Volume 1 2019

Examples of Innovative Multimodal Treatments in Virginia

Name of Multimodal Project	City of Alexandria Contra-Flow Bike Lanes
Mode (s) Included	Bicycles and vehicles
Project Description	Contra-flow bicycle lane treatments were added to or planned for select streets in Old Town Alexandria. "The current configuration of one-way streets in Old Town Alexandria has been developed primarily to facilitate efficient movement of automobile traffic. This, combined with the organic, non-gridded nature of much of the rest of the City's street network, often make bicycling to specific destinations within short distances difficult. Contra-flow bike lanes help solve this problem by allowing bicyclists to operate in two directions on one-way streets." – City of Alexandria (source 1)
Implementation Date	Unknown.
Innovative Multimodal Design Features	Contra-flow bicycle lanes are an innovative element of Alexandria's *Complete Streets Design Guidelines.* According to these guidelines, contra-flow lanes provide more convenient and direct connections for bicyclists. These are used where there is a clear and observed need for a connection and where there is evidence of "wrong way riding." • Contra-flow lanes are usually short segments connecting the larger network. • Contra-flow lanes must have adequate roadway width for this exclusive lane and be placed on the left of motorists. • Conventional lane design except for the left side marking: this should be a double yellow line. Contra-flow lanes may also be separated by a buffer or vertical separation such as a curb. • Contra-flow lanes are less desirable on streets with frequent and/or high-volume driveways or alley entrances on the side with the proposed contra-flow lane. Documentation of a contra-flow bike lane was not available for Alexandria.
sFunding Sources	No clear funding source or project.
Link to Resource Document(s)/References	1. https://www.alexandriava.gov/uploadedFiles/localmotion/info/gettingaround/4%20-%20Roadways%20ONLINE.pdf
Images/Photographs	N/A

Examples of Innovative Multimodal Treatments in Virginia

Name of Multimodal Project	City of Charlottesville Contra-flow Bicycle Lanes
Mode (s) Included	Bicycles and vehicles
Project Description	Contra-flow bicycle lane added to South St in Charlottesville.
Implementation Date	Exact date unknown. Implemented prior to 2015. Reference document 2 was published August 2015 and refers to the contra-flow lane as “new.”
Innovative Multimodal Design Features	Charlottesville provides a contra-flow lane as an innovative approach to a handling wrong-way riding on South St W. Contra-flow lane marking lines are dashed for driveways. These lanes provide more convenient and direct connections for bicyclists.
Funding Sources	CIP funding leveraged with state and local funds
Link to Resource Document(s)/References	1. https://www.charlottesville.org/home/showdocument?id=40105#targetText=Contraflow%20bike%20lanes%20are%20designed,two%20way%20street%20for%20bikes. 2. https://www.charlottesville.org/home/showdocument?id=31214 3. http://charlottesville.granicus.com/DocumentViewer.php?file=charlottesville_ce1c6d0535fe02bc9032ab24e2b736d9.pdf
Images/Photographs	 South St W, Charlottesville: link  South St W Charlottesville - Images from Google Maps

Examples of Innovative Multimodal Treatments in Virginia

Name of Multimodal Project	City of Richmond Bicycle Boulevards
Mode (s) Included	Bicycles, pedestrians, vehicles
Project Description	Bicycle boulevard projects in Richmond, VA are also referred to as "bike-walk streets," in the Richmond Bicycle Pedestrian Master Plan. These are low-traffic, slow-speed streets. The design or redesign of these streets usually includes street trees, narrow vehicle lanes, on-street parking, or other traffic calming devices that allows for comfortable cycling without the need for separated lanes. Shared-use marking are standard and small traffic circles are desired.
Implementation Date	Ongoing, included in Richmond Capital Improvement Program (source document 2).
Innovative Multimodal Design Features	Establishment of bicycle boulevards is recent and innovative for Richmond. These treatments are prioritized for low-traffic, low-speed streets to encourage shared and safe lane usage with vehicles and bicycles. For the example corridors, these treatments include a range of treatments: small traffic circles, white and green shared-use markings (sharrows), on-street parking, traffic-calming signage street trees, and upgraded crosswalks.
Funding Sources	Richmond Capital Improvement Plan 2020-2024
Link to Resource Document(s)/References	1. Richmond Bicycle Master Plan: Link 2. Richmond Adopted Capital Improvement Plan, Fiscal Years 2020 – 2024: Link
Images/Photographs	Floyd Ave Bike Boulevard 2018: Link  Floyd Ave 2007: Link

Examples of Innovative Multimodal Treatments in Virginia

<table>
<tr><td></td><td>

Floyd Ave 2018: Link


East Grace St bicycle boulevard.</td></tr>
</table>

Examples of Innovative Multimodal Treatments in Virginia

East Marshall St bicycle boulevard.

Several other examples can be found in the bike ped master plan. Images from Google Maps.

Examples of Innovative Multimodal Treatments in Virginia

Name of Multimodal Project	Arlington County Bicycle Boulevards
Mode (s) Included	Bicycles, vehicles, pedestrians
Project Description	Arlington has implemented 1.7 miles of bicycle boulevards on a number of streets as of 2018. Low-traffic neighborhood streets were selected, and a number of traffic calming devices were incorporated, as well as shared-use markings (sharrows) to invite cyclists onto the street. The Master Transportation Plan includes recommendations to develop over thirty bicycle boulevards by 2040.
Implementation Date	Two bicycle boulevards implemented (implementation date not available): • 12th St S bicycle boulevard was implemented • 7th Rd S bicycle boulevard was implemented
Innovative Multimodal Design Features	These treatments are innovative for Arlington because of the: • Selection and treatment of low-traffic, low-speed streets to encourage shared and safe road usage for vehicles and bicycles; • Implementation of traffic calming devices such as upgraded crosswalks and rectangular flashing beacons (7th Rd S); and • The substantial number of bicycle boulevards (over 30) in the Master Transportation Plan.
Funding Sources	CIP (source document 1) funds street upgrades, including bike and ped projects. No bicycle boulevard projects are specifically listed.
Link to Resource Document(s)/References	A complete list of implemented bicycle boulevards and their dates of implementation could not be found. The following references show funding and goals related to bicycle infrastructure in Arlington: 1. Arlington County Capital Improvement Plan 2019 – 2028 has bicycle infrastructure outlined, but no bike boulevards specifically: link 2. Comprehensive Master Transportation Plan (MTP) for Arlington: link. This document details the future bicycle infrastructure investment, inclusive of over 30 bicycle boulevards by 2040. 3. Draft MTP Bicycle Element update: link
Images/Photographs	Image showing 12th St South bicycle boulevard in 2018. Reportedly moved to 11th St south in February 2019.

Examples of Innovative Multimodal Treatments in Virginia

Examples of Innovative Multimodal Treatments in Virginia

Name of Multimodal Project	Fairfax County Bike Boxes
Mode (s) Included	Bicycles, in between vehicle lane stop line and crosswalks.
Project Description	Bike Box: • A marked, designated area at a signalized intersection that places bicyclists at the front of the traffic queue when the signal is red. • Allows bicyclists to enter and clear an intersection before motor vehicles. • Provides left-turn ability for cyclists through intersection if placed at all intersection stop lines. • Provides a storage area for bikes at an intersection where there is heavy bicycle traffic and left turn movements.
Implementation Date	Unknown.
Innovative Multimodal Design Features	Fairfax County guidance for bike boxes: • Should only be used at signalized intersections where there is no right turn on red. • May require additional signage to inform motorists and cyclists how to correctly use the bike box. • Must be accessed via a bike lane, which allows cyclists to safely move ahead of motor vehicles in the intersection.
Funding Sources	No clear dedicated funding sources
Link to Resource Document(s)/References	1. Driver's Guide to Bike Lanes in Fairfax County 2. For Fairfax County Definition: Fairfax County Comprehensive Plan, Franconia-Springfield Area and Fort Belvoir North Area, ctr+f "bike box"
Images/Photographs	An implemented example of a bike box in Fairfax County could not be found.

Examples of Innovative Multimodal Treatments in Virginia

Name of Multimodal Project	Charlottesville Bike Boxes
Mode (s) Included	Bicycles, vehicles, pedestrians
Project Description	From source doc 1: Bike Boxes at University Ave and Rugby Rd are implemented to allow safer crossing for bicyclists through the following improvements: • A two-stage turn box for westbound University Ave bicyclists turning south on McCormick Rd; • Bike boxes on University Ave and Rugby Rd; and • An optional two-stage turn box for eastbound University Ave bicyclists turning north on Rugby Rd.
Implementation Date	Implemented, reportedly August 2014 from source 2.
Innovative Multimodal Design Features	Charlottesville implemented an integrated set of bike boxes, two-stage turn boxes, bicycle lanes, upgraded crosswalks, and shared use markings (sharrows) for the intersection of University Ave and Rugby Rd. This intersection is likely one of the best examples of substantial design and reorientation of an intersection to support bicycle and pedestrian safety in Virginia. The intersection accomplishes this despite the intersection's non-standard configuration.
Funding Sources	City of Charlottesville has $200,000 in their 2019 budget for bicycle infrastructure. Could not find resource indicating funding source for bike boxes for this specific example.
Link to Resource Document(s)/References	1. Bike Boxes at University Ave and Rugby Rd: Link 2. Local news source reporting implementation date: Link
Images/Photographs	From source document 1: 

Examples of Innovative Multimodal Treatments in Virginia

link

Images from Google Maps.

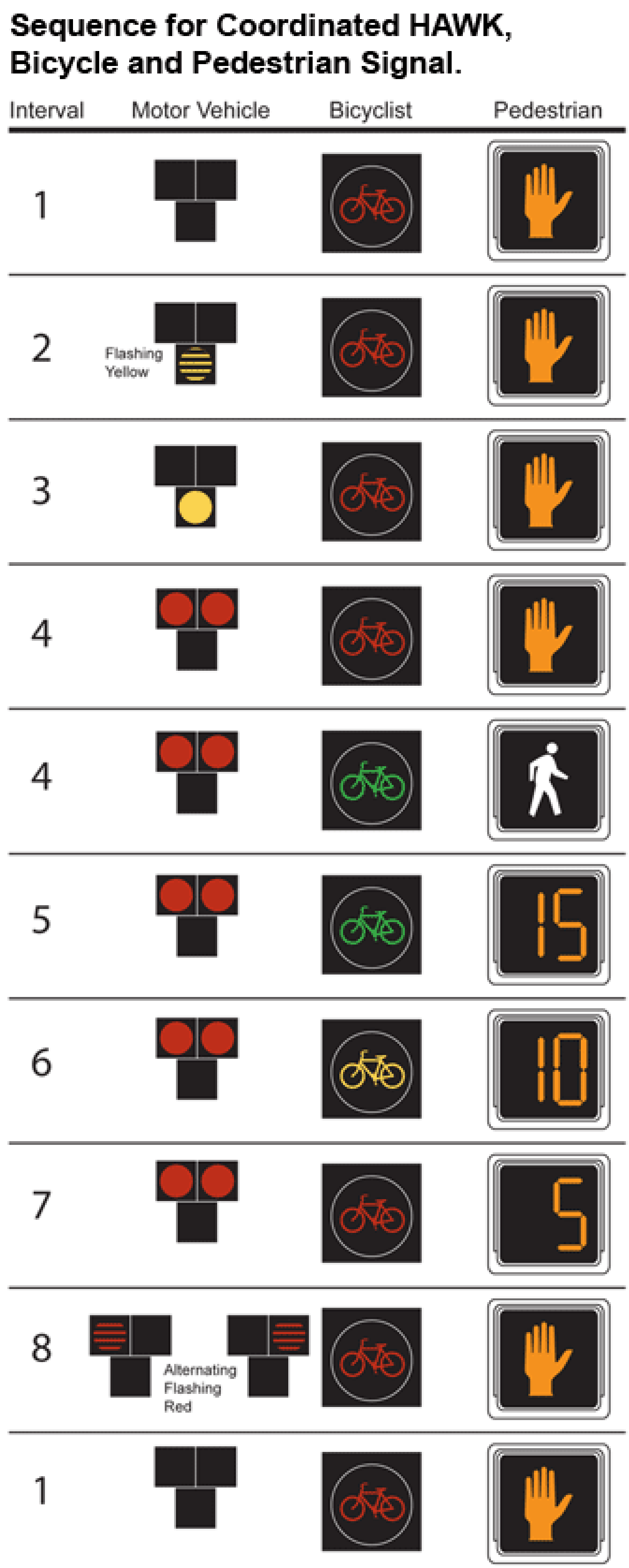
Examples of Innovative Multimodal Treatments in Virginia

Name of Multimodal Project	City of Alexandria Pedestrian Hybrid Beacons
Mode (s) Included	Pedestrians, vehicles, bus riders
Project Description	The Alexandria HAWK brochure discusses Alexandria's version of a pedestrian hybrid beacon referred to as a 'HAWK', an acronym for High intensity Activated crossWalK. The signal is currently experimental and required approval from the FHWA for experimentation. The HAWK is expected to be adopted into standard traffic engineering manuals in the near future. Alexandria HAWK brochure (source 1): "The HAWK (High intensity Activated crossWalK) is technically a "beacon" in that it remains dark for traffic unless a pedestrian activates the push-button. When the pedestrian presses the button, approaching drivers will see a FLASHING YELLOW for a few seconds, indicating that they should reduce speed and be prepared to stop for a pedestrian in the crosswalk. The FLASHING YELLOW is followed by a SOLID YELLOW and then by a SOLID RED, requiring them to STOP at the stop line. At this time, the pedestrian receives a WALK indication on the associated countdown timer. Visually impaired pedestrians will hear the signal indicating that it is safe to cross. At the end of the WALK indication, the pedestrian is displayed a FLASHING DON'T WALK indication and motorist sees an ALTERNATING FLASHING RED. During this period motorists are required to STOP and then proceed once pedestrians have cleared the crosswalk."
Implementation Date	Implemented on N Van Dorn Street in 2008 (included pilot study with data collection).
Innovative Multimodal Design Features	Alexandria implemented HAWK beacons at the intersection of N Van Dorn St and Maris Ave. This implementation allowed for increased safety for pedestrians crossing to the Metro bus stop on the north side of N Van Dorn St. This intersection connects to neighborhoods of low to moderate density that are adjacent to schools.
Funding Sources	Source 2 indicates HAWKs are provide through the Traffic Engineering Division.
Link to Resource Document(s)/Reference s	1. Alexandria HAWK brochure: Link 2. NACTO HAWK sequence: Link 3. City of Alexandria website indicates HAWKs are provided through the Traffic Engineering Division: Link 4. Alexandria DOT document indicating HAWK location and original experimental design/problem statement: Link
Images/Photographs	From Google Maps, Alexandria N Van Dorn St and Marris Ave: Link

Examples of Innovative Multimodal Treatments in Virginia

From Alexandria Hawk Brochure

From Alexandria Hawk Brochure


Sequence for Coordinated HAWK, Bicycle and Pedestrian Signal.
Interval
Motor Vehicle
Bicyclist
Pedestrian
1
2
Flashing Yellow
3
4
4
5
15
6
10
7
5
8
Alternating Flashing Red
1

Examples of Innovative Multimodal Treatments in Virginia

Name of Multimodal Project	Alexandria Rectangular Rapid Flash Beacon (RRFB)
Mode (s) Included	Pedestrian, vehicles
Project Description	Rectangular Rapid Flashing Beacons are solar-powered safety devices with rapid flashing LED lights activated by a pushbutton. The LED lights are set to allow time for vehicles to safely yield to pedestrians at a crosswalk. Studies by the Federal Highway Administration have shown these mechanisms to help increase driver yielding behavior at crosswalks. RRFBs have been implemented at the following locations in Alexandria: 1. 201 Yoakum Parkway (between Edsall Road and Stevenson Avenue): Heavily-used transit stops are located on both sides of this four-lane roadway between multi-family housing units. 2. Duke Street at Telegraph Road: The sidewalk on the north side of Duke Street between West Taylor Run and Roberts Lane is heavily used by pedestrians headed to-and-from Old Town, Patent and Trademark Office (PTO) and the King Street Metro. 3. Braddock Road at Braddock Road Metro: This heavily-used mid-block location was previously delineated by in-pavement lights. By installing rapid-flash beacons and removing in-pavement lights, the City intends to improve visibility of the signals and compliance by motorists. 4. Mount Vernon Ave. at Kennedy Street: A developer contributed $16,000 toward installation as part of the Mount Vernon Commons development.
Implementation Date	As part of its 2008 Pedestrian and Bicycle Mobility Plan, Alexandria installed RRFBs at four intersection crossings in December 2009.
Innovative Multimodal Design Features	RRFBs are an innovative pedestrian safety and traffic calming device. Alexandria has coupled these with reflective yield signage, upgraded crosswalks, and pedestrian islands in some instances.
Funding Sources	According to NACTO, "The effort was coordinated with the Police department to ensure enforcement at the crossing and paid for by the Department of Transportation and Environmental Services. The cost was $25,000 per beacon, not including labor and installation costs, and $91,000 for assembly and installation. Mount Vernon Ave. at Kennedy Street: A developer contributed $16,000 toward installation as part of the Mount Vernon Commons development."
Link to Resource Document(s)/References	1. NACTO: link
Images/Photographs	300 Yoakum Pkwy: link

Examples of Innovative Multimodal Treatments in Virginia

Mt Vernon Ave: [link]

Images from Google Maps.

Examples of Innovative Multimodal Treatments in Virginia

Name of Multimodal Project	Loudoun Rectangular Rapid Flashing Beacons (RRFBs)*
Mode (s) Included	Pedestrians, vehicles, bicyclists
Project Description	According to Virginia Center for Transportation Innovation and Research (source 1): "April 8, 2013, the Virginia Department of Transportation (VDOT) installed a Rectangular Rapid Flashing Beacon (RRFB) system at Belmont Ridge Road in Loudoun County that included two units at the Washington and Old Dominion (W&OD) Trail crossing in addition to advance warning units for the northbound and southbound travel directions. The results of the study indicated that the RRFB systems had a positive effect on motorist awareness. This was evidenced by: the increased yield rates when the system was activated versus not activated; speed reductions when the system was activated; and trail user perspectives on increased opportunities to cross and increased safety at the crossing location."
Implementation Date	April 8, 2013
Innovative Multimodal Design Features	Loudoun's project is an example of RRFBs implemented in tandem with upgraded reflective crosswalks. Additionally, zig-zag pavement markings start in vehicle lanes several hundred feet from the crosswalks to indicating drivers should pay special attention to the upcoming crosswalk. These treatments were also combined with a study to verify the measure the results of the treatments.
Funding Sources	Specific funding source could not be identified, although source 1 indicated VDOT was reponsible for installation.
Link to Resource Document(s)/References	1. Evaluation of a Rectangular Rapid Flashing Beacon System at the Belmont Ridge Rd and W&OD Trail Mid-Block Crosswalk: link 2. BOARD OF SUPERVISORS FINANCE/GOVERNMENT OPERATIONS AND ECONOMIC DEVELOPMENT COMMITTEE INFORMATION ITEM: link 3. BOARD OF SUPERVISORS BUSINESS MEETING ACTION ITEM: link
Images/Photographs	From source document 1:

Examples of Innovative Multimodal Treatments in Virginia

(a) (b)

Figure 2. Eastbound Approach *(a)* and Westbound Approach (b) of W&OD Trail at Belmont Ridge Road

Figure 5. RRFBs and Signage at W&OD Trail Crossing

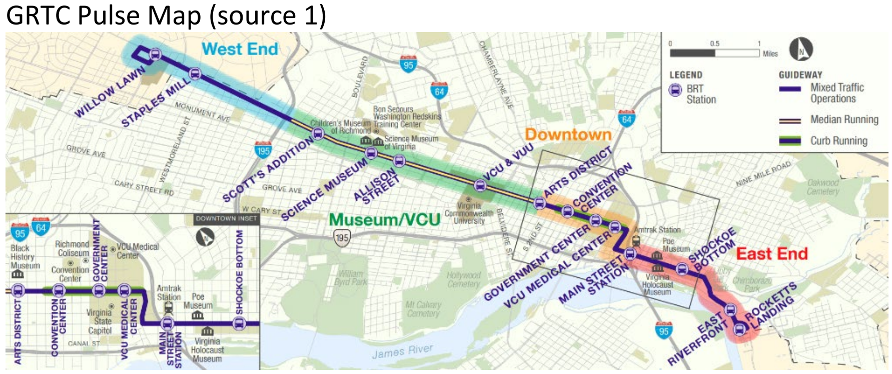
*It appears FHWA and VDOT do not allow RRFBs. From source doc 3: Effective December 21, 2017, Federal Highway Administration (FHWA) rescinded its Interim Approval of Rectangular Rapid Flashing Beacons (RRFBs) (Attachment 2). Consistent with FHWA's actions, Virginia Department of Transportation will not allow RRFB's on future projects.

Belmont Ridge Rd is undergoing redesign and expansion. The portion of the road intersecting W&OD Trail has been raised so no conflict exists between the two. Consequently, the RRFBs have been removed. See following image.

Examples of Innovative Multimodal Treatments in Virginia

Google Maps 2019

Examples of Innovative Multimodal Treatments in Virginia

Name of Multimodal Project	GRTC Pulse
Mode (s) Included	Bus Rapid Transit, bicycles
Project Description	GRTC Pulse is a Bus Rapid Transit (BRT) service that runs 7.6 miles along Broad St, Main St, and other major activity corridors in the City of Richmond. The Pulse earned a Bronze Standard BRT rating by the Institute for Transportation and Development Policy (ITDP).
Implementation Date	Service began Sunday, June 24, 2018.
Innovative Multimodal Design Features	Over three miles of the Pulse runs in dedicated median or shoulder-running bus lanes. Platforms are large and high-quality, with level boarding and real-time arrival signage. Bicycles can be loaded onto the front of the bus. Bicycle parking is available at Pulse stations. The Pulse was designed with careful research conducted in the study area and a robust and ongoing public outreach element (source 3). Pulse riders can purchase passes on their phone or at the fare vending machine (off-board fare collection). Several payment methods are available. The stations are ADA accessible and include audio jack and braille raised character instruction panels (source 4). The Pulse home page has a link to a trip planner that is powered by Google. There are also links to other transit services including C-VAN/CARE paratransit. There is a bus tracking app downloadable from the App Store/Google Play. Source 5 indicates Pulse ridership is double predicted levels, and Richmond transit ridership is up 17% a year after implementation.
Funding Sources	From source 2: Based on the Design-Build contract, the following is the project budget. This includes a project contingency of 5%. • TIGER (FTA/USDOT): $24,900,000 • City of Richmond: $7,600,000 • Henrico County: $400,000 • DRPT/VDOT (Commonwealth of Virginia): $32,016,000 • Total Contributions: $64,916,000
Link to Resource Document(s)/References	1. GRTC Pulse Map: Link 2. GRTC FAQs regarding the Pulse: Link 3. GRTC public outreach: Link 4. GRRC Pulse payment methods: Link 5. WBUR: Link
Images/Photographs	GRTC Pulse Map (source 1) 

Examples of Innovative Multimodal Treatments in Virginia

	Source 5 

Examples of Innovative Multimodal Treatments in Virginia

Name of Multimodal Project	Virginia House Bill 2023 § 33.2-319
Mode (s) Included	Vehicles and bicycles
Project Description	Virginia House Bill 2023 § 33.2-319 describes the eligible cities and subsequent projects eligible for payments and new funds through the Commissioner of Highways. These projects concern existing highways that are classified as principal and minor arterial roads. Dimensional standards apply. This bill contains section D., which updates the bill to allow for continued payments but not additional funds to cities that convert an existing vehicle lane to a bicycle-only lane. In addition, the city is required to expend funds equal to or greater than the funds spent on road and street maintenance and operations in the year prior to conversion. This means the Highway Commission is allowing continued payments but retracting the amount spent on maintenance, a net positive for funding bicycle-only lanes.
Implementation Date	2017
Innovative Multimodal Design Features	While not focused on design, this state-level bill creates a path for funding the conversion of vehicle lanes to bicycle-only lanes. Additionally, this bill requires the new bike lanes to be in keeping with the National Association of City Transportation Officials' Urban Bikeway Design Guide. This is an example of law, design standards, and funding coming full-circle to improve transportation options for Virginia.
Funding Sources	Commissioner of Highways (Virginia Department of Transportation)
Link to Resource Document(s)/References	1. https://law.lis.virginia.gov/vacode/title33.2/chapter3/section33.2-319/
Images/Photographs	Not Applicable

Multimodal System Design Guidelines

Implementation Example Report: Roanoke Valley Transportation Planning Organization

The objective of this report is to document experiences with the 2013 Multimodal System Design Guidelines (MMSDG). Implementation examples help to identify benefits and challenges, along with opportunities for improving these Guidelines in the current update.

Summary of MMSDG Implementation Efforts

Developed in 2013, several of Virginia's government entities used the MMSDG in local and regional planning processes. To date, at least four different efforts are known to have used this resource. Those efforts include:

- **Roanoke Valley: Long Range Transportation Plan**
- Fairfax County: Mixed Use Area Plans
- City of Lynchburg: Better Streets Design Handbook
- City of Norfolk: Downtown Multimodal Plan

Roanoke Valley TPO's Long Range Transportation Plan (LRTP)

In an update of its Long-Range Plan, the Roanoke Valley Transportation Planning Organization made use of the MMSDG. The region had off- and on-road bike plans, which were the focus of the region's multimodal planning. Significant multimodal elements, such as transit, had never been studied to that extent. The region also lacked a vision for all the different travel modes. The MMSDG prompted TPO staff to realize that the Long-Range Plan was missing elements in its multimodal systems plan. The TPO prepared two new modal plans which would feed into the LRTP process: the *Regional Pedestrian Plan: A Coordinated Approach to a Walkable Roanoke Valley* and the *Roanoke Valley Transit Vision Plan*. Many MPOs combine their bicycle and pedestrian plans, yet those modes serve different audiences. Planning for each mode required enough work to keep the plans separate. The MMSDG confirmed the value in analyzing each mode separately.

Documenting Implementation Effort

To research this implementation effort, consultant staff reviewed the Roanoke Valley's planning documents and received information from Cristina Finch, Director of Transportation for the Roanoke Valley-Alleghany Regional Commission. Results are incorporated into the following.

Why Use the MMSDG

Why did the Roanoke Valley TPO use the MMSDG for its long-range planning?

TPO staff recognized that its region's long-range planning efforts were missing transit and pedestrian elements. The region had spent significant time developing and updating plans for off-road trails in the Regional Greenways Plan and on-road bike connections in the Regional Bikeways Plan. The MMSDG demonstrated the importance of delving uniquely into each transportation mode to fully understand the region's multimodal transportation system – existing and desired.

Other Modes

Staff realized there was a lack of planning that had been done for other alternative modes. The TPO had spent relatively less time planning for pedestrian facilities and transit services. The MMSDG identified components that were missing from a multimodal system plan. Although Valley Metro provides bus service in the urban areas, transit service in the suburbs was a missing component. Pedestrian connections within activity centers throughout the region were another missing component. The MMSDG provided a framework and a step-by-step process for developing a multimodal system plan and map, which the TPO wanted to complete and use in the LRTP process.

Geographic Considerations

TPO staff understood that the Roanoke Valley region, due to its topography and past development patterns, had inherent limitations for multimodal transportation. While some parts of the urban area are more conducive to alternative transportation, not all parts of the region are planned to feature multimodal transportation options.

Prioritizing Multimodal Infrastructure

The MMSDG helped the Roanoke Valley TPO develop a plan that identifies the types of multimodal accommodations that are desired and how these accommodations function together within a corridor. The TPO used the MMSDG to prioritize multimodal infrastructure projects in the constrained list in its LRTP and program multimodal projects in the SYIP and TIP.

Components

What components of the Guidelines did you use?

The TPO used many components from the MMSDG.

Multimodal Centers and Districts

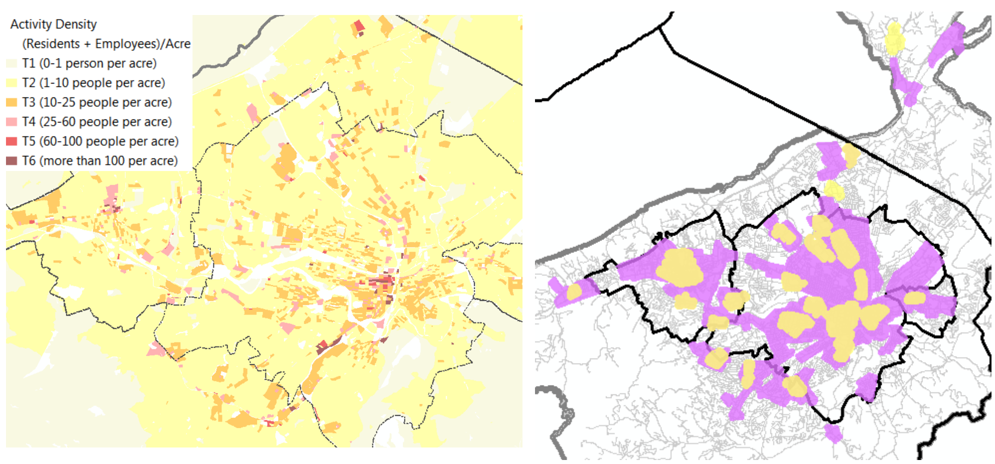


Figure 1: The Roanoke Valley TPO used activity density, existing infrastructure, future land developments, future transportation plans, and local knowledge to determine multimodal districts and centers in a coordinated effort with every locality.

With local stakeholders, TPO staff reviewed the presence of dense residential and employment areas, existing multimodal transportation infrastructure, and the likelihood of an area to possess multimodal characteristics in the future. The TPO identified multimodal districts and centers with individual jurisdictions through a coordinated effort. The Transportation Technical Committee identified places where walking for transportation was important. The TPO identified the multimodal districts and multimodal centers using population density from the 2010 Census, employment density rom 2012 Infogroup private sector data, existing infrastructure, future land developments, future transportation plans, and local knowledge. The TPO met with each locality to determine the multimodal district and center boundaries for their jurisdiction. The TPO adopted the multimodal district and center boundaries in January 2015 to guide the region’s transportation planning efforts.

Modal Emphasis and Multimodal System

Plan In each modal plan, the TPO identified critical transit, pedestrian, and on- and off-road bike corridors, which became the emphasized modes for those corridors. This work produced a multimodal system plan and map with overlaid multimodal districts, multimodal centers, bikeways, greenways, pedestrian corridors, and transit networks.

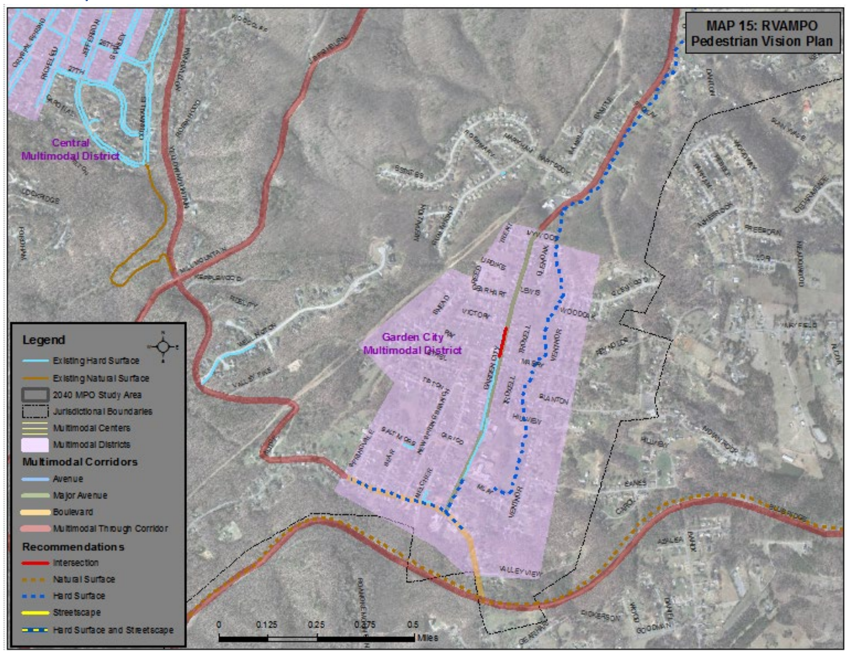


Figure 2: Pedestrian Plan within the Garden City Multimodal District.

TPO staff believed that Modal Emphasis was better used at the local, project level scale. For example, staff used the concept of Modal Emphasis with a study of downtown Roanoke streets, as part of a bus station relocation.

Benefits

How did the MMSDG help development and/or implementation these regional plans?

TPO staff found the Guidelines helpful to visualize the places in the region with a propensity for multimodal transportation and in recognizing the importance of developing a plan for each travel mode. Using the Guidelines, the TPO established regional priorities for pedestrian infrastructure and a phased vision for transit improvements. These decisions focused on mobility within and between Multimodal Centers and Districts, rather than other places in the region. The Centers and Districts provided a foundation for pedestrian and transit planning and will in the next bike plan update.

Challenges

What challenges did you encounter in applying the MMSDG?

With its regional plans, TPO staff felt that the Modal Emphasis component was less useful because those efforts were big picture, visionary plans.

Opportunities for Improvement

What guidance did you wish the Guidelines provided, but you found lacking?

Through its planning processes, TPO staff identified opportunities for improving the MMSDG.

Stakeholder Buy-In

In these processes, TPO staff heard from stakeholders who questioned the process. Some stakeholders thought they should simply pick and pursue multimodal projects that they wanted, as opposed to using an intentional systems improvement approach outlined by the MMSDG process.

Urban Development Areas

The Guidelines could mention UDAs, given their importance in Virginia and VTrans. Staff wondered how Centers and Districts could be integrated or tied to UDAs.

Off-Road Facilities

Off-road trails and paths can be critical parts of the multimodal system. Yet, the MMSDG makes no mention of off-road facilities.

Multimodal System Design Guidelines

Implementation Example Report: Fairfax County

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SUMMARY OF MMSDG IMPLEMENTATION EFFORTS

Developed in 2013, several of Virginia's government entities used the MMSDG with local and regional planning processes. To date, at least four different efforts are known to have used this resource. Those efforts include:

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- City of Norfolk: Downtown Multimodal Plan

FAIRFAX COUNTY MIXED USE AREA PLANS

Fairfax County regularly prepares updates to its Comprehensive Plan ("Comp Plan") through ongoing efforts to revise activity center plans. Upon DRPT's release of the MMSDG, Fairfax County worked with DRPT and VDOT to incorporate the guidance of this document into the existing Comp Plan framework and update process. This resulted in the development of the *Fairfax County Methodology for Developing a Multimodal System Plan*, including an *Urban Street Standards Approach and Process*. These efforts were then applied to the update of the Reston Town Center TSA plan and subsequent activity center plans.

DOCUMENTING IMPLEMENTATION EFFORT

To research this implementation effort, consultant staff reviewed the *Reston Town Center TSA plan* and supplemental *Appendix A: Fairfax County Methodology for Developing a Multimodal System Plan,* and interviewed current City staff, Beth Iannetta—Trails & Infrastructure Coordinator. Results of those interviews are incorporated into the following.

WHY USE THE MMSDG

Why did you use the MMSDG for development of the Better Street Design Handbook? VDOT required the consideration and application of the MMSDG upon the document's release. Fairfax County had previously completed multimodal plans (including Tysons) in which VDOT agreed to an MOU to allow a deviation from VDOT standards that were less applicable to urban areas. All in-progress (Reston) and future plans were required to incorporate the MMSDG.

COMPONENTS

What components of the Guidelines did you use?

The County was able to develop a methodology that took the spirit of the MMSDG and articulate it further into how Fairfax County could implement it with VDOT. This included a six-step approach elaborated in the *Appendix A* document of the Reston plan and summarized below. These steps directly corresponded to elements found within the MMSDG. The County also worked with VDOT to help VDOT create its own methodology for incorporating the guidelines.

Public Engagement (Step 1)

Staff reaffirmed existing Fairfax County practices of public engagement and input, and aligned it with provisions of the guidelines (pg. 25)

Analyzing Existing and Future Population and Employment (Step 2)

Staff referenced the activity density methodology and guidelines (pg. 26) and clarified definitions and designations for Multimodal District Classifications. This helped to reconcile differences between the MMSDG and previous County definitions and resulted in a translated comparison matrix.

Designating Multimodal Districts and Centers (Steps 3 & 4)

Staff translated established activity center designations into the MMSDG guidelines and produced a countywide map that identifies the 21 activity centers with corresponding Multimodal Districts and Centers (including boundaries)

Designating Multimodal Corridors (Step 5)

Staff collaborated with VDOT to align Fairfax County Roadway Classifications, VDOT Functional Classifications, and the MMSDG Multimodal Corridor Types.

Defining the Modal Priority and Creating Corridor Cross-Sections (Step 6)

Once steps 1-5 were complete, staff created cross sections of each corridor in the multimodal district to be in compliance with minimum dimensions defined in the MMSDG.

BENEFITS

How did the MMSDG help the development and/or implementation of the Handbook?

The MMSDG has the ability to provide a helpful framework, but for municipalities like Fairfax County with established guidelines, definitions, and planning capacity, it adds another layer of information that requires translation.

CHALLENGES

What challenges did you encounter in applying the MMSDG?

Incorporating the MMSDG added an additional layer of complexity and translation to fit Fairfax County and VDOT standards and practices. In addition,

Urban Character

Fairfax County has several very urban areas for which the MMSDG designations and guidance to not apply very well. This required the County to work with VDOT to create Urban Streets Standards that acknowledged that MMSDG design standards and VDOT suburban design standards were not always applicable to urban areas.

Definitions

The MMSDG created new language and definitions that did not fit into Fairfax County Comp Plans (classification and district definitions and criteria). This created a challenge for Fairfax County staff to incorporate the Comp Plan language into the MMSDG language, then be able to explain it to VDOT in terms of VDOT's design standards (e.g. roadway classifications). As described above, this translation challenge was overcome by creating a translation matrix between the different classifications, standards, and criteria.

Too Prescriptive

Some definitions were too prescriptive, including types of centers w.r.t GSF of office, employment factor, etc. was challenging. Recommended rethinking definitions for P-Zone and centers. Staff had trouble understanding and applying the "green" classification, which could be interpreted to mean landscaped medians. This was challenging in providing guidance to VDOT, which doesn't focus on greenscapes.

Opportunities for Improvement

What guidance did you wish the Guidelines provided, but you found lacking?

Considering some of the challenges, staff identified a few potential improvements to the MMSDG.

Implementation

The MMSDG needed more clarity on the implementation side, specifically how engineers (e.g. VDOT) would implement the guidelines of the document. It needs more guidance on process—possibly a methodology document for reconciling differences in language. This is important because MMSDG requires a cultural change to apply the guidelines; more guidance on implementation is needed.

Bike-Ped Standards and Practices

Bike-ped practices and standards are changing very quickly. It may need to be updated

Urban Streets

More urban street standards would have been helpful. It was challenging to apply some of the guidelines to more urban areas (e.g. Tysons).

Multimodal System Design Guidelines

Implementation Example Report: City of Lynchburg

The objective of this report is to document experiences with the 2013 Multimodal System Design Guidelines (MMSDG). Implementation examples help to identify benefits and challenges, along with opportunities for improving these Guidelines in the current update.

Summary of MMSDG Implementation Efforts

Developed in 2013, several of Virginia's government entities used the MMSDG with local and regional planning processes. To date, at least four different efforts are known to have used this resource. Those efforts include:

- Roanoke Valley: Long Range Transportation Plan
- Fairfax County: Mixed Use Area Plans
- **City of Lynchburg: Better Streets Design Handbook**
- City of Norfolk: Downtown Multimodal Plan

Lynchburg Better Streets Design Handbook

In 2013, the Virginia Department of Health received a grant to conduct a series of workshops to generate community interest and to educate stakeholders, regarding the implementation of *Complete Streets* policies. A subsequent local assistance grant resulted in additional workshops on the principles of Green Streets. The City of Lynchburg's Planning Commission later formed an advisory committee to draft a Complete and Green Streets policy that would be incorporated into a Comprehensive Plan update.

Using the MMSDG, the City drafted a *Better Streets Design Handbook* that was intended to be included as part of the City's updated Comprehensive Plan. While the updated plan included a Complete Streets Policy, the Handbook was never formally adopted. Yet, the Handbook remains as a reference for City staff.

Documenting Implementation Effort

To research this implementation effort, consultant staff reviewed the Better Streets Design Handbook and interviewed current and former City staff: Anne Nygaard, Planner II in Community Development, and Don DeBerry, former City Engineer in Public Works. Results of those interviews are incorporated into the following.

Why Use the MMSDG

Why did you use the MMSDG for development of the Better Street Design Handbook? City Community Development had attended a conference session on the MMSDG and was interested in developing a set of guidelines the City could use for future road design projects. They wanted to have a resource that road designers could use to implement multimodal facilities during regular maintenance projects, for example incorporating bicycle lanes into the design when the road is repaved during a water line replacement. The City used the guidelines to develop typical sections for several corridors. From a methodology perspective, staff felt that the MMSDG was useful.

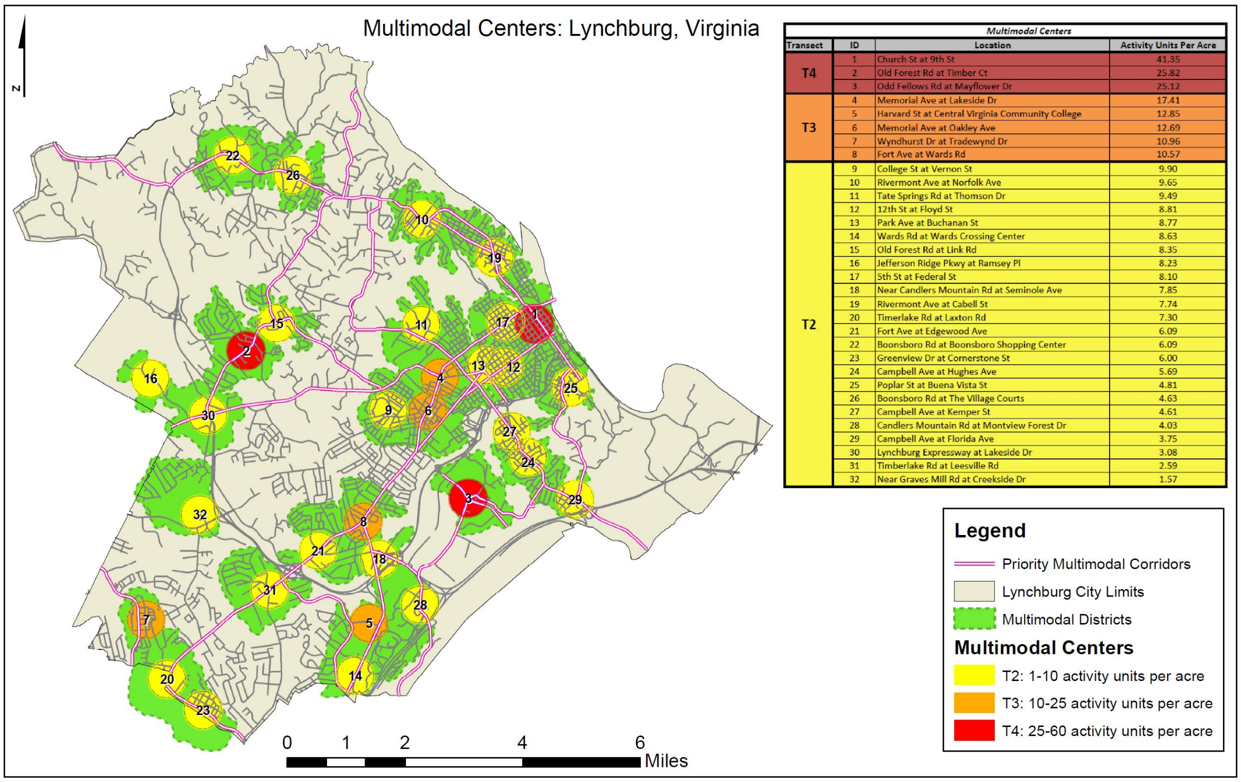
COMPONENTS

What components of the Guidelines did you use?

The City and their consultant used several components of the MMSDG.

Multimodal Districts and Centers

Staff defined Multimodal Districts and Centers, using methodologies in the MMSDG. As explained under the challenges section, staff indicated the low density and sprawling character of the City's 50-mile land area made identifying the multimodal districts and centers challenging, especially in the suburban areas.



Multimodal Centers			
Transect	ID	Location	Activity Units Per Acre
T4	1	Church St at 9th St	41.35
	2	Old Forest Rd at Timber Ct	25.82
	3	Odd Fellows Rd at Mayflower Dr	25.12
T3	4	Memorial Ave at Lakeside Dr	17.41
	5	Harvard St at Central Virginia Community College	12.85
	6	Memorial Ave at Oakley Ave	12.69
	7	Wyndhurst Dr at Tradewynd Dr	10.96
	8	Fort Ave at Wards Rd	10.57
T2	9	College St at Vernon St	9.90
	10	Rivermont Ave at Norfolk Ave	9.65
	11	Tate Springs Rd at Thomson Dr	9.49
	12	12th St at Floyd St	8.81
	13	Park Ave at Buchanan St	8.77
	14	Wards Rd at Wards Crossing Center	8.63
	15	Old Forest Rd at Link Rd	8.35
	16	Jefferson Ridge Pkwy at Ramsey Pl	8.23
	17	5th St at Federal St	8.10
	18	Near Candlers Mountain Rd at Seminole Ave	7.85
	19	Rivermont Ave at Cabell St	7.74
	20	Timerlake Rd at Laxton Rd	7.30
	21	Fort Ave at Edgewood Ave	6.09
	22	Boonsboro Rd at Boonsboro Shopping Center	6.09
	23	Greenview Dr at Cornerstone St	6.00
	24	Campbell Ave at Hughes Ave	5.69
	25	Poplar St at Buena Vista St	4.81
	26	Boonsboro Rd at The Village Courts	4.63
	27	Campbell Ave at Kemper St	4.61
	28	Candlers Mountain Rd at Montview Forest Dr	4.03
	29	Campbell Ave at Florida Ave	3.75
	30	Lynchburg Expressway at Lakeside Dr	3.08
	31	Timberlake Rd at Leesville Rd	2.59
	32	Near Graves Mill Rd at Creekside Dr	1.57

Figure 1: Multimodal Centers and Multimodal Districts identified in the Better Streets Design Handbook

Typical Street Sections

Staff used the MMSDG to develop typical sections for several multimodal corridors. This included guidance on where to place bike lanes, sidewalks and other street features.

BENEFITS

How did the MMSDG help the development and/or implementation of the Handbook?

Staff said the Guidelines could be useful with new road or intersection projects. City Community Development staff indicated an interest in updating its Manual of Specifications that is used for road design to incorporate the Guidelines so that the City can retrofit its existing roads when road projects arise.

CHALLENGES

What challenges did you encounter in applying the MMSDG?

Overall, development of the Better Streets Design Handbook was a challenging process. There were several difficulties with feasibility, funding, and the application to Lynchburg. Many challenges had nothing to do with the MMSDG but there were issues with how the Guidelines apply to Lynchburg.

Suburban Layout

Lynchburg is largely suburban, encompassing 50 square miles. Trying to focus multimodal investments was challenging. The Guidelines' concept of modal emphasis is ideal for cities with gridded streets where one road can have one mode emphasized and another parallel road can emphasize a different mode. The mountainous topography in Lynchburg creates few parallel roads with adequate right-of-way and few roads that connect districts or centers. This forced staff to include as many modes as possible into a corridor, as there are few parallel routes. Most of the City lacks a complete street grid.

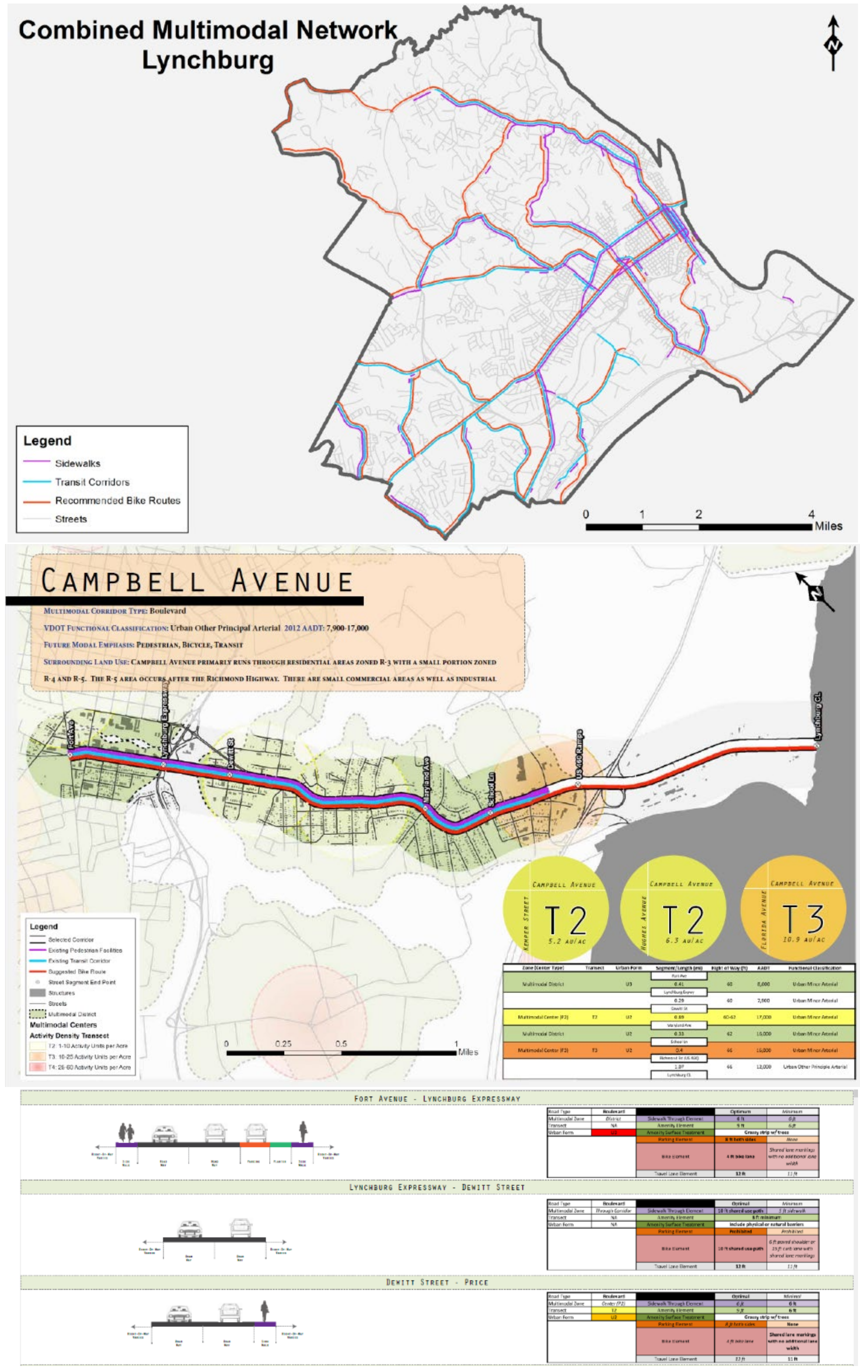


Figure 2: The City used the concepts of Modal Emphasis, Multimodal Corridor Types, and Transect Zones to develop typical sections for several multimodal corridors.

Staff also had trouble identifying multimodal centers because land uses in Lynchburg are spread out and low density. City staff felt this task required some guess work and felt it was forced.

Right of Way and Topography

Lynchburg is an older City with narrow right of ways. The hilly topography also causes challenges, as there are difficulties with providing bike facilities.

Unrealistic to Implement because of Funding Limitations

Overall, there was a feeling that by designing the typical sections of all of the major roadway corridors in the City, the Better Street Design effort was considered a pipe dream. Transportation funding is limited. Lynchburg has a slow growth rate and there are few opportunities to reconstruct all the corridors. The Planning Department completed several corridor studies, approximately half a dozen. However, none of them are being implemented, according to Mr. DeBerry.

Communication

There is limited communication or guidance on how to best coordinate between the Community Development and Public Works departments. There is a gap between the departments, in determining what will be studied and what can be built next. There could also be better coordination with the Metropolitan Planning Organization.

Unfocused Effort

In retrospect, staff thought the effort should have been more focused. The Handbook attempted to address all major streets in the City, making the document unrealistic. The Handbook could have been incorporated as Guidelines, by reference, whenever the City embarks upon a planning effort. Staff thought they should have focused on only a few important corridors.

Defining Centers

Staff had identified 35 multimodal centers, partly because they had troubles determining what justified a center. Staff feels that they identified too many centers, given they did not have the funds to develop plans for each. The definition of a "Center" needed to be expanded for a community like Lynchburg. Staff mentioned that one of the activity centers is a Wal-Mart shopping center but felt this was not a realistic multimodal center. The scale of the centers was also challenging. City staff expanded the area for the Liberty University center because it needed to encompass the entire campus.

Opportunities for Improvement

What guidance did you wish the Guidelines provided, but you found lacking?

Considering some of the challenges, staff identified a few potential improvements to the MMSDG.

Facilities for Modes at Intersections

Staff wished there was more guidance on how to design intersections to accommodate all the different modes. How should bike and pedestrian facilities interact with transit? For example, more guidance on bike boxes, narrowing the intersections, and putting in more refuges for pedestrians to cross could have been helpful.

Transit Guidance

Transit headways in Lynchburg are longer than 30 minutes. Staff would like to see more guidance on how to encourage transit ridership, to help justify shorter headways and improved bus stops.

Smaller Urbanized Areas

Staff had the impression that the Guidelines were written for a more urbanized city with a comprehensive street grid. Using the MMSDG felt forced at times. Staff was curious about the transition between urban and suburban areas – how can these areas be tied together with the Guidelines.

Interim Steps and Simplification

Lynchburg staff wanted more guidance on interim steps and how to change a typical roadway into a multimodal facility. Retrofitting streets is complicated and staff wanted guidance on how to make that process easier. Staff initially felt confident about using the MMSDG but found the planning process was more complicated than they anticipated. One example is Boonsboro Road – staff would like to understand what interim steps could be taken to improve safety for bicyclists and pedestrians without reconstructing the entire corridor. Tactical urbanism has become more popular, and there are ways to try out improvements on a temporary basis before moving curbs and other major construction projects. More guidance on this would be helpful.

Multimodal System Design Guidelines

Implementation Example Report: City of Norfolk

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- Fairfax County: Mixed Use Area Plans
- City of Lynchburg: Better Streets Design Handbook
- **City of Norfolk: Downtown Plan 2030 Update**

Norfolk Downtown Plan 2030 Update

In 2018, the City of Norfolk began updating its Downtown Master Plan. Norfolk's vision for the future of Downtown includes a fully integrated transportation hub for passenger rail, light rail, and ferry operations as well as a pedestrian- and bike-friendly place. The master plan update focused on creating pedestrian-friendly environments, connecting streets and public spaces with the water, creating active public spaces and "whole" places, and eliminating barriers that isolate different parts of the city. Transportation-related principles included increasing viable transportation choices and promoting walkability by taming traffic on through streets and providing safe, comfortable, and frequent pedestrian crossings. As part of the master plan update, the City developed a multimodal system plan for its downtown area including the downtown core, Neon Arts District, and the future redesign of the St. Paul's neighborhood.

Documenting Implementation Effort

This implementation effort is documented from the experience of EPR staff who prepared the multimodal system plan for the Norfolk downtown area.

Why Use the MMSDG

Why did you use the MMSDG for development of the Norfolk Downtown Plan 2030 Update? Making Norfolk's streets safe and comfortable for pedestrians was a recurring theme of the downtown plan update. The City and steering committee desired to transform the City's major roads that were designed for high-speed vehicle throughput to slow traffic down, discourage trips from using downtown streets as a cut-through to other areas, and improve safety for pedestrian and bicyclists.

The multimodal system plan provided a way for the City and steering committee plan and give direction to these intentions. By designating the downtown area as a multimodal center, all streets within the downtown were categorized as multimodal placemaking corridors, rather than multimodal through corridors. In addition, all streets in the downtown were designated with pedestrian modal emphasis, reflecting the policy in the system plan that all streets should be designed for pedestrians, not just vehicles. The multimodal system plan also engaged the Downtown Norfolk Council, Bicycle & Pedestrian Committee, and City departments in providing connected networks for transit and bicycle modes as well and these networks were incorporated into the overall plan. The multimodal system plan cohesively integrated the various visioning, strategic plans, revitalization strategies, and area plans that were developed in prior years with the goals of the Downtown Plan Update. It also supported the connectivity and urban form framework that the Downtown Plan Update team had previously prepared.

The City is also using some of the multimodal system planning for the downtown to showcase the multimodal planning concepts that will soon be applied on a citywide scale through the upcoming development of the City's Multimodal Transportation Master Plan.

Components

What components of the Guidelines did you use?

The multimodal system plan followed all the components specified within the MMSDG.

Multimodal Districts and Centers

The Downtown Plan Update team analyzed the activity density of the downtown area using population and employment data by Census blocks. The team initially identified three individual multimodal centers for the downtown core, Neon arts district, and St. Paul's neighborhood. The outer quarter-to-half mile radius rings of the three centers overlapped. The team agreed to consider the entire downtown area as one multimodal center to reinforce a policy for knitting together the St. Paul's neighborhood and the downtown core and to highlight the need for redesigning St. Paul's Boulevard so that it no longer acts as a pedestrian barrier. The single downtown multimodal district also further emphasized the need to improve connections between the downtown core and the arts district.

Multimodal Corridor Types and Modal Emphasis

The Downtown Plan Update team designated pedestrian emphasis on every street in the downtown area. The team designated bicycle emphasis on the 12 Plan corridors included in the Norfolk Bicycle and Pedestrian Strategic Plan and met with the Bicycle and Pedestrian Committee to refine the network. The team designated transit emphasis on streets where bus service currently runs.

The streets within the St. Paul's neighborhood will be realigned as part of the future neighborhood redevelopment outlined in the St. Paul's Transformation Plan. The team included the future street network in the multimodal system master plan. The team also included future pedestrian and bicycle connections across what is now the MacArthur Mall at the direction of the steering committee.

Typical Street Sections

The City used the designated modal emphasis and corridor types to design the cross-sections for new roads that will be constructed as part of the St. Paul's neighborhood redevelopment. The team also developed illustrations demonstrating how existing streets could be redesigned within the existing right-of-way to better balance the emphasized modes in different parts of the downtown area.

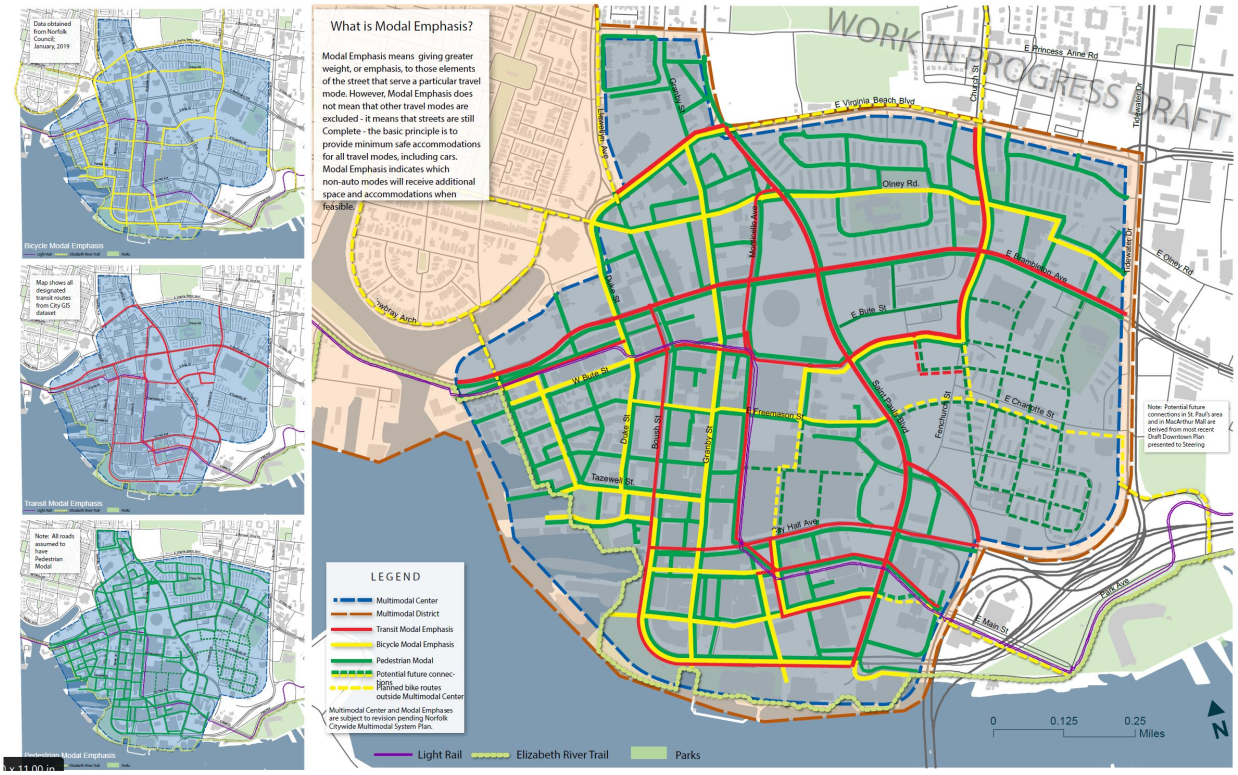

Figure 1: The multimodal system plan for the downtown area established one multimodal center for the downtown area including the downtown core, Neon arts district, and St. Paul's neighborhood. The multimodal system plan identified the modal emphasis for every street within the downtown area.

Major Avenues like Church Street north of Freemason include dedicated infrastructure for pedestrians, bicycles, transit, and vehicles while maintaining a comfortable and safe environment.

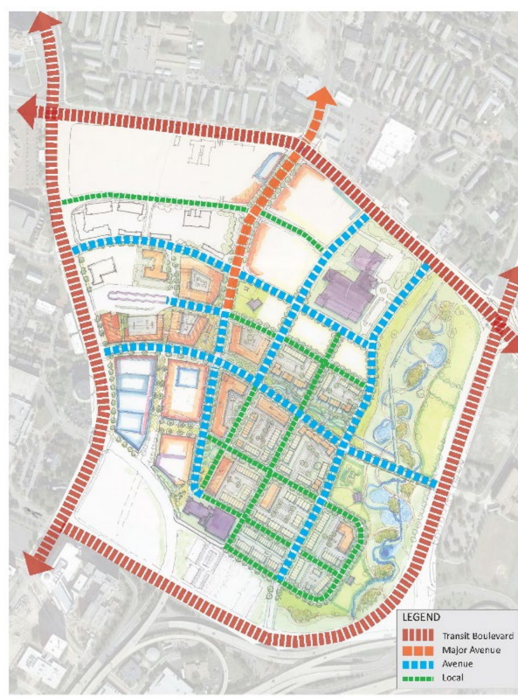

Figure 2: The multimodal corridor types from the Downtown Multimodal System Plan were integrated into the Transformation Plan for the St. Paul's Neighborhood. The Transformation Plan team developed cross-sections to illustrate how the neighborhood streets would better balance all modes.

Benefits

How did the MMSDG help the development and/or implementation of the Handbook?
By defining the multimodal centers, multimodal corridor types and the modal emphasis, the multimodal system plan will help decision-makers and roadway designers to understand the function of each corridor within the broader land use and system-wide context. It will ensure that future improvements are designed to best balance the emphasized modes. Furthermore, it will tie into a city-wide multimodal system planning process that is currently underway.

Challenges

What challenges did you encounter in applying the MMSDG?
Applying the MMSDG in Norfolk presented a few challenges.

Dedicated Transitways on Avenues and Local Streets

The Transit Boulevard is the only multimodal corridor type with dedicated right-of-way for transit. However, the Tide light rail alignment traverses Avenues and Local Streets in addition to Boulevards. The Guidelines were unclear on how to design these types of corridors with dedicated transitways.

Overlapping Multimodal Centers

The three initially defined multimodal centers overlapped significantly. The team decided to consolidate the three centers into one larger multimodal center. The team questioned how to determine the multimodal center place type with multiple focal points in close proximity and how large of an area was too large to be considered one multimodal center.

Are Multimodal Through Corridors a Necessity?

The team refrained from designating the multimodal corridor types for the streets on the edges of the multimodal center. The team and steering committee discussed a desire to prevent drivers from using downtown streets to pass through the downtown on the way to other areas. Although this was not discussed at length, the discussion highlighted the possibility that an urban, walkable community context such as downtown Norfolk could be better served by making all streets into placemaking corridors with no multimodal through corridors.

Opportunities for Improvement

What guidance did you wish the Guidelines provided, but you found lacking?

More Guidance for Designing Intersections

The team prepared several illustrations of redesigned streets and intersections at select locations. Additional guidance on multimodal intersection treatments would have been helpful.

Reducing Speeds

Some team members desired more information to show that lowering posted speeds does not significantly affect vehicular throughput overall.

Bus-Only Lanes

The City was interested in converting a travel lane in each direction to a bus-only lane or a bus-and-bike lane on several roads. More guidance on this topic would have been helpful.