North Carolina Department of Transportation

Complete Streets Planning and Design Guidelines

July 2012

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Preface

The North Carolina Board of Transportation adopted a Complete Streets policy in July 2009. The policy directs the North Carolina Department of Transportation (NCDOT) to consider and incorporate all modes of transportation when building new projects or making improvements to existing infrastructure. Under the new policy, NCDOT will collaborate with cities, towns, and communities during the planning and design phases of new streets or improvement projects. Together, they will decide how to provide the transportation options needed to serve the community and complement the context of the area.

The policy adopted by the Board of Transportation directed NCDOT to develop planning and design guidelines. The following chapters represent the planning and design guidelines, and are the result of a collaborative effort between NCDOT and representatives of metropolitan planning organizations, cities, towns, transit agencies, and the Federal Highway Administration. Development of the guidelines included public comment periods to gain feedback from cities, towns, transit agencies, advocacy groups, and other interested parties; the input gained informed the planning and design guidelines.

The following, included in this preface for reference, is NCDOT's adopted complete streets policy.

Under the Complete Streets policy, NCDOT is to collaborate with communities during the planning and design phases of new streets or improvement projects to decide how to provide transportation options needed to serve the community.

North Carolina Department of Transportation Complete Streets Policy

A. Definition
Complete Streets is North Carolina's approach to interdependent, multi-modal transportation networks that safely accommodate access and travel for all users.

B. Policy Statement
Transportation, quality of life, and economic development are all undeniably connected through well-planned, well-designed, and context-sensitive transportation solutions. To NCDOT the designations "well-planned', "well-designed" and "context-sensitive" imply that transportation is an integral part of a comprehensive network that safely supports the needs of the communities and the traveling public that are served.

The North Carolina Department of Transportation, in its role as steward over the transportation infrastructure, is committed to:

- providing an efficient multi-modal transportation network in North Carolina such that the access, mobility, and safety needs of motorists, transit users, bicyclists, and pedestrians of all ages and abilities are safely accommodated;
- caring for the built and natural environments by promoting sustainable development practices that minimize impacts on natural resources, historic, businesses, residents, scenic and other community values, while also recognizing that transportation improvements have significant potential to contribute to local, regional, and statewide quality of life and economic development objectives;
- working in partnership with local government agencies, interest groups, and the public to plan, fund, design, construct, and manage complete street networks that sustain mobility while accommodating walking, biking, and transit opportunities safely.

This policy requires that NCDOT's planners and designers will consider and incorporate multimodal alternatives in the design and improvement of all appropriate transportation projects within a growth area of a town or city unless exceptional circumstances exist. Routine maintenance projects may be excluded from this requirement if an appropriate source of funding is not available.

C. Purpose
This policy sets forth the protocol for the development of transportation networks that encourage non-vehicular travel without compromising the safety, efficiency, or function of the facility. The purpose of this policy is to guide existing decision making and design processes to ensure that all users are routinely considered during the planning, design, construction, funding and operation of North Carolina's transportation network.

D. Scope and Applicability

This policy generally applies to facilities that exist in urban or suburban areas; however, it does not necessarily exclude rural setting; and is viewed as a network that functions in an interdependent manner.

There are many factors that must be considered when defining the facility and the degree to which this policy applies, e.g., number of lanes, design speeds, intersection spacing, medians, curb parking, etc. Therefore, the applicability of this policy, as stated, should be construed as neither comprehensive nor conclusive. Each facility must be evaluated for proper applicability.

Notwithstanding the exceptions stated herein, all transportation facilities within a growth area of a town or city funded by or through NCDOT, and planned, designed, or constructed on state-maintained facilities, must adhere to this policy.

E. Approach

It is the Department's commitment to collaborate with cities, towns, and communities to ensure pedestrian, bicycle, and transit options are included as an integral part of their total transportation vision. As a partner in the development and realization of their visions, the Department desires to assist localities, through the facilitation of long-range planning, to optimize connectivity, network interdependence, context sensitive options, and multimodal alternatives.

F. Related Policies

This policy builds on current practices and encourages creativity for considering and providing multi-modal options within transportation projects, while achieving safety and efficiency. Specific procedural guidance includes:

- Bicycle Policy (adopted April 4, 1991)
- Highway Landscape Planting Policy (dated 6/10/88)
- Board of Transportation Resolution: Bicycling & Walking in North Carolina, A Critical Part of the Transportation System (adopted September 8, 2000)
- Guidelines for Planting within Highway Right-of-Way
- Bridge Policy (March 2000)
- Pedestrian Policy Guidelines – Sidewalk Location (Memo from Larry Goode, February 15, 1995)
- Pedestrian Policy Guidelines (effective October 1, 2000 w/Memo from Len Hill, September 28, 2000)
- NCDOT Context Sensitive Solutions Goals and Working Guidelines(created 9-23-02; updated 9-8-03)

G. Exceptions to Policy

It is the Department's expectation that suitable multimodal alternatives will be incorporated in all appropriate new and improved infrastructure projects. However, exceptions to this policy will be considered where exceptional circumstances that prohibit adherence to this policy exist. Such exceptions include, but are not limited to:

- facilities that prohibit specific users by law from using them,
- areas in which the population and employment densities or level of transit service around the facility does not justify the incorporation of multimodal alternatives.

It is the Department's expectation that suitable multimodal alternatives will be incorporated as appropriate in all new and improved infrastructure projects within a growth area of a town or city.

As exceptions to policy requests are unique in nature, each will be considered on a case-by- case basis. Each exception must be approved by the Chief Deputy Secretary.

Routine maintenance projects may be excluded from this requirement if an appropriate source of funding is not available.

H. Planning and Design Guidelines

The Department recognizes that a well- planned and designed transportation system that is responsive to its context and meets the needs of its users is the result of thoughtful planning. The Department further recognizes the need to provide planners, designers and decision-makers with a framework for evaluating and incorporating various design elements into the planning, design, and construction phases of its transportation projects. To this end, a multi-disciplinary team of stakeholders, including transportation professionals, interest groups, and others, as appropriate, will be assembled and charged with developing comprehensive planning and design guidelines to support this policy.

These guidelines will describe the project development process and incorporate transparency and accountability where it does not currently exist; describe how (from a planning and design perspective) pedestrians, bicyclists, transit, and motor vehicles will share roads safely; and provide special design elements and traffic management strategies to address unique circumstances.

An expected delivery date for planning and design guidelines will be set upon adoption of this policy.

I. Policy Distribution

It is the responsibility of all employees to comply with Departmental policies. Therefore, every business unit and appropriate private service provider will be required to maintain a complete set of these policies. The Department shall periodically update departmental guidance to ensure that accurate and up-to-date information is maintained and housed in a policy management system.

Approved by North Carolina Board of Transportation, July 9, 2009

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1. Implementing Complete Streets in North Carolina

Even before the founding of the Interstate Highway System, transportation planning and design was focused on the safe movement of cars and trucks from point A to point B, alleviating bottlenecks along the way, and increasing access and capacity in response to increasing traffic. It didn't matter whether the facility was an interstate highway, a freeway, a community main street, or a rural road, the automobile was an emerging mode of transportation and getting motorists from their origins to their destinations as quickly and smoothly as possible was the role of the transportation planner and engineer. This seemed an appropriate response to the desires of the times—a growing country wanting quick access to commerce and connectivity from city to city and region to region.

Over time, though, the demand for transportation services has changed, and this auto-only focus has had unintended consequences for communities, for those needing or wanting to use other transportation modes, and even for motorists. For the past 50 years, streets have been designed to serve motor vehicles and often have not included sidewalks or bicycle facilities. As a result, it is difficult to walk, bicycle, or use transit in many places due to incomplete streets. People seeking to travel by modes other than the automobile need more transit services and better access to those services. Our residents also desire more pedestrian and bike friendly choices for mobility. These mobility choices will increase the level of independence for all users. Motorists are also facing increasingly congested roadways that have resulted from an auto-only emphasis. For all of these reasons, there is a growing need to ensure that streets provide safety and mobility for all users. Well-planned, well-designed, context-based streets are an integral part of a comprehensive transportation network that safely supports the needs of the communities and the traveling public, no matter how they are traveling.

Complete streets represent North Carolina's approach to interdependent, multimodal transportation networks that safely accommodate access and travel for all users of all ages and abilities.

The North Carolina Board of Transportation adopted a complete streets policy in July 2009. The purpose of the policy is to "guide existing decision making and design processes to ensure that all users are routinely considered during the planning, design, construction, funding and operation of North Carolina's transportation network." The adoption of the policy and subsequent formation of detailed guidance represents a significant shift in North Carolina's approach to street design. Meeting the mobility requirements of the 21st century requires collaborative, local context decision making and a shift away from designing an auto-focused highway system toward designing and operating a street network that safely and conveniently accommodates all transportation modes.

What are Complete Streets?

It is possible to find many examples of incomplete streets—streets that were designed primarily for vehicular throughput and that made it more difficult to move about using other modes. Conversely, and as defined by the National Complete Streets Coalition:

> *"Complete streets are designed and operated to enable safe access for all users. Pedestrians, bicyclists, motorists and transit riders of all ages and abilities must be able to safely move along and across a complete street."*

Therefore, a complete streets philosophy means that NCDOT and its partners will provide a network of streets that safely and comfortably accommodate all users, including bicyclists, pedestrians, and transit users. Typical elements that make up a complete street include sidewalks, bicycle lanes, appropriate street widths and speeds, and transit stops with benches, shelters, and access points that comply with Americans with Disabilities Act requirements.

Complete street design elements that emphasize safety, mobility, and accessibility for those using a variety of travel modes may also include crosswalks, bus lanes, adequate separation between sidewalks and streets, street trees and other landscaping, lighting, and signal systems. Though complete streets may initially be designed or built as apparently disconnected segments, the intent is to incrementally grow and develop extensive networks of complete streets. This will require systematic application of the complete streets principles and designs included in these guidelines.

When defining complete streets, NCDOT recognizes that streets are different from highways and, therefore, should be designed differently from highways. Highways operate at much higher speeds and function differently than streets. Highways serve an important function, focusing on providing the highest level of efficiency for very high traffic volumes, typically over longer distances, and providing connections between towns and cities. As such, they are more auto oriented and provide more access control than streets, and traditional highway design is appropriate and necessary for these types of facilities.

On the other hand, streets predominately serve to provide connectivity within communities and access to surrounding land uses. This requires a focus on providing design treatments for all modes so that people can move about within their communities by car, transit, bicycle, or on foot. It requires moving toward an understanding and expectation that "functionality" does not just apply to motor vehicles—streets should be evaluated and designed with an eye to functionality for all users. Streets also represent a significant portion of the public realm and play an important role in community livability. Therefore, street design practices and principles should differ from highway design practices and principles. These guidelines are intended to provide the direction for establishing those street design practices.

Finally, although freeways and expressways are not a part of a complete street framework, their intersections with surface streets, as well as bridges or underpasses crossing them, should be designed to safely and comfortably accommodate bicyclists, pedestrians, and transit users. This will further ensure the long-term development of complete street networks that support all users.

Streets that were primarily designed for vehicular throughput can make it difficult to move about using other modes.

Why Are Complete Streets Important for North Carolina?

The adoption of NCDOT's Complete Streets policy and the formation and ongoing implementation of these guidelines will represent a significant change in the approach to street design for North Carolina. At the heart of this transition to complete streets is the understanding that "transportation" is not only about moving cars, but also about moving people and connecting, supporting, and building communities. This includes the recognition that streets contribute to the quality of life and the economic vitality of places and are meant to serve all users. It is about providing North Carolinians with safe, comfortable, and viable options for how they move about their communities. This will be increasingly important as North Carolina continues to grow and urbanize, and as its residents continue to demand and require transportation choices, whether they live in large cities or in small towns.

Complete streets also provide healthier transportation options to North Carolina residents. Complete streets provide opportunities for physical activity that promote walking, biking, and transit use. In 2009, the Centers for Disease Control and Prevention recommended that communities adopt complete streets policies to fight against obesity, as over 100 recent studies have shown a connection between obesity and automobile dependence. By providing more facilities for walking, biking, and active transportation, North Carolina is helping to combat a major public health crisis.

North Carolina is diverse in its geography, communities, land uses, and the needs and expectations of its people. It offers a quality of life that draws people to live here and encourages businesses to grow here. Our population reflects the importance of this quality of life as retirees, young workers, and families choose to stay in North Carolina or to come here from other places. As the state continues to grow, it must

Complete streets provide for and encourage use by all users.

address the interconnection between transportation and economic development in a manner that maintains and enhances the quality of life that is paramount to the communities throughout this state. Serving our citizens, our businesses, and our communities will require the emphasis on viable transportation choices that are provided by complete streets.

For many years, the practice of street design was driven by functional considerations for motor vehicles, such as engineering criteria, cost, and user benefits. More recently, it has been recognized that while these represent legitimate reasons for pursuing street improvements, functional considerations must extend to all users of the street as well as the broad array of contextual factors that may affect a proposed street project. Understanding context is a critical element for designing a street that functions well in its surroundings. NCDOT recognizes that its complete street approach will help to better match streets with the many communities and contexts represented across the state.

As stewards of the state's transportation infrastructure, NCDOT is committed to providing an efficient transportation network, caring for the built environment by promoting sustainable development practices and working in partnership with local and regional government agencies, interest groups and the public to create a network of complete streets. There are many benefits of this complete streets approach including:

- Making it easier for travelers to get where they need to go;
- Providing for, and encouraging, the use of all modes of transportation;
- Increasing accessibility and mobility for the disabled, children, our aging population, and those without motor vehicles;
- Improving safety for pedestrians, cyclists, transit users, and motorists;
- Supporting public health goals by increasing opportunities for physical activity through active transportation;
- Building more sustainable communities;
- Increasing connectivity between neighborhoods, streets, commercial areas, and transit systems; and
- Adding value to communities and neighborhoods.

Complete streets provide a framework under which NCDOT and our local communities can use resources efficiently through a multimodal approach to providing infrastructure. This is an approach that serves more users. By creating efficiency in the use of the infrastructure we build and maintain, complete streets also serve to protect and enhance quality of life. Complete streets can assist with the creation of healthy communities that can sustain our generation, as well as the generations that follow ours.

Why is NCDOT Changing Its Approach?

North Carolina is a growing state, with a variety of communities and varying needs of its residents, businesses, and visitors. A common element amidst this diversity is that transportation provides an integral link between the quality of life and the economic development of the state. If we are to maintain and enhance the quality of life that encourages business to grow here, and people to want to live, work, and play here, NCDOT must change its approach to meet the needs of this growing, changing population and business environment.

NCDOT's complete streets guidelines also reflect the direction from the Board of Transportation's policy to engage in a collaborative process with cities, towns, and communities toward integrating pedestrian, bicyclist, and transit facilities and services into its total state transportation vision. The approach emphasizes NCDOT's partnership with localities in the planning, design, construction and maintenance of an interconnected, interdependent network of context-based streets that provide for all modes. This complete streets approach aligns with the U.S. Department of Transportation's (USDOT) 2010 policy statement for complete streets, which states that "Transportation programs and facilities should accommodate people of all ages and abilities, including people too young to drive, people who cannot drive, and people who choose not to drive." The policy also states that "The establishment of well-connected walking and bicycling networks is an important component for livable communities, and their design should be a part of Federal-aid project developments." Complete streets represent an efficient approach to providing these emerging networks across North Carolina.

Given this, complete streets are an investment in the future of North Carolina's communities and citizens through a commitment to creating sustainable transportation networks that support livable communities. Creating a network of complete streets provides choices beyond the automobile and allows citizens to walk, bike, and use transit, resulting in improved public health and livability. NCDOT's commitment to complete streets represents its ongoing commitment to providing a safe and functional street network by recognizing that complete streets provide those essential benefits to all users, including motorists, pedestrians, bicyclists, and transit users.

How Will NCDOT Implement Complete Streets?

Complete streets implementation actually began with the adoption of the Complete Streets Policy. With that adoption came the responsibility to plan and implement all future street projects to provide for the safe travel of all users, but also recognition that NCDOT's transportation divisions and districts, planners, and engineers need processes and guidelines to apply this new philosophy and approach.

The challenge that transportation planners and designers face is to balance the interests of each mode of travel when designing street projects. This approach recognizes that complete street designs are not "one size fits all." If streets are to reflect their local and surrounding contexts, then a variety of street types are required, as well as the understanding that there are a variety of ways to provide for all users, depending on the context. Each street's design should be tailored to the context of the area in which the street is located and should address the needs and desires of those living, working, and traveling on that street. Therefore, NCDOT's planners, designers, and construction and maintenance engineers will consider and incorporate, through collaborative processes, multimodal solutions in the design and improvements of all transportation projects.

These planning and design guidelines represent a significant step towards implementing complete streets in planning, design, and construction activities undertaken by NCDOT and the jurisdictions with which they collaborate. The processes, street types, and recommendations included in the planning and design guidelines are intended to support the concept of collaboratively-designed and context-based complete streets. The purpose of the guidelines is to provide direction in the decision making and design processes to ensure that all users are considered during the planning, design, construction, funding, and operations of North Carolina's transportation network. The philosophy of stronger partnerships in the provision of the network of streets to accommodate all users requires a change in the processes for incorporating multiple modes into both existing and future transportation improvement projects.

To that end, the long-range planning and project development processes described in Chapter 2 are intended to provide an approach for planning and designing complete streets to provide a multimodal transportation network that adds value to the community. This approach provides flexibility to apply complete streets that will reflect local input, existing and future context, and the overall street network. Chapter 3 describes the importance of understanding context and identifies various area types that reflect the diverse land use mixes and patterns found across North Carolina. Chapter 3 also includes a discussion about how to provide for quality of service for pedestrians, bicyclists, and transit users. Chapter 4 provides additional information about land use context, and also describes a variety of street types, cross-sections, and design elements for creating a network of complete streets. Intersections are the point at which two or more streets meet, and thus represent a point of opportunity and conflict for street users. Chapter 5 details principles for complete streets intersections, quality of service for all modes, and intersection design for different street types (main streets, parkways, boulevards and avenues). Chapter 6 outlines transit considerations with complete streets, including facility access, placement, and elements. Structures such as bridges and tunnels can provide key links within a transportation system; thus, Chapter 7 describes recommended design for complete streets facilities on bridges and underpasses. Chapter 8 describes various street elements within maintenance and operations projects, which constitute a large percentage of roadway projects that NCDOT implements each year. Finally, Chapter 9 covers design considerations for various elements including clear zones, super elevations, utilities and stormwater facilities.

How Will These Guidelines Be Implemented?

These guidelines are intended to provide comprehensive guidance for incorporating complete streets into everyday practice (including new construction, widening, modernization projects, and maintenance projects) so that North Carolina's streets increasingly support mobility for those using all travel modes. To accomplish this, these guidelines apply to all North Carolina's streets (not including freeways and interstates, which are not considered or treated as streets). These guidelines also apply to all processes and practices that affect those streets.

These guidelines are effective with the publication of this document. To facilitate implementation of the guidelines, the following is provided:

1. Beginning as early in a new project or TIP request as practical, a collaborative process between NCDOT and the local government will be initiated to evaluate existing and future context and purpose of the street and determine how to make it safe and accessible for all users. This collaborative process (discussed further in Chapter 2), should provide maximum opportunities for project collaboration and project scope development.

2. Existing projects that have not progressed to the "design public hearing stage" are to follow the same collaborative process as new projects to identify and determine the feasibility of appropriate complete street designs and the revised project scope, cost, and project schedule, if applicable.

3. For operations and maintenance work by NCDOT, local governments are encouraged to review and comment on upcoming resurfacing projects and other project lists for the opportunities to recommend complete streets features. When requested and determined by the Division Engineer to be feasible within the scope and budget for the project, such features will be considered for inclusion. If it is not feasible to include these features due to scope, funding, timing or other reasons, the features may need to be considered as a new or future project request.

4. NCDOT will partner with local governments in the development of local transportation visions. Local transportation visions, adopted policies and plans should promote and identify projects that work toward an interconnected network of context sensitive and multimodal complete streets. NCDOT will collaborate with the local area to develop projects that strive toward achieving the purposes of the Complete Streets Policy.

The guidelines provide a bridge between the adopted policy and the broad variety of policies, manuals, and practices currently used for planning, designing, constructing, and managing North Carolina's streets. (As this guidance evolves into standard principles and practices within NCDOT, current policy and guidelines will be reviewed and updated over time.) In the meantime, where existing policy and guidance conflicts with the Complete Streets Planning and Design Guidelines, NCDOT should be flexible and collaborate with local government to reach an agreeable solution that safely and efficiently provides the various travel components of complete streets.

What Will These Changes Mean for Communities and Stakeholders Across the State?

NCDOT recognizes that streets contribute to the mobility, quality of life, and the economic vitality of our communities. Therefore, NCDOT will be seeking the active support of, and collaborative involvement from, local communities, citizens, and stakeholders in planning, designing, and implementing streets that provide safe and comfortable access to all users. Crucial to the success of complete streets will be the stronger partnerships forged between NCDOT and local jurisdictions, Metropolitan Planning Organizations (MPOs), Rural Planning Organizations (RPOs), transit agencies, and other agencies and stakeholders across the state.

The process described in these guidelines provides many opportunities for community and stakeholder involvement in the decision making process. Local direction should initially be provided through discussion with local staff regarding the community's plans and policies. As described in the following chapter, community representatives' and stakeholders' ideas and thoughts will be further sought at appropriate milestones as projects are planned and designed. Planning and designing complete streets requires an understanding of the local area's vision for land use and transportation in order to plan ahead for the transportation system instead of reacting to change in potential needs of the transportation users.

Ultimately, these changes mean that NCDOT will work in partnership with communities to provide a network of complete streets throughout the state—streets that reflect the communities and contexts they serve, and that allow the state and those communities to safely and efficiently meet the mobility needs of current and future North Carolinians, whether they are driving, using transit, walking, or bicycling.

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2: Incorporating Complete Streets in the Planning Process

North Carolina's transportation planning, design, construction, and maintenance processes will change as NCDOT's approach to street design shifts to an emphasis on providing a safe network of facilities to accommodate access and travel for all users. The intent of these guidelines is to establish a collaborative process with cities, towns, and communities for designing complete street networks that are in harmony with the context of the diverse communities throughout North Carolina.

The type of land uses adjacent to the street will have a primary effect on the street design. Three broad categories of land use types (described further in Chapter 3) exist within North Carolina: urban, suburban, and rural. It is also important to consider the transitions between these types. To create context-based complete streets, the adjacent land use context needs to be integrated with the street function so that each street contains appropriate elements to address the needs of existing and future land uses. Several different street types are identified and addressed in this document: main street, avenue, boulevard, parkway, and rural road. Information provided in the guidance will help planners, designers, and others match the land use area and sub-area type with the street type to create streets that address the needs and desires of those living, working, or traveling on the street.

The challenge that transportation planners and designers face is to balance the interests of each mode of travel. To do so, our processes must be collaborative, involving Metropolitan Planning Organizations (MPOs), Rural Planning Organizations (RPOs), advocacy groups and local communities in the consideration and incorporation of all modes in the design and improvements of all streets. The purpose of this chapter is to provide guidance on the process for planners, designers, construction and maintenance engineers to follow in integrating complete streets into the decision making process.

This chapter outlines the project development process from the earliest phases of project definition through final design and construction. The Complete Street Planning and Design Guidelines will be integrated into other NCDOT planning processes, including the North Carolina Statewide Long Range Transportation Plan (2040 Plan), Program and Resource Plan, State Transportation Improvement Program (STIP), Five Year Work Program, Comprehensive Transportation Plan (CTP), the Long-Range Transportation Plan (LRTP) and other plans including local land use plans, small area plans, comprehensive bicycle and pedestrian plans, regional bicycle plans, county, urban, and regional bicycle routes and maps and greenway plans. It is NCDOT's intent for these planning processes and documents to use the complete street types described in Chapter 4, so that accommodation of all users continues to be integrated into each of these existing processes.

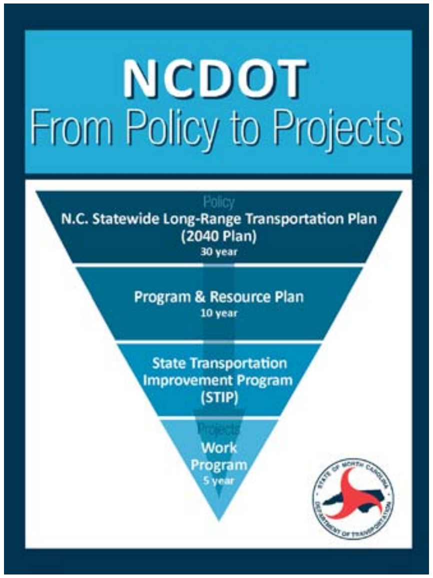
Transportation Planning Process

Transportation planning as a process in North Carolina generally includes elements/plans that are driven internally by NCDOT in collaboration with MPOs and RPOs (as shown in Figure 1), and elements/plans that are driven by MPOs or RPOs, in collaboration with NCDOT (as shown in Figure 1A). For example, the NCDOT defines its transportation policies and priorities in the North Carolina Transportation Plan (2040 Plan). For MPOs, on the other hand, the planning process begins with the Comprehensive Transportation Plan (CTP), which should reflect local priorities and policies. These overarching processes converge as identified projects in the State Transportation Improvement Program (STIP). All are completed under the umbrella of Federal requirements that apply to state departments of transportation and local or regional entities. The following sections describe the purpose and content of each of these documents, as well as the inter-relationship between them, whether state, regional or local. Planning for Complete Streets should begin as a project is included in each of these documents.

North Carolina Transportation Plan (2040 Plan)

The North Carolina Transportation Plan is a 30 year document that defines the mission and goals of the NCDOT and sets out key objectives and strategies to achieve them. These elements guide decision making, including investment decisions. The plan outlines the resources needed to support the Program and Resource Plan and sets forth an investment strategy that embraces all modes. This plan is developed by transportation professionals at NCDOT with input from regional and local bodies, based on significant public input. The plan undergoes a complete revision every eight years, with data updates every four years.

Figure 1: From Policy to Projects

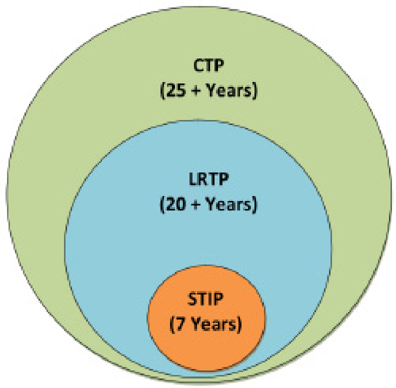


The existing North Carolina Transportation Plan (also known as The Statewide Plan) was last updated in 2004. In 2010, NCDOT began a major update called the "2040 Plan." The 2040 Plan (and subsequent Statewide Plan updates) is intended to reflect changes that have occurred since the previous Statewide Plan in terms of broad economic and social developments, internal governance and program delivery mechanisms, and changes in the State's goals for mobility, growing the multi-modal network, and freight logistics. It is being developed with broad input from Metropolitan and Rural Planning Organizations (MPOs, RPOs) local governments and other stakeholders. The 2040 Plan and subsequent updates will include complete streets as a priority for future project and program planning, in order to ensure that all streets are planned and constructed to support safety and mobility for all users.

Comprehensive Transportation Plan and Long Range Transportation Plan

Long range transportation planning identifies anticipated deficiencies and needs for a 25-50 year time frame. It is a collaborative process with MPOs and local governments working in partnership with NCDOT. As shown in Figure 1A, the Comprehensive Transportation Plan (CTP) lays the very long-range vision for the transportation system with specific consideration given to multimodal facilities and is developed to reflect the community's land use vision and context. The CTP essentially serves as an "inventory" of potential projects that could be used to address network deficiencies for motorists, pedestrians, bicyclists, and/or transit users and inter-city rail service.

Figure 1A: Transportation Planning Process

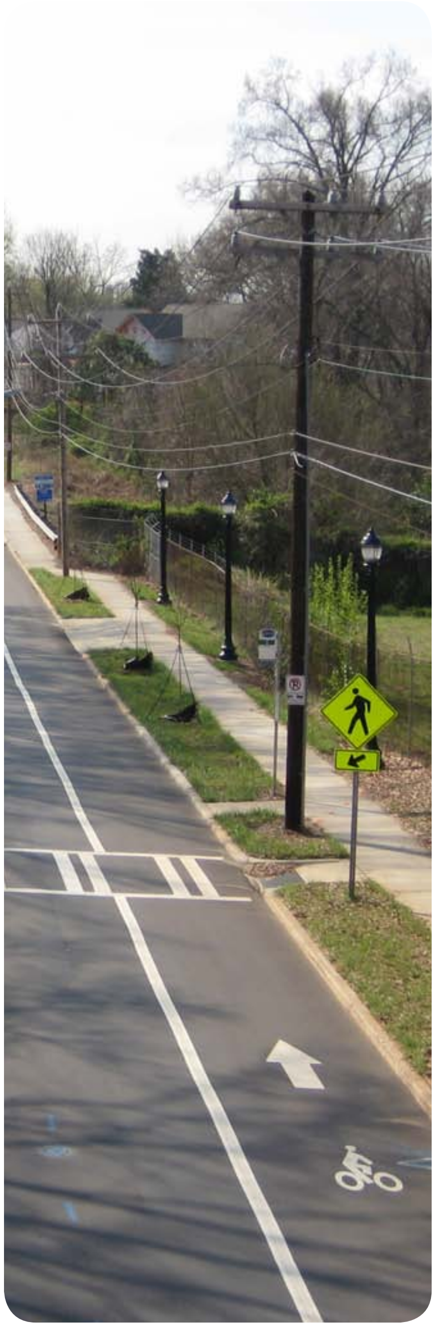


The CTP consists of maps and a report that provides additional information about the potential projects shown on the maps. The maps for the CTP are mutually adopted by the MPO/RPO and NCDOT. During development and prior to adoption of the CTP, NCDOT will work with the MPO/RPO to ensure that the CTP considers statewide and regional objectives and strategies that have been identified in the North Carolina Transportation Plan. MPOs and RPOs should work with NCDOT to ensure that their CTP promotes their community's vision for complete streets, both through the maps, the accompanying report development, and through the formation of problem statements to be included as part of the report. The problem statement helps to bridge the gap between undefined projects and the eventually-defined projects and their federally-required purpose and need statements.

For MPOs, the long range transportation plan (LRTP), as required by Federal law, should address at least a 20 year timeframe and must be financially-constrained as well as meeting other Federal planning requirements. As such, it serves as a "subset" of the CTP, where specific projects are first defined. RPOs do not have an LRTP and the STIP (described below) serves as their plan. Unlike the CTP, the LRTP should only include projects that are feasible or buildable from an environmental, engineering, and cost/benefit perspective. It is important to recognize that while a project may not be financially feasible within the LRTP timeframe, it may be needed to handle travel demand within the longer timeframe of the CTP. Due to continued development, demands on the transportation system are growing more rapidly than improvements to the transportation infrastructure. During CTP updates it is critical that elements of the CTP beyond the timeframe of the LRTP are reexamined to ensure they are still needed based on either projected travel demand or deficiencies as complete streets. MPOs rank identified projects from their financially-constrained LRTPs and submit them into the prioritization process for inclusion in the STIP.

Program and Resource Plan

The Program and Resource Plan is a 10 year plan that addresses both transportation needs, as identified through the North Carolina Transportation Plan, the CTPs, and LRTPs, and fiscal constraints. The plan is based on a process called "Strategic Prioritization," which enables NCDOT to apply limited transportation resources to the projects that will best meet the NCDOT's mission and goals in a data-driven and transparent way. Under Prioritization, professional staff from NCDOT, regional MPOs, and RPOs prioritize their transportation needs. Those needs



are categorized by the three goals of safety, mobility and infrastructure health, and then ranked based on objective criteria such as crash data, congestion levels, pavement and bridge conditions, etc. Moving forward, these goals and criteria will be expanded to ensure that the concepts of safety, mobility, and infrastructure health extend to all users and that projects are envisioned as complete streets. The result of the prioritization process is a list of North Carolina's transportation needs, unconstrained by fiscal or other considerations. The document also identifies 10-year performance targets for the goals of safety, mobility, and infrastructure health. A technical analysis shows how various investment mixes will yield differing outcomes in meeting the goals.

The Program and Resource Plan also includes a "cash-constrained" 10 year budget for the Department. It is based on forecasted expenditures, revenues (state and federal), cash balances and includes trend analyses of revenues, commitments, reimbursements, payout rates, etc.

A critical step in the Program and Resource Plan is the convergence of the strategic prioritization outputs and the cash-constrained 10 year budget to the previously unconstrained needs list. NCDOT applies funding levels and additional constraints such as eligibility, equity, etc. The outcome is a 10-year plan (the "Project List") that shows the prioritized projects and programs NCDOT plans to carry out with the projected available funds to achieve defined performance targets. It should be emphasized that the 10-year Program and Resource Plan is a fluid document that is based on projections that will change, especially in the latter years.

Five Year Work Program

The Work Program derives from the Program and Resource Plan. It contains both program and project-level information. The Work Program is an accounting of the state's annual transportation program grouped by five categories:

- Construction & Engineering
- Maintenance
- Operations
- Administration
- Transfers

The Work Program is NCDOT's commitment to the projects we plan to build and the services we plan to offer over the next five years. Work Program projects are found in the first five years of the (10 year) Project List. The Five Year Work Program is produced and reviewed by the Board of Transportation every year. The first two years of the Work Program are aligned with the biennial budget cycle.

State Transportation Improvement Program (STIP)

The state also publishes the State Transportation Improvement Program (STIP), which is a 7 year subset of the (10 year) Project List included in the Program and Resource Plan and is required under federal and state law. The STIP describes the projects to be programmed during the upcoming 7 years (note that NCDOT reviews the draft STIP annually and publishes the STIP every two years). The project list in this strategic planning document also includes smaller projects, called division-managed construction projects. Moving forward, the STIP will increasingly incorporate complete streets, as MPOs, RPOs, and NCDOT continue to identify and prioritize projects based on their ability to serve all users, while meeting the other broad goals described in the North Carolina Transportation Plan.

Project Development Process

Once a project is defined and prioritized through the planning and programming processes described above, it moves into the project development process which will ultimately result in a specific street design to be constructed. As with the CTP and LRTP, the project development process will also incorporate complete streets concepts and designs. The project development process begins in NCDOT's Project Development and Environmental Analysis (PDEA) Branch. PDEA leads the formation of a National Environmental Policy Act (NEPA) document. The NEPA process consists of an evaluation of the environmental effects of a federal undertaking (in this case, a street or roadway project), including its alternatives. The NEPA document makes a definitive recommendation as to how motor vehicle, bicycle, pedestrian, and transit use is to be accommodated (i.e., number of lanes, separate bike lanes, multi-use paths, sidewalk width, transit shelter locations).

The NEPA process requires a "purpose and need statement" for each project. As the foundation for subsequent decision making, the development of the purpose and need chapter of the NEPA document should consider all modes of travel. It should focus not only on the traditional aspects of safety and capacity for motor vehicular traffic, but rather on the safe movement of people. During the project development process, the CTP and LRTP vision should be referenced to ensure consistency and that the appropriate and necessary multimodal facilities are considered throughout the planning process. For example, moving forward (and as CTPs increasingly reflect complete streets), the problem statements developed as part of the CTP can serve to help define the purpose and need statement for projects going through the project development process.

The following section describes how localities, MPOs/RPOs, and others will work with NCDOT through project development. The project development process entails a series of steps (shown in Figure 2) to collaboratively define the ultimate design for a street. This process is compatible with and enhances the NEPA process, particularly the intent to carefully consider alternatives and select the appropriate design. The key to the process is to evaluate the existing and future context and users of a street, examine potential alternatives, and select the design that will make the facility safe, functional, and accessible for all users.

Because complete streets are not a “one size fits all” design, the selected solution will depend on the surrounding context, goals and objectives defined by project stakeholders, as well as careful analysis of tradeoffs of different solutions. The intent is to design the best complete street for a given context. The questions that are asked in each step of the process have been transformed into a checklist that should be revisited throughout the planning process (the checklist is included in the Appendix).

Formation of the Design Input Team

The recommended project development process begins with formation of a design input team that meets throughout the life of the project to ensure that all users are considered on a facility. This design input team should include both internal and external team members. Internal members may include the NCDOT Roadway Design Project Engineer, Division Construction Engineer, and a PDEA Group Supervisor, with a number of NCDOT Branches and Units, including Transportation Planning Branch (TPB), PDEA, Pre-Construction, Bicycle and Pedestrian Division, Public Transportation, Transportation Mobility and Safety, and the Program Development Branch. Some members may play more critical roles at different stages over the life of a project. For example, a member of TPB would be invited to participate in the early phase of project planning, but would typically not be involved through final design and right-of-way acquisition. External members should include city or county jurisdiction staff and MPO or RPO representatives.

Figure 2: Project Development Process

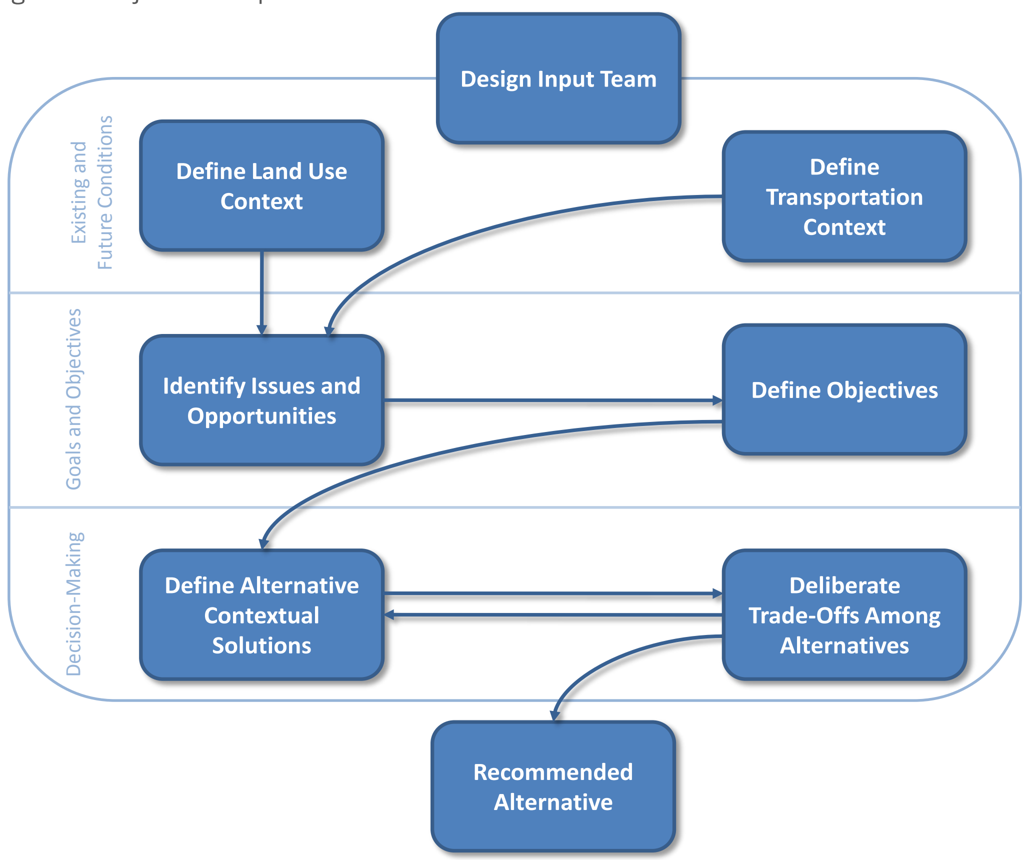
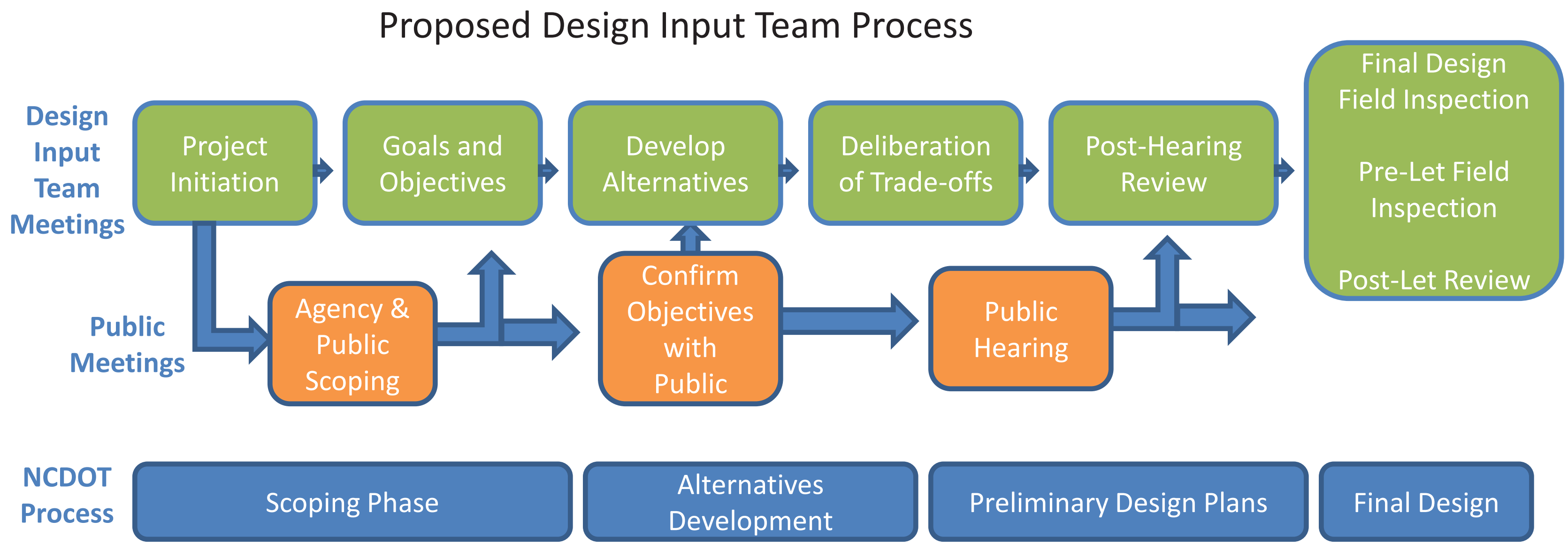


Figure 3: Relationship Between Project Development Process and Milestones



The key with the design input team is to bridge the project definition phase (CTP and LRTP) with the project development phase. The design input team begins meeting at the start of the project (after the project moves to PDEA). The design input team carries out the steps outlined in Figure 2, and also meets at the key milestones identified in Figure 3. The steps in Figure 2 are described in the following sections.

Evaluation of Existing and Future Conditions

With all stakeholders at the table as a team, the initial steps for evaluating existing and future conditions involves defining the land use context and the transportation context. This initial meeting of the design input team should take place in conjunction with the project initiation meeting. The land use context assesses the existing and future land use along a corridor. It is important to note that the land use context may vary along the same corridor; it may be urban on one end and rural on the other, and different street solutions for the same corridor may be appropriate. In any case, it is critical that the context be considered both in terms of the areas adjacent to the street, and the broader context beyond the street and corridor.

Define Land Use Context

The following are questions to consider in defining the existing and future land use context:

Existing Conditions:

- Is this an urban area, a rural area, or an area of transition (urban to rural or rural to urban)?
- What is the jurisdiction land use and zoning for the area?
- What is the existing land use mix and density?
- What are the typical building types, their scale, setbacks, urban design characteristics, relation to the street?

Future conditions:

- Are there any development pressures on the area? What is the nature of the emerging land use context?
- What is the jurisdiction’s future land use vision (as identified in a comprehensive plan, corridor plan, policies, or other sources)?
- Does the adopted plan(s) make specific recommendations regarding density, setbacks, urban design, etc. through the project area?

Define Transportation Context

The team will also discuss the existing and future transportation context for both the surrounding street/roadway network and the street itself. These questions will require research and study of all documented plans and policies affecting the street. It will be a collaborative discussion among stakeholders to assess what the street looks like today (or what the area looks and feels like if this is a new street), and an assessment of plans and policies for the future corridor. The discussion should address the following:

Existing Conditions:

- What is the character of the street? What does the area look and feel like?
- How does the street currently function? What are the daily and hourly traffic volumes? Operating and posted speeds?
- How does this corridor function within the larger transportation network?
- What design features and accommodations for bicyclists, pedestrians, and transit users are included on the corridor (number of lanes, sidewalk availability, bicycle facilities, transit service and stops, traffic control, etc.)?
- What is the existing quality of service (safety and accessibility) for each mode? What is the general crash history for motorists, bicyclists, and pedestrians (are there any specific safety issues to be addressed)?

Future Conditions:

- What are the projected traffic volumes along the corridor?
- What trip generators (existing and future) are in the vicinity of the proposed project that might affect travel patterns and connections in and around the corridor?
- What are the locally adopted multimodal plans or policies affecting bicycle, pedestrian, or transit use?
- Are there any planned transportation projects in the larger area that would affect the street segment?

Chapter 3 provides detailed descriptions of urban, suburban, and rural area types that can help to define the existing and future land use and transportation contexts. The design input team should reference and note these area types during this phase in the process and as they discuss goals and objectives for the project.

Establish Goals and Objectives

Once the broader land use context and transportation context are evaluated and agreed upon as a team, the goals and objectives for the project can be defined at a second meeting of the design input team. This phase includes analysis of the project issues and opportunities and definition of the objectives, both of which are conducted at the time of scoping. Public feedback is gathered during this phase through separate citizens' information workshops. The purpose of the workshops is to solidify the vision for the project and confirm the assumptions moving forward.

Identify Issues and Opportunities

This step in the process takes all of the observations about the past and present function of the corridor together to define issues and opportunities. The team should evaluate:

- What are the deficiencies/problems with the street today?
  - Are there gaps in the bicycle or pedestrian network near or along the street?
  - Are there gaps in the overall street network (connectivity, capacity, etc.)?
  - Are there inconsistencies between the amount or type of transit service provided along the street and the types of facilities and/or land uses adjacent to the street?
- What are the key opportunities with this project (i.e. a tool for economic development or improved community health, a missing link in the bicycle, pedestrian, or vehicular system, improving the level or quality of service for a particular mode, etc.)?

Define Objectives

The assessment of issues and opportunities leads to the definition of the objectives for the project, with the surrounding context as a basis for decision making. The design input team should evaluate:

- How do the local government, community, and all users want the street and neighborhood to change, if at all?
- What are the existing functions that need to remain in place?
- How can those functions be balanced with new users of the street?
- How would this project increase the connectivity of the larger network?
- How would this project improve the mobility and safety of all potential users of the street?
- How would this project meet the needs of the community?

Public input is important in ensuring that important objectives are not overlooked and are verified, and that all transportation and environmental concerns are addressed as the project moves forward. This is particularly critical if major changes have taken place with the project planning or substantial time has elapsed.

Decision making

Once the framework for the project is devised by defining the issues, opportunities, goals, and objectives, the design input team is ready to focus on developing alternative design solutions at the third meeting, evaluating those alternatives, and moving towards the recommended design. \

Develop Alternatives

The development of alternatives occurs after initial public outreach and prior to the preparation of preliminary design plans and public hearings. This step should rely on the street typologies included in Chapter 4 to help determine the range of solutions. Each street type defines a zone for every street component. Flexibility is built into the street cross-sections in terms of width of these zones (green zone, motor vehicle travel zone, median zone). Some alternatives may include the same street zones but differ in their dimensions. The design input team should ask:

- How will the proposed project accommodate existing and planned bicycle, pedestrian, and transit facilities?
- What modes does each alternative scenario serve and how?
- How do the alternatives fit within the land use and transportation context and defined objectives?
- How will the alternative scenarios under consideration meet the needs of stakeholders?

Deliberate Tradeoffs

All of the scenarios identified should be tested against the land use and transportation context and the objectives for the project to determine any inconsistencies or constraints. The solutions within various alternative scenarios will likely vary by cost, right-of-way needs and/or how various modes are accommodated. This requires an evaluation and description of tradeoffs prior to selection of the recommended alternative. This evaluation and description of tradeoffs is a necessary part of the NEPA process and should occur prior to publication of the NEPA document, with input gathered at a public hearing. During this phase, the preliminary design plans are under development which allows for comparison of tradeoffs in street cross-sections, right-of-way needs, ability of the alternatives to meet the identified objectives, etc. At the end of this process, the reasons behind the selected cross-section should be transparent and understood. Items to be considered include, but are not limited to:

- Consistency with local context, land use and transportation plans and policies, and project objectives, as defined through this process;
- Balanced modal capability (to achieve functionality for all users);
- Accessibility to achieve functionality for all users;
- Right-of-way availability;
- Environmental (natural and human) considerations; and
- Overall cost.

Recommended Alternative

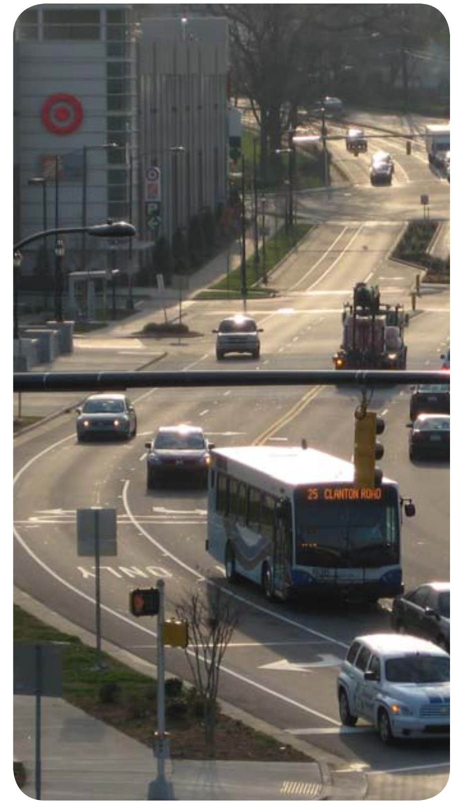
Once tradeoffs have been evaluated and described among alternatives, the team will come to a recommended alternative. The recommended alternative should reflect the ultimate design for the project with specific design features and dimensions.

The design input team should continue meeting beyond the public hearing and definition of a recommended alternative to ensure that the proposed improvements are incorporated into final design and construction. Specific meetings for design input team follow-up include a post-hearing meeting, a final design field inspection, a pre-let field inspection, and a post-let review. At the pre-let field inspection, the team will review the contract documents before a contractor bids on the project. A checklist that summarizes all of these steps is included in Appendix A of these guidelines.

It is important to note that the intent of the project development process outlined in this chapter could apply to other types of NCDOT projects, such as resurfacing or bridge projects, to ensure that treatments for all users are considered. The key is to help streamline and assist in the decision making process and to foster collaboration with stakeholders early in the process.

This chapter has explained that complete streets will be integrated into the long-range planning, programming, and project development processes. The current approach to planning is based on traditional functional classification of streets. This approach recognizes functional classifications for streets that address function for all users of the street network. The approach also focuses on the existing and future land use and transportation contexts, and agreed-upon goals and objectives for the street. This approach will be based on identification of area types and street types as defined in Chapters 3 and 4.

3: Understanding Context and Designing for All Users



Context Factors

Planning and designing complete streets requires a fundamentally different design approach and philosophy. It requires both an understanding of the existing and future land use and transportation contexts, and an understanding of how different design treatments affect peoples' ability to safely and comfortably use the street, whether on foot, bike, or by transit. Designing streets requires that those concepts be considered integral to the design from the beginning, rather than as "additional" or "special" design elements simply added onto a more traditional highway design. This context-based approach recognizes that complete streets are not "one size fits all" and ensures the most efficient, inclusive, and appropriate application of complete streets designs on a wide variety of streets.

As described in Chapter 2, one of the first steps when developing complete streets is evaluating the existing and future land use and transportation contexts. Done properly, land use should never be considered in isolation, nor should the transportation solution be developed without a full understanding of the uses of surrounding land, both existing and future.

This chapter describes urban, suburban, and rural area types that reflect the diverse land use mixes and patterns found across North Carolina. While "streets" are more typical to cities, suburbs, and towns than to rural areas, it is important to recognize the need to provide design recommendations for rural areas as well. This chapter also discusses quality of service levels by various modes of travel. Quality of service emphasizes that street designs affect the functionality of the street for each mode, including those other than the automobile. Designing complete streets requires moving away from a highway-oriented emphasis to balancing motorist level of service with the quality of service for other users.

Designing complete streets requires both an understanding of the future and existing land use and transportation contexts, and an understanding of how different design treatments affect peoples' ability to safely and comfortably use the street.

Understanding the Built Environment and Street Type

The design of a practical, functioning street depends on a clear understanding of the application of the context-based approach in designing complete streets in a particular setting. Once the context for an area is understood, the function of each street can be established and design parameters can be selected to achieve a balance between land use and street design.

This relationship between land use and street design also affects the character of the street. Character is reflected not only in the travel lanes but also in the overall dimensions and design treatments from building face to building face along the street. Character is also reflected in the space between a building's edge, a street tree, or a parked car. This aspect of character is influenced by the location and quality of street elements. Also, character can be defined by its surface qualities. The manner in which the elements are applied to streets creates its formal character and consists of qualities such as the shape, material, colors, textures, pattern, and compilation of the street elements.

Typical street elements may include street furniture, medians, lighting, landscaping, street trees, signage, parking, pavement markings, and paving material. These elements not only provide function, but contribute to the character of the street.

The character of a street is defined by both land use and street design.

Area Types

Within North Carolina, three broad categories of land use types exist: urban, suburban, and rural. These categories can be further divided into nine sub-area types (three in each area) to aid in more specifically identifying the context of the area through which a transportation facility passes. These nine sub-areas are described further in the following sections. While the current land use context may be readily apparent, land use and transportation plans and policies for the area must be reviewed to determine anticipated changes over time. As described previously, this review is a collaborative process that incorporates local areas' land use information in the project development process. In the review of these plans, one should consider whether the area is transitioning from a rural area to a suburban one or from a suburban area to an urban one. Generally speaking, the urban, suburban, and town contexts represent the greatest need for street designs to be treated distinctly different from highway designs. Chapter 2 describes the project development process and series of steps to follow to help create a shared solution for the transportation facility.

Urban Area Types

Urban areas usually represent a heavy mix of commercial, residential, and civic activity for a region. Development is typically most intense in terms of the density and the mix of uses. Within urban areas, the intensity of land use often decreases with the distance from the urban core. Open areas exist but are generally limited to parks, school playgrounds, or large lawns or wooded areas associated with institutional sites. Common elements include a high level of pedestrian interaction, as many buildings front directly onto a sidewalk. There is transit availability, bicycle activity, and grid or modified grid street patterns. In general, urban areas are experiencing renewed growth in residential and mixed-use activities, thus requiring greater attention to accommodating all modes of transportation. In the following section urban areas are divided into central business district, urban center, and urban residential sub-areas.

Central Business District

Central business districts are the most intensely developed area of a city. As the “downtown” or employment center of an urban area, development is typically commercial or mixed-use and vertically dense. Right of way may be constrained by existing adjacent land uses. Driveway access to parking and commercial uses may be frequent. Building setbacks are normally uniform and close to the street. On-street parking is common, but employment centers and large destinations are typically served by structured parking. Pedestrian, bicycle, and transit activity is nearly always present and of substantial volume. A network of streets, sidewalks, pedestrian and bicycle routes that link dense development is usually found, and the transportation system is dependent upon this network of modes. Transit centers where multiple bus routes converge are often present. Rail stations and intermodal facilities may also exist. Central business districts can range in size, depending on the overall size of the community.

Urban Center

Urban centers are areas that are developed at moderate to high levels of intensity, including areas outside the central business district in larger cities and the downtowns of small to mid-sized municipalities. The urban center will typically contain a mix of land uses, including commercial and institutional uses that support neighborhoods within its vicinity. Typical commercial uses may include grocery and drug stores, department stores, restaurants, and movie theaters. Institutional uses such as schools, libraries, and post offices may be found in these areas. Professional or medical offices are common. Building lot sizes will vary, but are usually relatively narrow. Buildings traditionally have a common setback relatively close to the street. Access points are limited through the consolidation of driveways. Land uses may be mixed vertically and horizontally. Urban centers vary in size. The transportation network should allow for access to the center by a variety of modes, as well as provide for high levels of connectivity within the center, particularly for pedestrians, cyclists, and transit (where appropriate). This can allow urban centers to develop into "park once" destinations.

Urban Residential

Urban residential districts typically consist of single-family residential developments at a common scale and setback from the street, often interspersed with multi-family development such as duplexes and quad-plexes. Larger multi-family buildings, such as apartments or condo buildings, may also be present. Sidewalks are usually present and on-street parking is common. Access points may be limited through the consolidation of driveways, though shared driveways may be less frequent in single-family residential areas. Off-street parking is common for single-family houses and duplexes, with parking lots provided for larger multi-family buildings. High levels of pedestrian, bicycle, and transit activity are usually found in these areas.

Suburban Area Types

Suburban areas are usually found at the periphery of an urbanized area and are characterized by pockets of development that are often disconnected and contain structures that are generally consistent in height and aesthetics. Suburban areas can vary widely in character, appearing more rural in areas further removed from the metropolitan core and more urban in areas with denser populations and development. Suburban areas offer different challenges than urban areas, but also present opportunities (and the need) for providing more streets and street networks, as well as more complete street designs. Suburban areas are divided into suburban center, suburban corridor, and suburban residential.

Suburban Center

The suburban center is distinguished from the suburban corridor due to its (typically) higher density, greater mix of uses, and nodal form. Suburban centers are characterized by concentrations of commercial and residential uses. The commercial uses are usually grouped together and are notable for a uniform building setback. Residential development in this area is often a mix of single family and multi-family units. Residential development often defines the edge of a suburban center, with areas of predominantly residential development patterns punctuated by non-residential centers at key points along main roads. Pedestrian and bicycle activity are highest nearby or in the suburban center and sidewalks are usually present. Access points will vary from numerous driveways to shared access points. On-street parking is common in these areas, but surface parking lots are predominant. The transportation network should allow for access to the center by a variety of modes, as well as provide for high levels of connectivity within the center, particularly for pedestrians, bicyclists, and transit (where appropriate). This can allow suburban centers to develop into a "park once" destination, even when accessed by car.

Suburban Corridor

Suburban corridors are characterized by auto-oriented development. The development pattern is typically linear and may span for miles along the same street, containing numerous commercial and retail destinations along with medium- to high-density residential development located adjacent to (or very nearby) commercial properties, perhaps along perpendicular residential streets. The residential and non-residential developments are, however, usually disconnected (i.e., they lack direct access between the two). Bicycle and pedestrian facilities are often present, but the volume of these users is typically lower than in suburban centers. Transit services are often present in the suburban corridor. The auto-oriented network typical to the suburban corridor presents the need to provide more and better streets—streets that allow for better access for bicyclists, pedestrians, and transit users.

Suburban Residential

Generally located on the outermost periphery of an urbanized area, suburban residential areas have transitioned from rural developed but remain a mix of developed, undeveloped, and natural areas. Development pockets are typically segregated, disjointed, and are predominantly residential (low to moderate density) with intermittent, isolated commercial and other non-residential properties between. Building setbacks may be deeper than in urban areas. Internal streets in these suburban areas typically carry a lower volume of vehicular traffic (though streets connecting subdivisions often carry very high volumes due to lack of connectivity in the street network) and contain a mixture of direct driveway access, subdivision street access and public street intersections. Pedestrian and bicycle activity in these areas is higher than in rural areas, and public transit service is occasionally encountered.

Rural Area Types

Rural areas are characterized by natural areas, agricultural uses, and limited development, except in towns, villages, or crossroads. Rural areas are distinguished from other area types by their separation from other developed areas and by an intent or desire of residents to retain the natural or rural character of the area in the future. The rural area type can be subdivided into three different sub-areas: rural village, rural developed, and countryside.

Rural Developed

Rural developed areas are characterized by scattered, very low-density development. The development is primarily residential with occasional other uses. Rural developed areas may include a limited number of residential subdivisions or isolated commercial/industrial uses. Linear large-lot residential development is common along rural secondary routes. They are distinguished from the suburban area in that there is an intention or desire to retain the rural character of the area in the future. In rural developed areas, buildings generally have deep setbacks from roadways. Occasional driveways require a driver to be more alert for entering and exiting vehicles than in natural rural areas, and present potential conflicts with pedestrians and bicyclists. Pedestrian and bicycle activity is more frequent than in the countryside, but may be of modest volume, due in part to lack of facilities and connectivity. Touring or weekend bicycling may be common (especially if it is a designated bike route).

Rural Village

A rural village is a concentrated area of development within a rural area with businesses and civic uses, and may include adjacent or interspersed housing. A village is often an incorporated municipality, but not always. A rural village is distinguished from an urban center or a suburban center by its isolation, size, and separation from other areas of development. There are varied building setbacks in a rural village and frequent driveways and intersections are common. Pedestrian activity can be moderate to high. Bicycle activity is variable. Transit activity may be present, but is not common.

Countryside

Countryside reflects the traditional concept of rural open space and includes farmland, forestland, park land, and other open space. There are few access points along the roadway and little development. Building setbacks from the roadway are large and there are infrequent access points. Pedestrian and transit activity is usually infrequent and of low volume; however, bicyclists, and to some extent pedestrians, may be attracted to roadways that traverse scenic rural areas and/or connect more intensive development types.

Quality of Service

What is Quality of Service?

Engineers and planners have long used level of service (LOS) to describe how transportation facilities function for motorists. Planning and designing complete streets also requires understanding how well transportation facilities function for bicyclists, pedestrians, and transit users. These guidelines describe how to provide for quality of service for these users. Quality of service is based on street design elements that make using a facility safe and comfortable for bicyclists, pedestrians, and transit users, thereby improving streets' functionality for all users. In contrast to LOS, which is a quantified measure of how effectively transportation facilities move cars, quality of service is a qualitative measure of how well transportation facilities serve other users.

Quality of service also takes into consideration the ways in which buildings, circulation, parking, and landscaping are arranged on an adjacent site and the effect that site has on where a street contextually falls in the continuum of street networks. Streets should strive to provide high quality of service for bicyclists, pedestrians, and transit users, as described in this section and in Chapter 4.

Elements of Quality of Service

Quality of service emphasizes the safety and accessibility of travel, rather than a quantifiable measure of throughput of travel. For walking, biking, and transit to be attractive travel options, the experience of using non-motorized transportation must be convenient, comfortable and safe. Quality of service applies to the design elements provided along streets, but can also be assessed within the context of the street network, as part of the collaborative process described in Chapter 2. Street, transit, rail, bicycle, and pedestrian facility planning lays the vision for street improvements with consideration of multimodal facilities and connections to the surrounding street network. This vision is developed through collaborative dialog with local jurisdictions and reflects the community's land use vision and context. Transportation projects will often have tradeoffs among design elements that provide higher quality of service for different users. But in every instance, the solution must strive toward connectivity of a complete streets network, and the design input team should strive to improve quality of service for all users when designing new or modified streets.

The following section describes the types of facilities that contribute to quality of service for bicyclists, pedestrians, and transit users. For each element, an image is shown demonstrating good quality of service. This quality of service concept is built into Chapter 4 and is incorporated into each of the street type cross-section diagrams.

Quality of service is based on street design elements that improve street functionality for bicyclists, pedestrians, and transit users.

Bicycle Quality of Service

Providing for bicycle quality of service may vary based on context. The surrounding land use, the speed of cars on the street, and the directness of the route connecting destinations are all important factors in identifying the appropriate elements for bicycle facilities. In addition, there are different types of bicyclists with varying levels of expertise. While bicyclists have the legal right to use the traffic lanes, some cyclists will be more comfortable than others riding in mixed traffic. Creating viable transportation options means that a variety of types of facilities should be provided to create a bicycling network. Creating bicycling networks is often an incremental process, and facilities should be provided where appropriate.

Bicycle Lanes

Dedicated bicycle lanes are the preferred option to provide for the greatest variety of cyclists on streets, particularly those streets with higher volumes and speeds. The most recognizable form of a bicycle lane is a striped lane with a painted arrow and cyclist icon. Bicycle lanes are the backbone of a complete bicycle network, as they visually distinguish a bicycle-only travel lane in which a cyclist does not have to maneuver around motor vehicles and vice versa. Bicycle lane widths are typically four feet to six feet of pavement. The gutter pan on an urban street is not to be considered part of the bicycle lane. When bicycle lanes are adjacent to on-street parking or on higher-speed streets, the minimum width of a bike lane is five feet. The bicycle lane shown below is in excellent condition: it is clearly marked and well-maintained. To maintain a high quality of service in bicycle lanes, pavement markings should be re-striped regularly, streets and bicycle lanes should be kept clean of debris, and bicycle lane signage should be present and visible.

Shared-Lane Markings

In streets where bicycle lanes cannot be accommodated, shared lanes provide an alternative to bicycle lanes. Shared-lane markings are lane markings that indicate a shared-use lane for motorists and cyclists. Shared-lane markings increase a motorist's awareness of the presence of cyclists (by raising the motorists' expectation that they will encounter cyclists), reduce the incidence of wrong-way bicycling, and indicate to both drivers and cyclists the ideal lateral positioning of the cyclist In the lane. However, the use of markings is limited to lower-speed streets. The shared lane marking shown in the image below is well-maintained and clear to motorists. To maintain a high quality of service in shared-lane markings, "Share the Road" signs or "Bicycles May Use Full Lane" signs should be present and pavement markings should be re-striped regularly.

Multi-Use Path

On streets where physical separation of bicycle traffic from motoring traffic is appropriate (such as on very low-access, high-speed facilities like parkways and potentially rural roads), multi-use paths should be considered. Multi-use paths are paved pathways that accommodate both cyclists and pedestrians. The image shows an off-road multi-use path in excellent condition that accommodates two-way pedestrian and bicycle traffic. In order to maintain a high quality of service on multi-use paths, paths should be well lit, clear of debris, and have appropriate signage. Intersections of multi-use paths with streets and roadways also must be carefully designed (see Chapter 5) to provide a high quality of service.

Signage

Bicycle signage is an important element that alerts motorists to the presence of bicycle traffic while providing information to bicyclists. Both bicycle lanes and shared lane markings should include signage, but bicycle signage that identifies a designated bicycle route can be a stand-alone element. Signed bicycle routes often help bicyclists to navigate lower-volume street networks, for example. The signage shown depicts a designated bicycle route. To maintain a high quality of service, signs should be posted at regular intervals in high-visibility locations. Offering additional wayfinding information with bike route signs as appropriate can enhance quality of service.

Paved Shoulders

In many rural areas, four foot wide paved shoulders are the typical treatment for accommodating bicyclists. Four foot wide paved shoulders allow bicyclists to travel on a paved surface adjacent to through traffic, if desired. Where speeds are 55 mph and above, five foot wide paved shoulders should be considered. In the image, both sides of the street have paved shoulders to accommodate pedestrians and cyclists. To maintain a high quality of service, it is extremely important that shoulders are kept free from debris, and any drainage structures have bicycle safe grates. If rumble strips are necessary, they should be designed to allow passage of bicycles.

Cycling Elements at Intersections

There are a number of other treatments that can improve bicyclists' ability to safely navigate high-conflict areas like intersections. Bicycle boxes, bicycle stop bars and lead signal indicators position the cyclist ahead of motorists at intersections and improve visibility between bicyclists and motorists. In addition, bicycle detection at intersections improves network and intersection function for bicyclists. Additional treatments not specified above and included in AASHTO, NACTO, or other guidance, will be considered.

Pedestrian Quality of Service

Safety of the pedestrian and separation from high speed traffic is of the utmost importance in planning for pedestrian quality of service. Complete streets need to provide for a range of passive and active uses including, but not limited to walking, waiting for transit, and crossing the street. While specific treatments or dimensions may vary by context, the goal in any environment is to have a continuous pedestrian network that provides dedicated space for pedestrians and separation from vehicles. In urban areas, this network exists or can be created. However, in rural areas, the pedestrian network may not be continuous or may utilize shoulders of high-traffic roads. Pedestrian facilities should be encouraged in all environments, with the specific treatment based on the context and the street type.

Sidewalks

Sidewalks are the primary mode of pedestrian travel and are a crucial element in any pedestrian network. Sidewalks should be part of a continuous network, connected with crosswalks and separated from traffic with a buffer (see next treatment). To maintain a high quality of service, sidewalks should be kept level, smooth, and free of debris, and they should be kept continuous across driveways and other entrances. They should also be kept free of conflicts, such as utility poles or fire hydrants, with sidewalk dimensions that allow for appropriate unobstructed walking space. The minimum unobstructed walking space for a sidewalk on a street is five feet, with six feet or wider applications for higher-volume, higher-speed streets, and/or more intensive land uses (as described in Chapter 4). The sidewalk shown below exceeds this minimal width, reflecting the context. Such treatment should be encouraged where possible, particularly in urban areas.

Buffer

Providing a buffer between pedestrians and traffic is important for providing good quality of service. A buffer is a strip of land that separates vehicular traffic from the sidewalk or other pedestrian facility. Buffers typically are planting strips or, in more intensive areas of development, hardscaped amenity zones. For most street types, these types of buffers are also planted with trees to provide shade and for additional (vertical) buffering. A buffer greatly enhances the pedestrian experience by providing additional separation from traffic. Other elements of complete streets can also contribute to a buffer, such as bicycle lanes and on-street parking. The buffer pictured below includes both a planting strip with street trees and a cycle track. To maintain a high quality of service, these buffers should be kept clear of debris and be of sufficient width to separate the sidewalk from fast-moving vehicles.

Pedestrian Crossings

Pedestrian crossings and/or crosswalks are another crucial element in any pedestrian network. Designing complete streets means understanding that pedestrians must be able to cross the street. Providing well-designed crossings, whether at intersections or mid-block (marked and unmarked), encourages walking and helps to complete the pedestrian network. Crossing treatments vary depending on a number of factors, including nearby land uses, transit stop locations, and characteristics of the street. Crossing treatments range from signage to marked crosswalks at intersections, marked mid-block crossings or, where appropriate, pedestrian beacon signals. Crosswalks provide for pedestrian visibility and also serve to assign the right of way. Well-designed and located mid-block crossings can help shorten blocks and connect destinations more directly. The image below shows a high-visibility striped pedestrian crossing, an important element in a pedestrian network. To maintain a high quality of service, pedestrian crossings should be well-marked with appropriate signage and located in areas without sight distance issues or constraints.

Curb Extensions

Curb extensions (also called nubs or bulb-outs) are extensions of sidewalks that narrow the street, increase pedestrian visibility, and decrease pedestrian crossing distance. They are also an element of traffic calming that prioritizes pedestrian safety, can reduce vehicle speeds, and can serve to protect on-street parking. The curb extensions in the image show a high quality of service in a small town environment.

Signage

Signage helps to improve pedestrian safety by alerting motorists that pedestrians may be present. Signage can also improve the visibility of pedestrian facilities at pedestrian crossings, such as a marked crosswalk. The signage in the adjacent image serves as a reminder that motorists must stop for pedestrians in a crosswalk. To maintain a high quality of service, crosswalks at mid-block locations, and under some circumstances at unsignalized intersections, should include signage placed to allow enough distance to allow a motorist to react and slow down if necessary.

Multi-Use Path

A multi-use path separates pedestrian and bicycle traffic from vehicular traffic on streets with less frequent access or higher speeds, such as parkways or some rural roads. Multi-use paths are popular with recreational walkers or runners and commuters, and in places where destinations are spaced further apart. The multi-use path in the image below is of excellent quality, providing enough width to accommodate pedestrians and cyclists in two directions. In order to maintain a high quality of service for multi-use paths, they should be lit, kept free of debris, and appropriately signed. Intersections of multi-use paths with streets and roadways also must be carefully designed (see Chapter 5) to provide a high quality of service.

Shoulders

In rural areas, shoulders may be the only pedestrian facility. Wide shoulders on rural roads allow pedestrians to travel along a paved surface in a separate space from traffic. To maintain a high quality of service, shoulders should be kept free of debris, be of sufficient width to accommodate pedestrians, and be connected with crosswalks where needed, such as at a major off-road trail crossing.

Lighting

In order to allow for pedestrian quality of service during evening hours, lighting should be provided near transit stops, commercial areas, or other locations where night-time pedestrian activity is likely. Pedestrian-scale lighting such as street lamps helps to illuminate a sidewalk, and improves pedestrian safety and security. In order to maintain a high quality of service, lighting should be regularly maintained, equally spaced, and focused downward to reduce glare.

ADA Requirements

Pedestrian quality of service is especially important for persons with limited mobility. The Americans with Disabilities Act (ADA) requires certain elements like curb ramps and minimum clearance widths to make the pedestrian network accessible to all users. The image below shows a high-quality crosswalk that includes ADA ramps, detectable warning pads, and level landings.

Photo source: Dan Burden, www.pedbikeimages.org

Other Pedestrian Amenities

There are other elements that can enhance an individual's experience on a complete street and improve the function of the street for pedestrians and other users. For example, street trees provide shade, additional buffering from the street, and an element of traffic calming. Street furniture, such as benches, and enhanced walking surface texture can provide a better pedestrian experience. To maintain a high quality of service, these pedestrian elements should be regularly maintained.

Transit Quality of Service

Transit modes may include commuter, light rail, streetcars, or buses. As a street user, transit can take many forms, including operating in vehicle travel lanes or within dedicated lanes. Some transit, such as light rail, can operate outside of the street right-of-way and merge with the street for needed connections. Pedestrian access is an essential component in the success of transit networks. Proper circulation of pedestrians and bicyclists adjacent to transit stations and transit stops is important to ensure safe and convenient access.

Streets that are well-designed for transit can encourage more people to get out of their cars and onto the bus. Such streets provide accessible bus stops and assist buses in moving through traffic. Transit systems have realized that bicycling and transit go well together. Most transit agencies now provide bicycle parking at bus and rail stops, and more than 100 transit systems in the United States (and a growing number in North Carolina) carry passengers' bicycles on buses and trains.

Complete street concepts and initiatives ensure safe and convenient access to public transit for all users. Creating safe and comfortable bus stops and smooth, predictable transit trips help make transit an attractive option.

Transit Service

The frequency of transit service greatly affects the perceived quality of service. A transit system with a reliable, accurate schedule has the potential to attract additional choice riders and increase demand for more frequent service.

Transit service varies greatly across different land use types. In an urban area, high-frequency transit service is typical and has a variety of connected transit routes. However, in a more suburban area, limited transit service is more typical, and often the frequency is approximately one bus per hour. Because the service is infrequent, long waits can occur. Long headways and unpredictable schedules will not lead to additional riders, regardless of the quality of facilities at a bus stop. Therefore, the reliability of transit service is an integral element in transit quality of service.

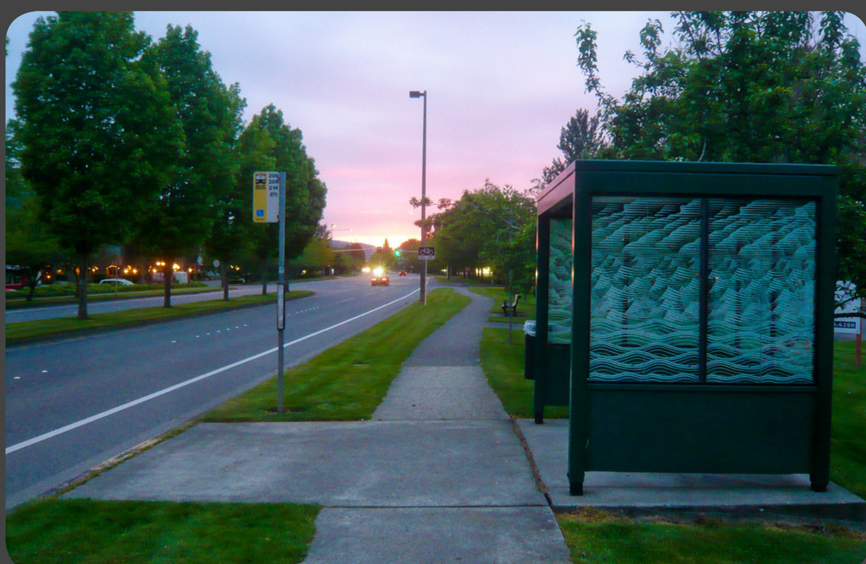
Bus Shelters

Bus shelters provide a place protected from the elements for transit users to wait for a transit vehicle. Bus shelters should include seating, lighting, and bus information. The bus shelter in the image below is well maintained and includes seating for waiting passengers. In order to maintain a high quality of service, bus shelters should be maintained regularly, kept secure, and kept free of debris and graffiti. Bike racks at shelters can provide multimodal connections.

Adequate Connections to Transit

Transit stops are only one element in a transportation network, and every transit user is also a pedestrian or cyclist at the beginning or end of their trip. For that reason, connections to transit stops are an essential element in a complete transportation network. Sidewalks and pedestrian crossing treatments should connect transit to the surrounding area, and bicycle facilities should connect to transit where possible. To maintain a high quality of service, sidewalks should be kept clear, with wayfinding and signage if necessary, and crosswalks should be well-marked.

ADA considerations at transit stops include a flat, stable landing pad that allows individuals of all abilities to safely get on or off the bus. Clear zones inside shelters and around other stop amenities also improve ADA access.



Schedules & Routes

Transit schedules and posted routes are an essential element of transit service. Schedules provide information to transit users on bus routes, transfers, and timetables. A variety of schedule types are available, from printed timetables to interactive bus displays, which indicate when the next bus will be arriving. In order to maintain a high quality of service, schedules should be kept up to date and include any service advisories for special circumstances.

Seating

In places where there is not enough demand or usage to justify a complete bus shelter, seating alone can improve the experience of waiting for a bus. Seating typically includes one or more benches near a bus stop. The image below includes a wide sidewalk, a bus shelter, and a bench in a rural area. To maintain a high quality of service, seating should be kept clean and well maintained.

Lighting

Lighting enhances the visibility and safety of a transit stop. Lighting also improves the readability of transit features such as schedules. Lighting should be provided at bus stops that are served by routes in the evening and early morning. Connecting sidewalks should also be well lit. Lighting should be maintained regularly and checked to be in good working order to maintain a high quality of service.

Signage

A bus stop post is a basic element of transit quality of service. This post can identify the route serving a stop and provide any additional information on the route and schedule. Signage helps transit users locate the bus stop. In the image to the right, bright colors and clear printing allow transit users to quickly see which routes serve the bus stop. To maintain a high quality of service, signage should be well lit and located in high-visibility locations.

Transit Design

Elements such as bus pull-out lanes allow buses to stop without blocking traffic and provide easier and safer boarding. It is important for the practitioner to understand the dimensions and capabilities of the type of transit using the street, and the ramifications that their operation and stops and stations will have on the design of the street. In many street contexts, bus pull-out lanes, for example, would not be appropriate since the emphasis may be less on vehicular throughput and more on pedestrian and transit access.

The purpose of this chapter was to identify urban, suburban, and rural area types that reflect a variety of land use types across North Carolina. The chapter described quality of service levels by various modes of travel to show the importance of providing functionality for those modes other than the automobile. Chapter 3 laid the foundation for Chapter 4, in which appropriate street types are described based on the surrounding context and functional criteria. These context-based and functional criteria (classification, speed, volume, and access density) assist in the decision making process to identify the preferred street design solution.

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4: Planning and Design Elements

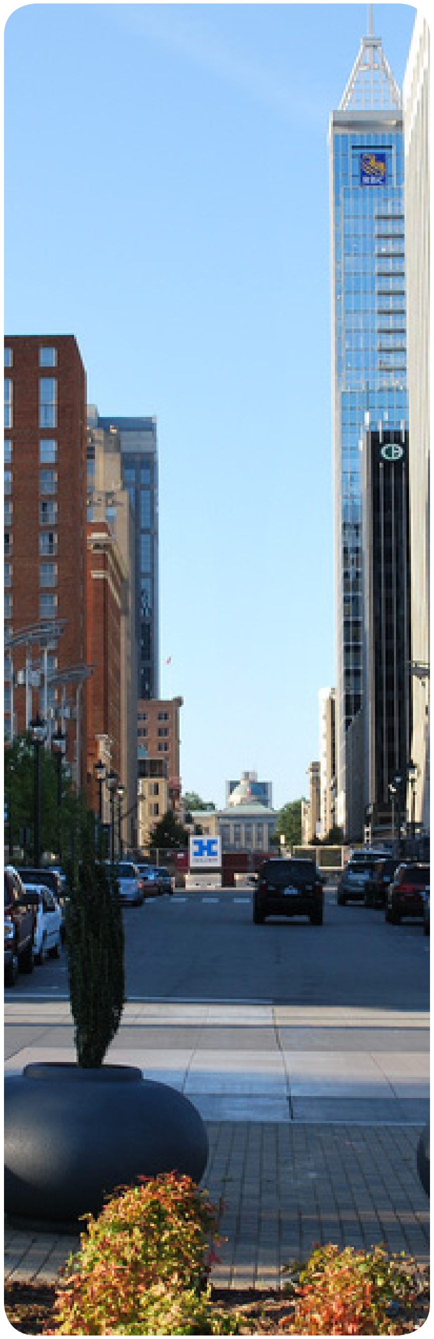
North Carolina's complete streets approach is intended to be flexible enough to apply to streets in communities across the state. When selecting the planning and design features for a particular street, the design input team must consider the current and future land use context of the corridor and its desired purpose and function.

Once the initial land use context had been identified, the design input team can collaborate on the design solutions that are appropriate for the street. A range of street types are described in detail in this chapter. A conceptual plan view, summary list of key elements, applicable street zones, and a street cross-section are shown for each. The design input team should use a variety of context-based land use, transportation, and functional criteria to refine the street type and design. These street sections should be used as guidance for the design in creating a complete street design that supports a transportation network that integrates motorists, bicyclists, pedestrians, and transit users and services.

Planning and Design Considerations

Land Use Context and Street Network

In defining the context of a complete street, an initial step is to identify the existing and future land use context where the street is located. Elements of land use context include the pattern, use, and density of development, both current and future.



Complete street design should be based on a collaborative discussion about local needs and the role of the street in the region's transportation network. The network should be planned to support the transportation needs generated by the planned or anticipated land uses while being compatible with characteristics of the surrounding neighborhoods and communities.

The structure of the network, the ability of the streets to serve traffic and provide mobility for non-motorists, provide access and accessibility, the spatial relationship of the street elements, and other elements of the right of way should encourage and support the development pattern, land-use, and development intensity in accordance with the community's vision. The total street network should improve the integration of land-use and transportation by avoiding mismatches between land uses and streets, and by creating the right combination of land uses and streets to facilitate the anticipated growth.

Area Type Considerations

The type of area the street is adjacent to will have a primary effect on the design of the street. While areas and sub-areas are defined in Chapter 3, it is important to understand the range of issues that should be considered in each area, as well as the importance of considering the future land use expectations of the community.

Urban

Urban areas have the most intense street use by the widest range of users. These streets may have to accommodate various modes with dedicated facilities, separate bike lanes for bicyclists, on-street parking to serve local businesses, and transit areas, with either dedicated travel lanes or dedicated loading and multi-modal connection areas. The transition areas between the different uses require special attention. For instance, planting strips and other buffers that separate the curb from the sidewalk should safely accommodate passenger access in areas where on-street parking or a transit stop is provided. In these types of areas, a hardscaped amenity zone may provide the better treatment.

Suburban

Suburban areas are located at the periphery of more urban areas or may be transitioning to urban areas. These areas may have a limited street network and be less intensively developed, creating challenges for providing pedestrian connections and accommodations for bicyclists as well as transit users. Bicycle lanes are the preferred treatment for accommodating bicyclists on higher volume and higher speed suburban streets. Along auto-oriented commercial strip areas, driveways can sometimes account for more than half of the sidewalk length within a block, creating potential bicycle/pedestrian-auto conflicts. Suburban areas are often expected to transition through time into more urban conditions. Therefore, they represent the greatest opportunities and needs for establishing better street networks (by providing more streets), lower target speeds, and better street designs to serve current and future users, who will be driving, walking, bicycling, and using transit. Additional streets and better networks should be provided as these areas develop to help achieve these objectives.

Rural

While recognizing that most streets (and complete streets) are in cities and towns, it is also important to consider how appropriate facilities can be provided in more rural environments. Rural areas may have the least network connectivity and, therefore, might have the most demand on single facilities. Travel lanes often need to accommodate motor vehicles, bicyclists, and transit with pedestrian access provided on shoulders or off-street. While rural areas can provide challenges to accommodating a full range of users, many times the provision of paved shoulders, multi-use paths or other facilities can safely and comfortably address user needs and provide complete streets. Different design treatments will be appropriate for different contexts and constraints.

Street Types

Street Types: Integrating Land Use & Street Function

In order to develop complete street networks in communities throughout North Carolina, a variety of street types have been defined and will be applied as complete streets. They represent a spectrum ranging from very pedestrian-oriented to very auto-oriented but, as described in this chapter, each can and should include ways to provide for the safe and comfortable travel of motorists, bicyclists, pedestrians, and transit users. Street design decisions and land use decisions should complement one another and achieve a pleasant balance between land use and street design. As illustrated in Figure 4, the following street types have been identified for the application of complete streets:

- Main Street
- Avenue
- Boulevard
- Parkway
- Rural Road
- Local/Subdivision Street

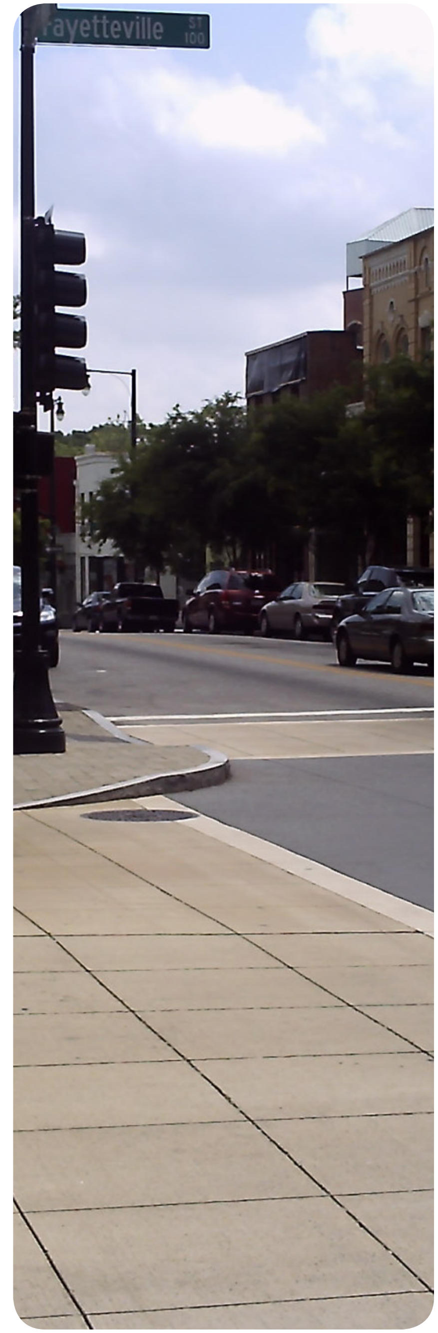
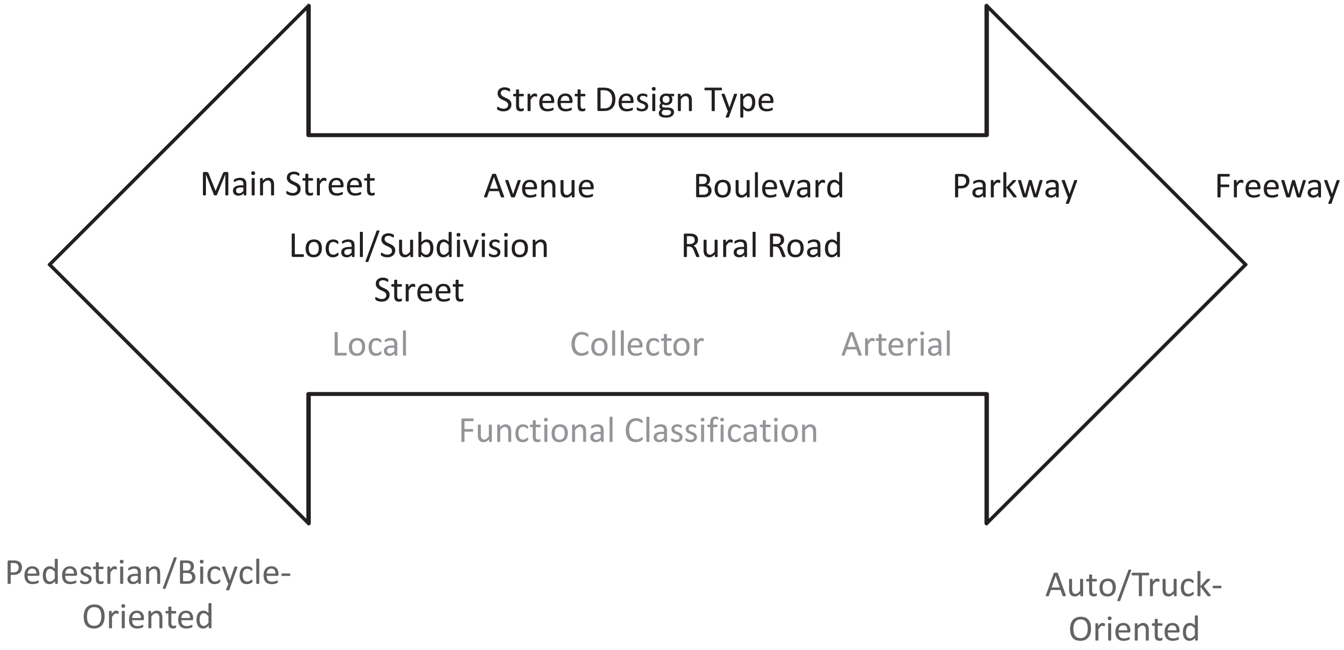


Figure 4: Arrow Showing Complete Street Types



Each street type's relative location on Figure 4 indicates the general function of the street within the complete street network. For example, the main street is the most pedestrian-oriented of these streets, and the parkway is the most auto/truck oriented. It should be noted that even a parkway provides design elements that improve safety and operation for bicyclists, pedestrians, and transit. While all of the street types should be designed to provide functionality for all users, the modal emphasis shifts. Rural roads serve as the primary connection and access to numerous towns and communities throughout the state. As such, they serve all types of road users, including bicyclists, pedestrians, and, in some places, rural transit. As a result, rural roads are also included in these guidelines.

The street types are defined on the following pages.

Main Street

- May function as an arterial, collector, or local street. May function as a collector serving as a primary thoroughfare for traffic circulation in a limited area. May function as a local destination street for an outlying business district.
- Designed to carry vehicles at low speeds (under 30 mph).
- A destination street for a city or town, serving as a center of civic, social, and commercial activity.
- Serves substantial pedestrian traffic as well as transit and bicycles.
- Includes wide sidewalks, crosswalks, and pedestrian facilities due to the emphasis on pedestrian travel.
- Bicycle lanes are allowed, but typically not necessary on these streets due to lower speeds and volumes, and the desire to keep pedestrian crossing distances to a minimum.

Avenue

- May function as an arterial, collector, or in a rural setting as a local route, but generally at low to moderate speeds.
- An urban street serving a range of traffic levels within and between various area types.
- Characterized by wide sidewalks (scaled to the surrounding land uses) and on-street bicycle facilities.
- May have on-street parking.
- Transit stops, shelters, and other amenities are located along the street, preferably within the right of way.

Boulevard

- Most often functions as an arterial designed to carry vehicles at moderate speeds.
- Thoroughfare characterized by multiple lanes and includes a street median.
- Wide sidewalks with appropriate planting strips and on-street bicycle lanes are necessary to accommodate pedestrians and bicyclists due to higher speeds and higher traffic volumes for motor vehicles.
- Building setbacks will typically be deeper than on avenues.
- Transit stops and shelters may be located within the right of way, requiring connections to sidewalks.
- On-street parking is not required. It is allowed where appropriate, but rare due to the nature of the street. If provided, parking should typically be placed on a separate, parallel frontage street separated with a side median.

Parkway

- Most often functions as an arterial designed with control of access to carry vehicles at moderate to high speeds.
- Urban or rural thoroughfare often characterized by landscaping or natural vegetation along roadsides and medians.
- Land uses are set back from the street and are typically not oriented toward the parkway.
- Pedestrian and bicycle traffic usually provided for on separate multi-use paths ideally located adjacent to the facility.
- Convenient access to off-street transit stations, stops, and park-and-ride lots.
- Tractor trailer and semitrailer truck traffic is frequently present.

Rural Road

- May function as an arterial, collector or local route, but with a range of speeds.
- A road outside of cities and towns serving a range of traffic levels in a country setting.
- Wide paved shoulders can be used to provide bicycle and pedestrian accommodations.
- Multi-use paths separated from the roadway may also be an appropriate treatment for bicycle and pedestrian accommodations.
- Accommodates bus facilities, including turnouts as appropriate. Public transit stops and shelters should be clearly marked and placed within the right of way.

Local/Subdivision Streets

Local/subdivision streets serve as a critical element in the street network, linking residential and business areas. Local streets are not defined by ownership or maintenance responsibility, but by the fact they functionally provide direct access to land uses within subdivisions. These streets typically have low speeds and very low traffic volumes, and have a strong focus on access and pedestrian/bicycle movements. Local/subdivision streets are subdivided into two types: residential and office/commercial/industrial. Characteristics similar to each include:

- Carries traffic at low speed.
- Provides direct access to local land uses.
- Provides linkages and connections to the overall street network.
- Street widths are based on land use, density, and lot size.
- On-street parking typically occurs, though at different levels, depending on land use characteristics.
- Bicycle lanes are typically not necessary due to low traffic volumes and low speeds.
- Pedestrian activity is expected, and should be accommodated on these streets.

Local streets are treated differently than the other street types in this document for several reasons. First, these are the streets that are typically built through the land development process, rather than as capital/public projects. Therefore, the local/subdivision street cross-sections are meant to be applied more prescriptively than are the cross-sections for the other street types. This offers predictability to those creating these streets. Second, even though these cross-sections are more prescriptive, there are several different cross-sections, to allow for the flexibility to establish the "right" street for a wide variety of land development types and intensities. This provides for both predictability and flexibility as land uses are being developed. These street types are offered here as examples to communities seeking to apply complete streets through their ordinances. Moving forward, NCDOT will accept these street types for maintenance in communities that implement complete streets, provided the street types are appropriately applied and have prior approval from NCDOT.

Why Multiple Cross-Sections?

The multiple cross-sections described for local/subdivision streets reflect the likelihood that on-street parking will be utilized. The intent is to ensure enough space for parking where needed, but to not create overly-wide streets that make it more difficult to maintain low operating speeds. The narrower cross-sections for both residential and commercial developments are meant to be applied where there is a low likelihood of on-street parking, due to the amount or placement of on-site parking. For example, a large-lot residential neighborhood with long driveways and rear-access parking will likely not require much on-street parking, and an overly wide cross-section is neither necessary nor in keeping with expected speeds. Likewise, a commercial development (such as a traditional "office park") with a large amount of surface parking, and little short-term parking turnover will also not require on-street parking.

At the other end of the spectrum, higher density or mixed-use types of development usually result in frequent and heavy utilization of on-street parking. For example, residential densities above a certain threshold or commercial mixed-use developments will need to apply the wider cross-sections. These cross-sections provide space for full-time on-street parking, while leaving travel lanes open – all of which supports an accessible, but calmed street environment. Further, the sidewalk width is scaled to reflect the context, which will include higher levels of parking turnover and resulting pedestrian activity along the street front.

The medium cross-section for residential developments is generally meant to be applied in residential neighborhoods where there will be some utilization of on-street parking, but not heavy parking on both sides of the street. This cross-section is similar to the "default" for many communities because it reflects the current NCDOT subdivision street cross-section.

Box 1 shows an example of how ordinance language can be used to apply similar local street cross-sections to the appropriate context. The local residential streets in this example are defined as:

- narrow (20 ft., measured face of curb to face of curb),
- medium (25 ft.), or
- wide (34 ft.).

All include 8 ft. planting strips and 5-8 ft. sidewalks.

The local office/commercial streets are defined as:

- narrow (24 ft.) or
- wide (40 ft.),

with 8 ft. planting strips and 5 or 8 ft. minimum sidewalks.

The local industrial street is 34 ft. wide, with an 8 ft. planting strip and 5 ft. sidewalk.

Box 1 – Sample Application of Complete Street Cross-Sections in Subdivision Ordinance (Charlotte, NC).

Land Use Conditions	**USDG Street Type/Cross-Section**
Residential Land Uses	
Default: except in conditions 1-4 below, use:	Local Residential Medium
1. If mixed use development:	Local Office/Commercial Wide
2. If all lots are greater than 10,000 square feet with all of the following conditions: • Lot frontage greater than 80 feet • More than one street connection • Parallel street located within one connected block	Local Residential Narrow
3. If the street is abutted only by lots fronting adjacent perpendicular streets with the following condition: • More than one street connection	Local Residential Narrow
4. If greater than 8 dwelling units per acre	Local Residential Wide
Industrial Land Uses	Local Industrial Street
Office/Commercial/Retail Land Uses	
Default: except in conditions 1-2 below, use:	Local Office/Commercial Wide
1. A conditional zoning district or small area plan prescribes the use of the Local Office/Commercial Narrow	Local Office/Commercial Narrow
2. The developer can reasonably demonstrate to city staff that the anticipated development will not create parking demand on the street.	Local Office/Commercial Narrow

Network and Local Streets

Throughout this document, there are references to the importance of both using and creating street "network" to create better, more complete streets. This is particularly important to consider as local/subdivision streets are being planned and constructed. These streets create vital connections between thoroughfares (avenues and boulevards, e.g.) and the neighborhoods or commercial developments that access them. Good network provides more direct (shorter) routes for bicyclists and pedestrians to gain access to the thoroughfares and to the land uses along them (or allows them to avoid the thoroughfare altogether). Likewise, good connections can also allow short-range, local vehicular traffic more direct routes and access, resulting in less traffic and congestion on the thoroughfares. This can, in turn, help make the thoroughfare itself function as a better, more complete street. For all of these reasons, a complete local street network should generally provide for multiple points of access, short block lengths, and as many connections as possible.

Box 2 shows one example of how block lengths are used to help create complete street networks in a community. The example shows how Charlotte applies block length expectations based on land use context. Generally, the more dense or intensive the expected

Box 2 – Example of Block Length Expectations for Local Streets, Based on Land Use Context (Urban Street Design Guidelines, Charlotte, NC).

Table 4.1 **Block Lengths for Local Streets**

Land Use/Location	Preferred or Typical Block Lengths for Local Streets	Maximum Block Length for Local Streets
Transit Station Areas[1]	400′	600′
Centers[1]	500′	650′
Corridors[1]	600′	650′
Non-Residential Uses[1,2]	500′	650′
Industrial	600′	1,000′
Residential ≥ 5 dua (gross) in Wedges	600′	650′
Residential < 5 dua (gross) in Wedges	600′	800′

land use, the shorter the expected block lengths to support those land uses. This is broadly applied to Charlotte's Centers, Corridors, and Wedges growth framework and also to specific types of land uses. Centers and Transit Station Areas represent the highest density location/context and have shorter block lengths. Lower-density land uses in the Wedges represent the lowest density location/context and can have longer block lengths. Charlotte's Subdivision Ordinance includes a flexible approach to applying these block lengths to developments.

Freeway/Expressway

Freeways and certain expressways are not considered part of the complete street types previously described. Planning and design of these facilities will focus on the capacity and safety requirements of motor vehicle traffic. However, streets at interchanges and grade separations should incorporate complete streets elements, and interchanges, expressway intersections with surface streets, and their bridges and underpasses will be designed to safely and comfortably accommodate bicyclists, pedestrians, and transit users. Along freeways and expressways, pedestrian space may consist of a multi-use path provided outside of the control of access.

Figure 5: Street and Area Type Matrix

<table>
<tr><th rowspan="2">Area Type</th><th rowspan="2">Land Use</th><th colspan="3">Main Street</th><th colspan="3">Avenue</th><th>Boulevard</th><th>Parkway</th><th colspan="3">Rural Road</th></tr>
<tr><th>Arterial</th><th>Collector</th><th>Local</th><th>Arterial</th><th>Collector</th><th>Local</th><th>Arterial</th><th>Arterial</th><th>Arterial</th><th>Collector</th><th>Local</th></tr>
<tr><td rowspan="3">Urban</td><td>Central Business District (CBD)</td><td colspan="3" rowspan="6">Urban/Suburban Main Street</td><td colspan="3" rowspan="6">Urban/Suburban Avenue</td><td rowspan="6">Urban/Suburban Boulevard</td><td rowspan="6">Urban/Suburban Parkway</td><td></td><td></td><td></td></tr>
<tr><td>Urban Center</td><td></td><td></td><td></td></tr>
<tr><td>Urban Residential</td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">Suburban</td><td>Suburban Center</td><td></td><td></td><td></td></tr>
<tr><td>Suburban Corridor</td><td></td><td></td><td></td></tr>
<tr><td>Suburban Residential</td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">Rural</td><td>Rural Village</td><td colspan="3" rowspan="2">Rural Main Street</td><td colspan="3" rowspan="2">Rural Avenue</td><td rowspan="2">Rural Boulevard</td><td rowspan="3">Rural Parkway</td><td></td><td></td><td></td></tr>
<tr><td>Rural Developed</td><td></td><td></td><td></td></tr>
<tr><td>Countryside</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Rural Road</td></tr>
</table>

Street Type Selection

By defining and implementing complete street designs that meet the intent of different street types and a variety of land use contexts, NCDOT has a better chance of meeting the multiple objectives of the different users of our streets. This section identifies planning and design criteria that represent both land use and street function.

As described in the previous section, different street types have been defined: main street, avenue, boulevard, parkway, rural road, and local/subdivision street. These street types are meant to represent the range of state-maintained streets throughout North Carolina.

The matrix shown in Figure 5 lets the planner/designer see the area type, land use, and street type together. The matrix provides initial guidance about appropriate street types for general contexts, but should not be applied without more information. With this selection made, the design input team should consider other functional and context-based criteria to help select the appropriate cross-section for the street.

Functional Criteria

Once the appropriate street type has been initially identified, the design input team can refer to the more detailed functional criteria shown in Figure 6. These functional criteria include classification, target speed, traffic volume, and access density, all of which assist in defining the ultimate cross-section. As with Figure 5, this information is intended to provide guidance to the design input team and is not intended to replace the project development process described in Chapter 2.

Functional Classification – Traditionally, functional classification is divided into arterial, collector, and local routes. An arterial is typically a higher volume facility serving longer regional trips (as well as local trips), may have high truck volumes, and connects to local collector routes. At the other end of the spectrum, local routes typically carry lower traffic volumes and primarily provide access to adjacent land uses. Collectors connect these two functional types by "collecting" traffic from the local routes and conveying it to the arterials. The street types defined in these guidelines also describe a functional classification, but one that is expanded to include functional considerations for all users. Therefore, the traditional functional classifications described in this section represent one type of useful design parameter to be considered in planning and designing complete streets.

Target Speed – Target speed refers to the preferred travel speed on the street. Speed is a critical component in improving motorist, bicycle, and pedestrian safety on a street and the target speeds for streets are typically lower than would be applied in most applications of traditional highway design.

Traffic Volume – Traffic volume represents the amount of motor vehicle traffic on a street, with ranges for low, moderate, and high. These ranges for traffic volumes overlap to allow flexibility in the number of lanes required based on area type, land use, and street type. Two-lane streets carry low to moderate traffic volumes. The general range for application is:

- Low: Less than 8,000 vehicles per day;
- Moderate: Between 6,000 and 24,000 vehicles per day; and
- High: More than 20,000 vehicles per day.

Access Density – Access density provides a relative measure of the amount of development and interaction along a street. Generally, more dense spacing of access is a reflection of the need for lower speeds in a corridor. However, there can be exceptions on roads with heavy access management. Denser access spacing also generally provides more network flexibility for pedestrians, bicyclists, transit users, and motorists. As shown in the Street Type Matrix (Figure 6), two measures can be used for access density:

1. Traffic Signal spacing:

- Low: Up to 1 signal per mile;
- Moderate: 1 to 3 signals per mile; and
- High: More than 3 signals per mile.

Figure 6: Street Type Matrix

Urban / Suburban	Main Street			Avenue			Boulevard	Parkway
Street Type	Main Street			Avenue			Boulevard	Parkway
Target Speed (MPH)	20-25	20-25	20-25	25-35	25-35	25-35	25-40	> 35
Traffic Volume	H / M	M	M / L	H	M	L	H	H
Access Density	H	H	H	M	H / M	H	L/M	L
Functional Classification	Arterial	Collector	Local	Arterial	Collector	Local	Arterial	Arterial

Rural	Main Street			Avenue			Boulevard	Parkway	Rural Road		
Street Type	Main Street			Avenue			Boulevard	Parkway	Rural Road		
Target Speed (MPH)	20-25	20-25	20-25	25-35	25-35	25-35	30-40	> 35	45-55	35-55	25-55
Traffic Volume	M	L	L	M	L	L	M	H / M	M	L	L
Access Density	M	M	M	L/M	M	M	L/M	L	L	L	L
Functional Classification	Arterial	Collector	Local	Arterial	Collector	Local	Arterial	Arterial	Arterial	Collector	Local

Suggested Ranges:

Traffic Volume	L - Low	Less than 8,000 vpd		
	M - Moderate	6,000-24,000 vpd		
	H - High	Greater than 20,000 vpd		
Access Density (Traffic Signal Spacing and Access Point Spacing)	L - Low	Up to 1 signal per mile	OR	Greater than 1000 ft. average spacing between access points (less than 5 access points per mile on each side of the street)
	M - Moderate	1 - 3 signals per mile	OR	400 -1000 ft. average spacing between access points (5-15 access points per mile on each side of street)
	H - High	More than 3 signals per mile	OR	Less than 400 ft. average spacing between access points (more than 15 access points per mile on each side of street)

Note: Access points include street intersections and commercial access points (excluding single family residential).
Access points should be counted on both sides of the street when determining the number of access points.

2. Access Point spacing:

- Low: greater than 1,000-foot spacing between access points (approximately 0-10 access points per mile);
- Moderate: 400- to 1,000-foot spacing between access points (approximately 10-30 access points per mile); and
- High: less than 400 foot spacing between access points (greater than 30 access points per mile).

Access points include street intersections and commercial access points. Access points should be counted on both sides of the street when determining the number of access points.

Street Cross-Sections

This section describes the characteristics of each street type using cross-sections and recommended dimensions. The cross-sections described in this section reflect the design elements that provide for good quality of service, as described in Chapter 3. Street quality of service focuses on a consideration of all modes of travel, including cyclists, pedestrians, and transit users. Therefore, streets have design treatments to provide access and accessibility for all modes. This section illustrates the requirements in a graphic format. As shown in the Street Type Matrix (Figure 6), there are nine basic street cross-sections, not including local/subdivision streets (main street, avenue, boulevard, and parkway in both urban/suburban and rural sections) as well as rural roads. In addition, a section is included for a multi-use path, since this is a recommended way to improve quality of service for some street types or contexts.

For each of these street types, a two-page summary is included. One page shows a conceptual plan view of a typical street (graphical and not to scale), a summary list of the key elements of each street type, and a discussion of the street zones within each section. The second page illustrates a street cross-section with ranges and, where necessary, explanatory notes.

Plan View

An illustrated plan view is provided for each typical street section. The purpose of the illustration is to provide a general understanding of the intended spatial relationships of the various street elements. The illustration serves as a diagram of one or more possible street configurations.

Key Elements

Key elements describe the overall characteristics of each street type. Since these typical street sections represent an integration of area type with street type, the key elements should be a confirmation that the design input team is considering the appropriate street section for the proposed application.

Street Cross-section Zones

Each of the street cross-sections is described as a series of zones to clarify the purpose of specific areas of the street, and to provide flexibility when defining the necessary components or their recommended dimensions for a specific context. Each of the street zones accommodate specific street design elements.

Development Zone

This is the area outside the street right of way (ROW) where public or private property is located or may be planned in the future. The relationship of the buildings in the development zone to the street is an important component of the character of the street, as well as how it functions for the street users. In a downtown area, it is likely that this zone includes buildings fronting or very near the back of the sidewalk. In suburban or rural areas, the development zone is more likely to include a deeper setback between the street and the developed portion of the street front (the buildings). Depending on context, this area could be a parking lot, a front lawn to a residence, or undeveloped land. In some cases, ROW for a utility strip is required behind a sidewalk which effectively shifts the development zone farther from the street.

Since the development zone is outside the street ROW, the types of street elements in this area can vary widely. Elements specific to the transportation network may include:

- Bicycle or pedestrian paths;
- Transit stops or facilities;
- Public parking lots; or
- Driveway connections between private parcels.

Green Zone

The green zone is generally a landscaped area between the street pavement (or curb) and the sidewalk. In general, the street designs provide a minimum of 6 to 8 feet in this area to allow space for street trees. Street trees buffer pedestrians and other street users from vehicular traffic, as well as providing for shade and an attractive public realm. Within a high-density urban area, the green zone may be hardscaped with trees in planters. It is important to note that the design needs to account for safe offset of stationary objects from the through traveled way.

In addition to street trees, green zone elements may include features such as other landscaping, signs, benches, fire hydrants, street and pedestrian light poles, and utility poles. Transit amenities such as bus shelters can be considered, but would typically be accommodated behind the green zone.

Sidewalk Zone (or Multi-Use Path Zone)

This area is reserved primarily for a paved sidewalk to carry pedestrians and provide access to transit and to adjacent land uses. In urban and suburban areas, the expectation is to provide sidewalks on both sides of the street unless there are site-specific constraints that make this impossible. When planning for, or accommodating, transit, safe and accessible pedestrian connections are needed between adjacent land uses and transit stops.

Detached sidewalks (located behind the green zone) are preferred because they separate (or buffer) pedestrians from moving traffic and allow for a planting area between the sidewalk and travel lanes. Sidewalk widths vary based on the street type and context. Recommended sidewalk widths range from 6 to 12 feet. Narrower sidewalks (5 feet) may be sufficient for local/subdivision streets in areas with low to medium land use densities. Wider sidewalks (up to 12 feet) are preferred in urban or main street settings with higher levels of pedestrian activity.

In urban areas or other areas with intensive development, it may be necessary to provide wider sidewalks extending to the face of existing buildings. Generally, the sidewalk zone should allow for unobstructed sidewalk width. Street and transit furniture (such as benches, trash cans, and newspaper racks), should be placed within the green zone or development zone, rather than the sidewalk zone, if there is sufficient width and offset from the curb.

On parkways or rural roads, instead of a sidewalk, the pedestrian space may consist of a multi-use path zone set back from the roadway. Multi-use paths are separate facilities that serve pedestrians and bicyclists. The multi-use path should be wide enough to serve bicyclists and pedestrians safely. The preferred cross-section is 10 to 12 feet with two-foot gravel shoulders on each side. A green zone and natural zone help provide a buffer from the main travel way.

Motor Vehicle Zone (or Shared Vehicle Zone)

The motor vehicle zone is generally considered the paved travel way of a street. Motor vehicle zone elements include the travel lanes, turn lanes and tapers, and channelized or striped pavement areas, and, in some circumstances, the gutter pans. Travel lanes are important for vehicular movement and capacity along a corridor. Travel lane considerations include the number and width of lanes, the street direction (one-way or two-way), and the width and incorporation of turn lanes. It is also important to consider these elements from the standpoint of their impact on other users. Street width, for example, can affect the ability of pedestrians to cross the street or the potential provision of bike lanes. The majority of street cross-sections in these guidelines show a range of lane widths from 10 to 12 feet. The recommendation for 10- to 11-foot lanes reflects that, for most urban and suburban street types, lanes less than 12 feet wide are both safe and appropriate, can help to reduce the overall footprint of the street, and/or allow space for other users of the street. Additional considerations include the need for turn lanes at intersections. Sufficient width and need for turn lanes should be evaluated within the context of the larger corridor.

A shared vehicle zone allows for both motorized and non-motorized vehicles, and typically includes additional pavement for bicycles. The preferred treatment for bicycles on higher volume and speed streets is a separate bicycle lane. If a shared vehicle zone is used instead, it might consist of additional space for a shared lane, additional space with shared lane markings, or on very low-volume, low-speed streets, a regular travel lane. The gutter pan is not considered part of the bicycle facility.

Parking may or may not be provided along a street. The relationship between parking lane width and vehicular lane width should be evaluated (in corridors with parking, vehicular lanes may need to be wider, depending on the street type and context). If a parking zone is adjacent to the traveled way, additional offset may be provided. Transit vehicles will often utilize the motor vehicle zone for bus stops if bus pull-offs are not provided or appropriate.

Parking/Transit Stop Zone

The parking zone is typically an 8 to 10-foot wide section allowing for parallel parking adjacent to traffic flow. Parallel parking should be limited to corridors with lower speed limits (35 mph or lower). Parking zones are not provided on parkways. Under certain circumstances, parking can be applied on boulevards. Parking zones are more typical on avenues and almost always included on main streets. Angle parking is allowed, preferably reverse angle parking. The parking/transit zone is a paved area. The gutter pan can be included as part of this zone without increasing the width of the parking zone. This zone can also be used as a bus pullout, where appropriate, or can serve as an extension of the green zone when providing bulb-outs to protect parking and improve pedestrian accommodations.

Bicycle Zone (Bicycle Lane)

A bicycle zone is an area reserved for a striped bicycle lane adjacent to the motor vehicle lane. The width is typically four to six feet of pavement. The gutter pan should not be considered part of the bicycle lane. When placed adjacent to a parking zone, the bike lane should be 5 to 6-feet wide. As described in the description of the shared vehicle zone, if separate bicycle lanes cannot be accommodated, shared lanes are allowed if the outside vehicular lanes are 14 feet and shared lane markings may be considered when travel speeds are 35 mph and below. On streets with limited right of way, shared-lane markings (without a wide outside lane) may be sufficient with travel speeds of 35 mph and below.

Median Zone

The median zone typically provides a landscaped buffer between traffic moving in opposing directions. Medians can also help to provide for pedestrian refuge opportunities in some contexts. Parkways and boulevards typically have a median, avenues may have a median, and main streets may have a median, though it is atypical. Rather than continuous medians, avenues may typically include intermittent landscaped islands to allow for more access, breaks in center turn lanes, and provide pedestrian refuge opportunities. Most two-lane streets do not have a median.

The primary considerations with medians include width and treatment. Median widths vary from 8 feet to 46 feet depending on street type and context. In most urban and suburban locations, curbs will be used to delineate the median from the traveled way. Median breaks should be identified early in the design and should be located to allow for access and to maintain network connectivity. The median zone typically includes street trees and shrubbery. Hardscaping may be provided at narrow points and at specified crossing points to facilitate pedestrian use. At crossing points, landscaping and limbs should be maintained to allow visibility for the pedestrian and motorist.

Another median type is a side median, which is used in a multi-way boulevard configuration. Side medians separate the primary thoroughfare traffic from traffic on the adjacent access street. Side medians are typically 8 feet or less in width.

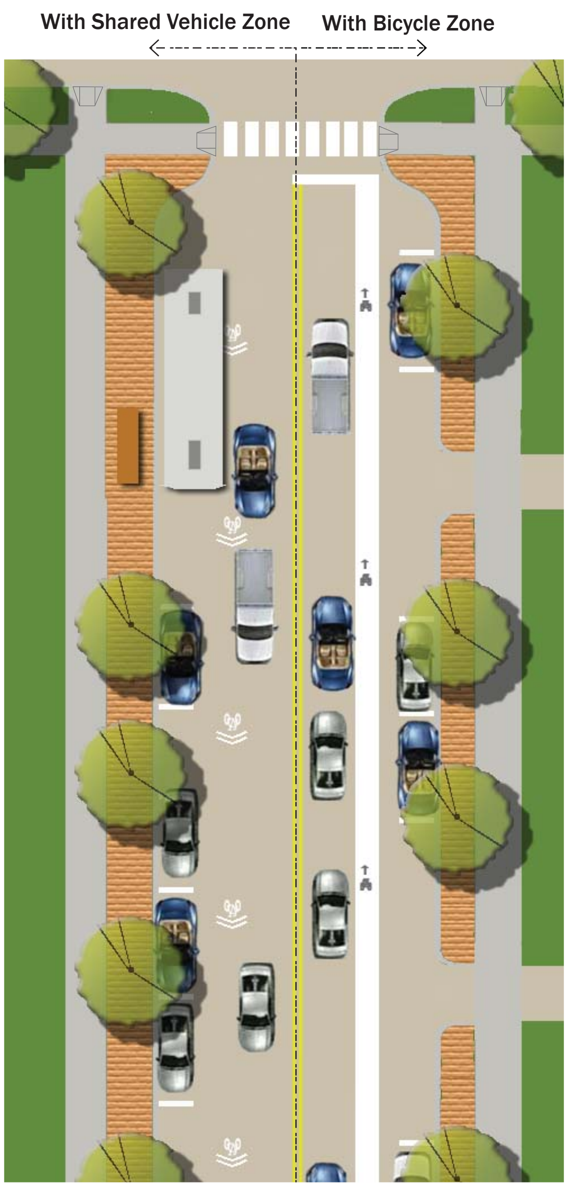
Street Cross-sections and Guidelines

The following pages illustrate street cross-sections for each street type. The purpose of the illustrations is to provide a general understanding of the intended spatial relationships of the various street components for each street type. These illustrations serve as a diagram of one or more possible street configurations.

Dimensional guidelines are provided for the appropriate combinations of street types with subarea type. The guidelines provide ranges that allow the design input team the flexibility to respond to particular conditions. **These cross-sections should not be used in isolation.** Consideration of the context and the elements discussed previously in this guideline document must be brought into the decision making process, as described in Chapter 2. Please also note that all pavement markings and placement of pavement markings should follow the guidelines specified in the current edition of the Manual on Uniform Traffic Control Devices (MUTCD).

URBAN/SUBURBAN MAIN STREET

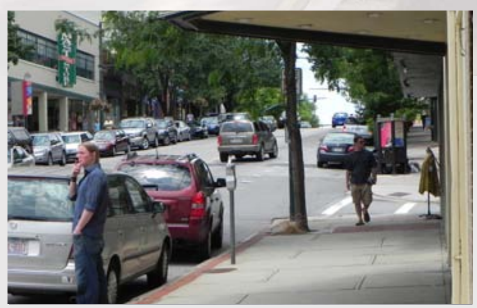
PLAN VIEW



Not all traffic control devices shown

KEY ELEMENTS

- May function as an arterial, collector or local street. May function as a collector serving as a primary thoroughfare for traffic circulation in a limited area. May function as a local street for an outlying business district.
- Designed to carry vehicles at low speeds.
- A destination street for a city or town, serving as a center of civic, social and commercial activity.
- Serves substantial pedestrian traffic as well as transit and bicycles.
- Characterized by wide sidewalks, crosswalks and pedestrian amenities, due to emphasis on pedestrian travel.
- Bicycle lanes are allowed but typically not necessary on these streets due to lower speeds and volumes and the desire to keep pedestrian crossing distances to a minimum.



STREET CROSS-SECTION ZONES

Sidewalk Zone: The pedestrian walk area is of sufficient width to allow pedestrians to walk safely and comfortably. Pedestrians are the priority on a main street.

Green Zone: Consists of the area between the sidewalk zone and curb. Includes street trees and other landscaping, as well as interspersed street furnishings and pedestrian-scale lighting in a hardscaped amenity zone.

Parking/Transit Zone: Accommodates on-street parking and transit stops. Width and layout may vary.

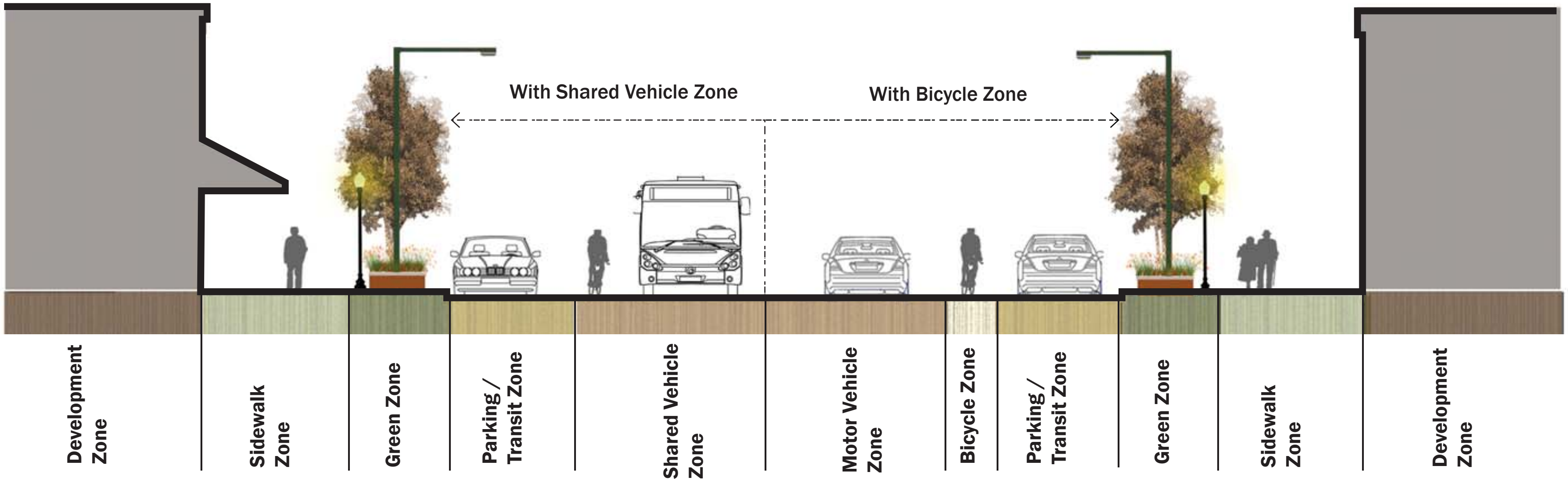
Bicycle Zone: A zone for bicyclists separate from vehicular traffic.

Motor Vehicle / Shared Vehicle Zone: The primary travel way for vehicles. A shared vehicle zone has mixed traffic (cars, trucks, buses and bicycles).

Development Zone: Development should be pedestrian-oriented with narrow setbacks and an active street environment.

URBAN/SUBURBAN MAIN STREET

ILLUSTRATIVE STREET CROSS-SECTION



STREET COMPONENT DIMENSIONAL GUIDELINES

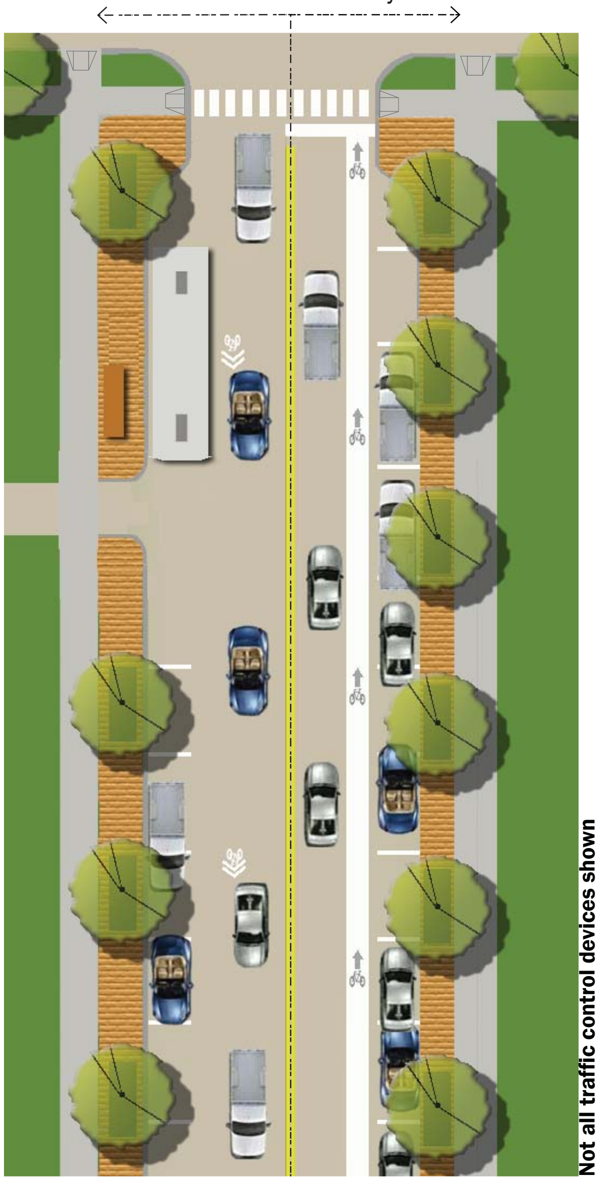
	Sidewalk Zone *(feet)*	Green Zone *(feet)*	Parking /Transit Zone *(feet)*	Motor Vehicle / Shared Vehicle Zone *(lane width- feet)*	Bicycle Zone *(feet)*
Central Business District	10' - 12' 12' - 20' in high volume pedestrian areas	6' - 8'	8' - 10'	10' - 13' (see note 4)	6' lanes (see note 4)
Urban Center / Suburban Center	8' - 12' 12' - 20' in high volume pedestrian areas	6' - 8'	8' - 10'	10' - 13' (see note 4)	6' lanes (see note 4)
Suburban Corridor / Urban Residential / Suburban Residential	8' - 10' 12' - 20' in high volume pedestrian areas	6' - 8'	8' - 10'	10' - 13' (see note 4)	6' lanes (see note 4)

NOTES

1. Sidewalk zone should typically extend to the front of buildings. Sidewalks are the most important element on a main street, because pedestrians are the priority. Therefore, the sidewalk width should typically be at least 10', unobstructed.
2. Green zone may include hardscaping, landscaping, street trees, lighting, and related pedestrian/bicycle/transit amenities. Hardscaping (with street trees in appropriately-designed planters) is typical for access to on-street parking and transit.
3. Parking is expected on main streets. Parking zone dimension may vary depending upon type of parking provided. Angle parking is allowed, preferably reverse angle parking. Angle parking will require a wider dimension than shown.
4. Shared lanes are the preferred treatment, due to the low speeds. In this case, travel lanes should be 13' to allow for maneuvering and opening car doors. Shared lane markings can be used on streets < 35 mph. If bicycle lane is provided, it should be 6' wide, and motor vehicle lane should be narrowed to 10'.

RURAL VILLAGE MAIN STREET

PLAN VIEW



KEY ELEMENTS

- May function as an arterial, collector or local street. Could function as an arterial in rural communities. May function as a collector serving as a primary thoroughfare for traffic circulation in a limited area. May function as a local street for an outlying business district.
- Designed to carry vehicles at low speeds.
- Bicycle lanes are allowed but typically not necessary on these streets, due to lower speeds and volumes and the desire to keep pedestrian crossing distances to a minimum.
- A destination for a rural village serving as a center of civic, social and commercial activity.
- Serves substantial pedestrian traffic as well as transit and bicycles.
- Includes wide sidewalks, crosswalks and pedestrian facilities due to the emphasis on pedestrian travel.

STREET CROSS-SECTION ZONES

Sidewalk Zone: The pedestrian walk area is of sufficient width to allow pedestrians to walk safely and comfortably. Pedestrians are priority on a main street.

Green Zone: This zone consists of the area between the sidewalk zone and curb. It includes street trees and other landscaping, as well as interspersed street furnishings and pedestrian-scale lighting in a hardscaped amenity zone.

Parking/Transit Zone: Accommodates on-street parking and transit stops. Parking zone widths and layout may vary.

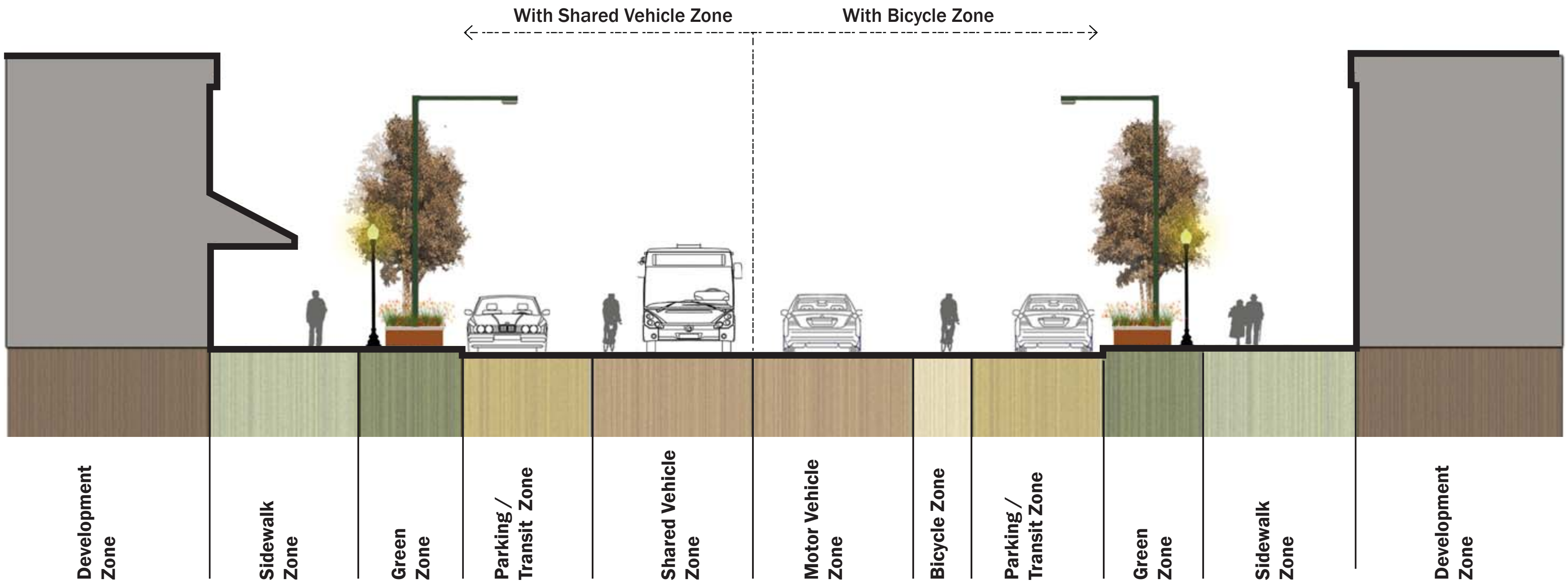
Bicycle Zone: A zone for bicyclists separate from vehicular traffic.

Motor Vehicle /Shared Vehicle Zone: The primary travel way for vehicles. A shared vehicle zone has mixed traffic (cars, trucks, buses, and bicycles).

Development Zone: Development should be pedestrian-oriented with narrow setbacks and an active street environment.

RURAL VILLAGE MAIN STREET

ILLUSTRATIVE STREET CROSS-SECTION



STREET COMPONENT DIMENSIONAL GUIDELINES

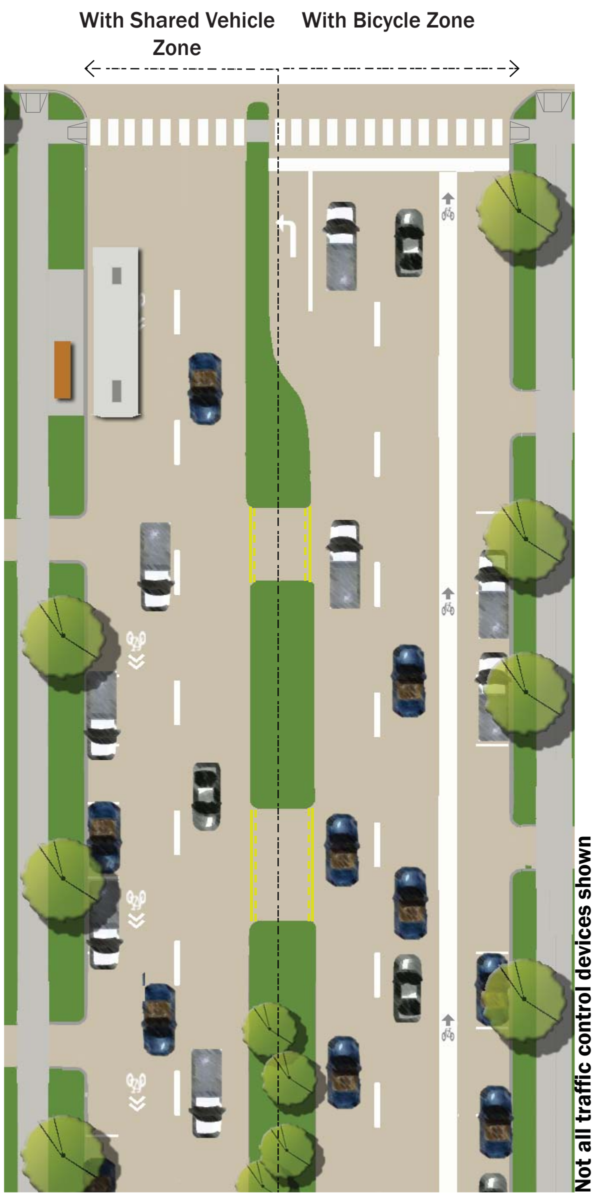
	Sidewalk Zone *(feet)*	Green Zone *(feet)*	Parking /Transit Zone *(feet)*	Motor Vehicle/ Shared Vehicle Zone *(lane width- feet)*	Bicycle Zone *(feet)*
Rural Village	10' - 12'	6' - 8'	8' - 10'	10' - 13'	4' - 6' lanes (see note 4)
Rural Developed	8' - 10'	6' - 8'	8' - 10'	10' - 13'	4' - 6' lanes (see note 4)

NOTES

1. Sidewalk zone should typically extend to the front of the building. Sidewalks are the most important element on a main street, because pedestrians are the priority. Therefore, the sidewalk width should typically be at least 10' unobstructed.
2. Green zone may include hardscaping, landscaping, street trees, lighting, and related pedestrian /bike /transit amenities. Hardscaping (with street trees in appropriately-designed planters) is typical, for access to on-street parking and transit.
3. Parking is expected on main streets. Parking zone dimensions vary depending upon the type of parking provided. Angle parking is allowed, preferably reverse angle parking. Angle parking will require a wider dimension than shown.
4. Shared lanes are the preferred treatment, due to the low speeds. In this case, travel lanes should be 13' wide to allow for maneuvering and opening car doors. Shared lane markings can be used on streets < 35 mph. If a bicycle lane is provided, it should be 6' wide, and the motor vehicle lane should be narrowed to 10'.

URBAN / SUBURBAN AVENUE

PLAN VIEW



KEY ELEMENTS

- May function as an arterial or collector, but generally at low to moderate speeds.
- An urban street serving a range of traffic levels within and between various area types.
- Characterized by wide sidewalks (scaled to the surrounding land uses) and on-street bicycle facilities.
- May have on-street parking.
- Transit stops, shelters and other amenities are located along the street, preferably within the right of way.

STREET CROSS-SECTION ZONES

Sidewalk Zone: The pedestrian walk area is of sufficient width to allow pedestrians to walk safely and comfortably.

Green Zone: The landscaped or hardscaped area along the edge of a street. On avenues, this zone should include grass, landscaping, and shade trees in planting strips or, in some cases, hardscaped amenity zones. Pedestrian or decorative lighting may be provided when appropriate for adjacent land uses.

Parking/Transit Zone: On-street parking is optional and should be considered in relation to providing convenient access to adjacent land uses. Parking zone width and layout may vary.

Bicycle Zone: Accommodation for bicyclists in a zone separate from the motor vehicle zone.

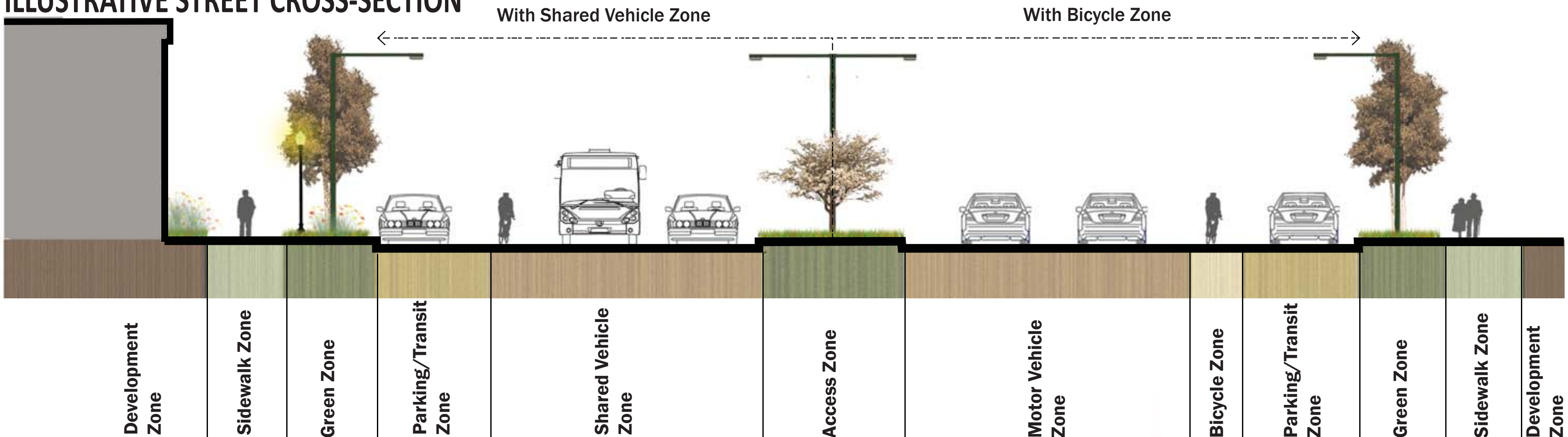
Motor Vehicle/Shared Vehicle Zone: The primary travel way for vehicles. A shared vehicle zone has mixed traffic (cars, trucks, buses and bicycles).

Access Zone: A landscaped zone or turning zone located between the travel lanes as a center median or turn lane. Avenues typically do not include a continuous median.

Development Zone: Development should be oriented toward the street with good functional and visual connection to the street.

URBAN / SUBURBAN AVENUE

ILLUSTRATIVE STREET CROSS-SECTION



STREET COMPONENT DIMENSIONAL GUIDELINES

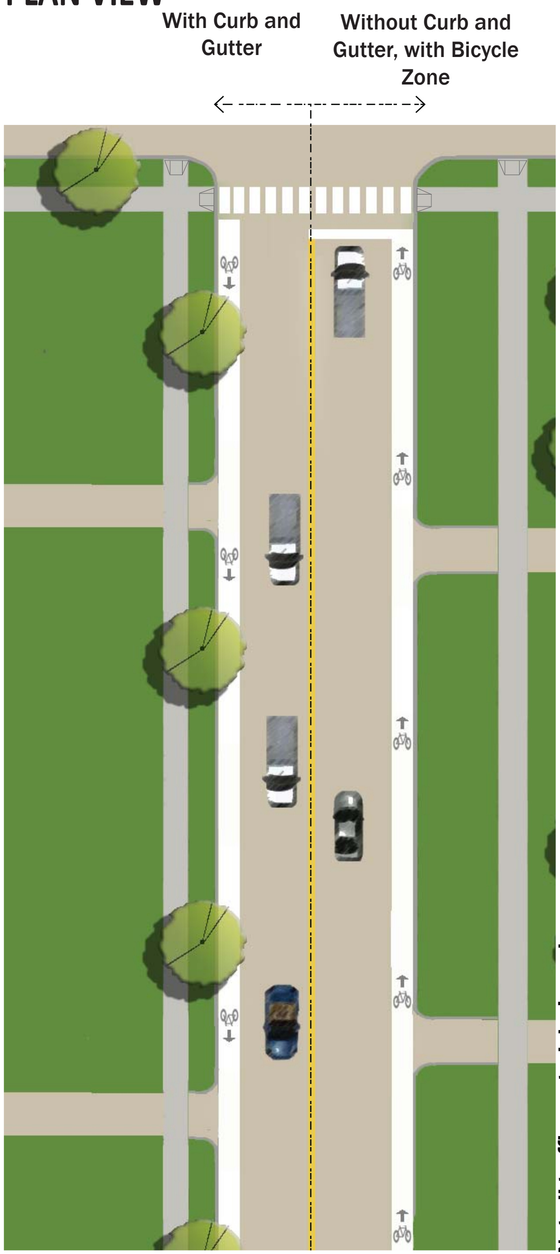
	Sidewalk Zone *(feet)*	Green Zone *(feet)*	Parking /Transit Zone *(feet)*	Motor Vehicle/ Shared Vehicle Zone *(lane width- feet)*	Bicycle Zone *(feet)*	Access Zone *(feet)*
Central Business District	**8' - 12' 12' - 20' in high volume pedestrian areas**	**6' - 8'**	**8' - 10'**	**10' - 11' (see notes 4 & 5)**	**4' - 6' lanes (see notes 4, 5 and 6)**	**0' - 17'6" (see note 7)**
Urban Center / Suburban Center	**6' - 10' 12' - 20' in high volume pedestrian areas**	**6' - 8'**	**8' - 10'**	**10' - 11' (see notes 4 & 5)**	**4' - 6' lanes (see notes 4, 5 and 6)**	**0' - 17'6" (see note 7)**
Suburban Corridor Urban Residential / Suburban Residential	**6' - 8' 12' - 20' in high volume pedestrian areas**	**6' - 8'**	**8' - 10'**	**10' - 11' (see notes 4 & 5)**	**4' - 6' lanes (see notes 4, 5 and 6)**	**0' - 17'6" (see note 7)**

NOTES

1. **Sidewalk zone should typically be a minimum unobstructed width of 6'. In areas that are currently or are planned to be pedestrian-oriented or mixed-use development, minimum 8' – 10' wide unobstructed sidewalks should be provided to allow for higher pedestrian priority and potential extension to the development zone.**
2. **Green zone may include landscaping, street trees, lighting, street furniture, hardscaping in some circumstances, and related pedestrian / bike/ transit amenities. 8' minimum green zone is preferred, to allow for separation between pedestrians and vehicles, and space for street trees.**
3. **Parking is an option on avenues. Parking zone dimension may vary depending upon type of parking provided. Angle parking is allowed, preferably reverse angle parking. Angle parking will require a wider dimension than shown.**
4. **5' bicycle lanes are the preferred treatment. Steep grades may call for wider bicycle lanes. If bicycle lanes are not possible, shared lanes may be allowed. For a shared lane, the outside lane should be a minimum of 14' wide. Shared lane markings can be used on streets ≤35 mph, with either shared lane or standard lane dimensions.**
5. **In the shared vehicle zone and the bicycle zone, the gutter pan is not considered part of the lane width or the bicycle lane width.**
6. **Bicycle lanes located next to on-street parking should be a minimum of 5' or 6' wide (generally, the combined dimension for parking and bicycle lane should be at least 13' from the face of curb).**
7. **Avenues may or may not include a center turn lane with intermittent landscaped islands. Avenues typically do not include a continuous median, but it may be allowed in some circumstances.**
8. **Pedestrian lighting should be considered at mid-block crossings, near transit stops, commercial areas, mixed-use areas or other locations where nighttime pedestrian activity is likely.**

RURAL AVENUE

PLAN VIEW



Not all traffic control devices shown

KEY ELEMENTS

- May function as an arterial, collector or local, route, but generally at low to moderate speeds and volumes.
- A rural street serving a range of traffic levels within and between various area types.
- Characterized by wide sidewalks (scaled to the surrounding land uses) and on-street bicycle facilities.
- May have on-street parking.
- Transit stops, shelters and other amenities are located along the roadway, preferably within the right of way.

STREET CROSS - SECTION ZONES

Sidewalk Zone: The pedestrian walk area is of sufficient width to allow pedestrians to walk safely and comfortably.

Green Zone: The landscaped or hardscaped area along the edge of a street. On avenues this zone should include grass, landscaping, trees in planting strips or, in some cases, hardscaped amenity zones. Pedestrian or decorative lighting may be provided when appropriate for adjacent land uses.

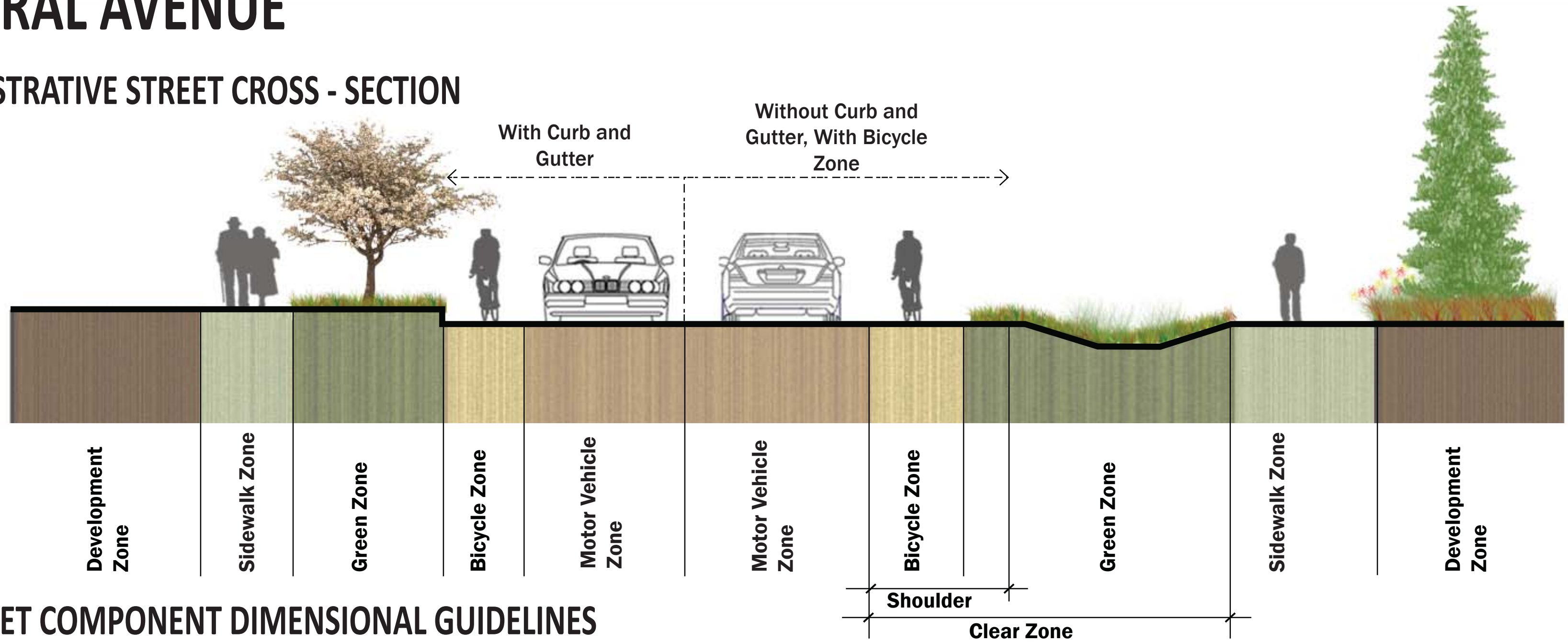
Bicycle Zone: Accommodation for bicyclists in a zone separate from the motor vehicle zone.

Motor Vehicle Zone: The primary travel way for motor vehicles. In a rural avenue without curb and gutter, the green zone would be relied on for drainage conveyance.

Development Zone: Development should be oriented towards the street with good functional and visual connection to the street.

RURAL AVENUE

ILLUSTRATIVE STREET CROSS - SECTION



STREET COMPONENT DIMENSIONAL GUIDELINES

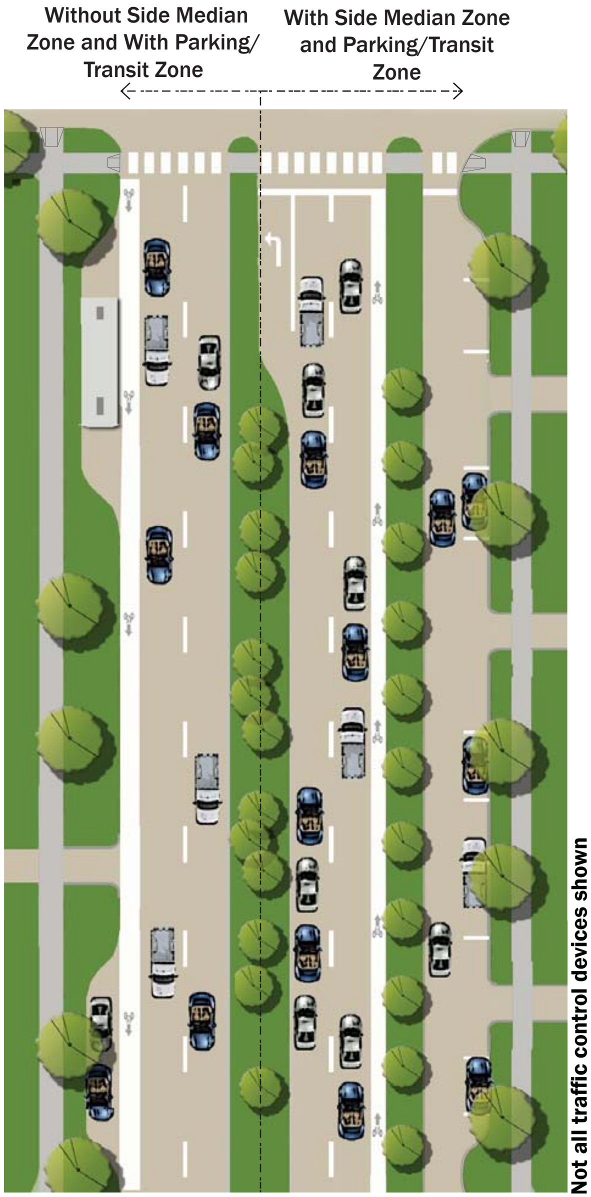
	Sidewalk Zone *(feet)*	Green Zone *(feet)*	Shoulder Zone *(feet)*	Bicycle Zone *(feet)*	Motor Vehicle Zone *(lane width-feet)*
Rural Village	6' - 8'	4' - 12' (see notes 2 and 3)	8' - 10'	4' - 6' bicycle lanes (see notes 5, 6 & 7)	10' - 12' lanes
Rural Developed	5' - 8'	4' - 12' (see notes 2 and 3)	8' - 10'	4' - 6' bicycle lanes (see notes 5, 6 & 7)	10' - 12' lanes

NOTES

1. Sidewalk zone should typically be a minimum unobstructed width of 6'. In areas that are currently or are planned to be pedestrian-oriented or mixed-use development, 8' wide unobstructed sidewalks can be provided.
2. Green zone may include landscaping, street trees, lighting, street furniture, hardscaping in some circumstances and related pedestrian/bike/transit amenities. 8' minimum green zone is preferred, to allow for separation between pedestrians and vehicles, and space for street trees.
3. For areas outside of towns and communities, wider green zones of 10' to 12' are preferred where street trees are provided.
4. Parking is an option on avenues. Parking zone dimensions vary depending upon the type of parking provided. Angle parking is allowed, preferably reverse angle parking. Angle parking will require a wider dimension than shown.
5. 5' bicycle lanes are the preferred treatment. Steep grades may call for wider bike lanes. If bicycle lanes are not possible, shared lanes may be allowed. For a shared lane, the outside lane should be a minimum of 14' wide. Shared lane markings can be used on streets $\leq$ 35 mph, with either shared lane or standard lane dimensions.
6. In the shared vehicle zone and the bicycle zone, the gutter pan is not considered part of the lane width or the bicycle lane width.
7. Bicycle lanes located next to on-street parking should be a minimum of 5' wide (generally, the combined dimension for parking and a bicycle lane should be at least 13' from the face of the curb).
8. Avenues may or may not include a center turn lane with intermittent landscaped islands. Avenues typically do not include a continuous median, but it may be allowed in some circumstances.
9. Pedestrian lighting should be considered adjacent to development.

URBAN / SUBURBAN BOULEVARD

PLAN VIEW



KEY ELEMENTS

- Most often functions as an arterial designed to carry vehicles at moderate speeds.
- Thoroughfare characterized by multiple lanes and including a street median.
- Wide sidewalks and on-street bicycle lanes are necessary to accommodate pedestrians and bicyclists due to higher speeds and higher traffic volumes for motor vehicles.
- Transit stops and shelters may be located within the right of way, requiring connections to sidewalks.
- On-street parking is not required. It is allowed where appropriate, but rare due to the nature of the street. If provided, parking should typically be placed on a separate, parallel frontage street separated with a side median.

STREET CROSS-SECTION ZONES

Sidewalk Zone: The pedestrian walk area is of sufficient width to allow pedestrians to walk safely and comfortably.

Green Zone: This zone serves to separate the sidewalk from the vehicles. This zone contains landscaping and trees or, in some circumstances, hardscape treatments.

Parking/Transit Zone: Accommodates on-street parking and transit pull-outs. Parking on the street is rare, but may be separated from the motor vehicle zone by side medians. Width and layout may vary depending on the type of parking provided.

Bicycle Zone: A zone for bicyclists separate from vehicular traffic.

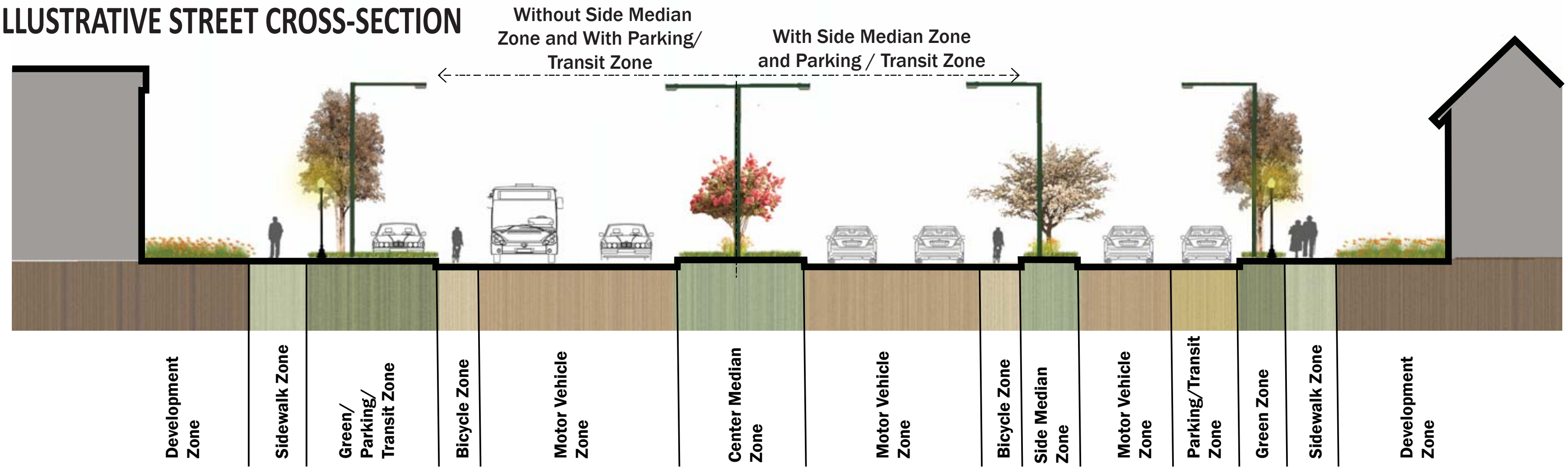
Motor Vehicle Zone: The primary travel way for motor vehicles.

Median Zone: A landscaped zone located between the travel lanes as a center median or as side medians that separate one-way parallel lanes. Median zones should consider provision for turn bays at intersections. May include hardscaping at pedestrian crossings.

Development Zone: Building setbacks vary but are typically deeper than on avenues. Building frontage may not always be directed to the street but physical connections to the street from building entrances are important.

URBAN / SUBURBAN BOULEVARD

ILLUSTRATIVE STREET CROSS-SECTION



STREET COMPONENT DIMENSIONAL GUIDELINES

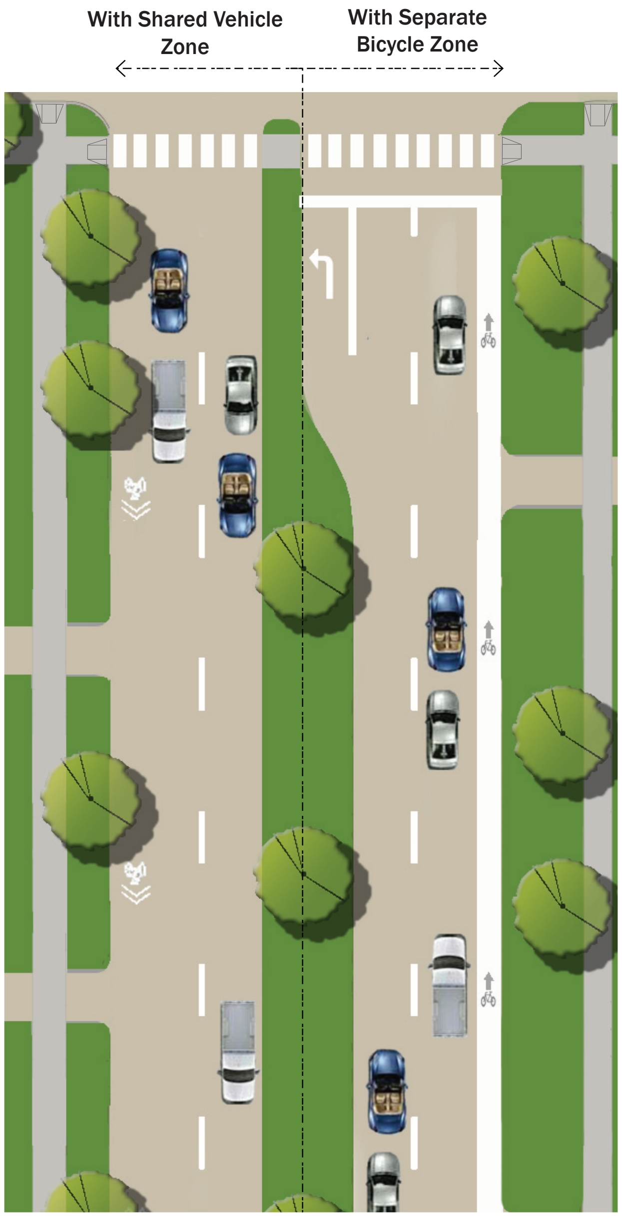
	Sidewalk Zone *(feet)*	Green Zone *(feet)*	Parking /Transit Zone *(feet)*	Bicycle Zone *(feet)*	Motor Vehicle Zone *(lane width- feet)*	Center Median Zone *(feet)*	Side Median Zone *(feet)*
Central Business District	6' - 10' 12' - 20' in high volume pedestrian areas	6' - 8'	8' - 10'	4' - 6' lanes (see notes 3 and 4)	10' - 11'	8' - 30'	8'+
Urban Center / Suburban Center	6' - 8' 12' - 20' in high volume pedestrian areas	6' - 8'	8' - 10'	4' - 6' lanes (see notes 3 and 4)	10' - 11'	8' - 30'	8'+
Suburban Corridor / Urban Residential / Suburban Residential	6' - 8' 12 '- 20' in high volume pedestrian areas	6' - 8'	8' - 10'	4' - 6' lanes (see notes 3 and 4)	10' - 11'	8' - 30'	8'+

NOTES

1. Sidewalk zone should typically be a minimum unobstructed width of 6'. In areas that are currently or are planned to be pedestrian-oriented or mixed-use development, minimum 8' wide unobstructed sidewalks should be provided.
2. Green zone may include landscaping, street trees, lighting, street furniture, and related pedestrian/bike/transit amenities. 8' minimum green zone is preferred, to allow for separation between pedestrians and vehicles, and space for street trees.
3. 5' bicycle lanes are the preferred treatment. Steep grades may call for wider bike lanes. If bicycle lanes are not possible, shared lanes may be allowed. For a shared lane, the outside lane should be a minimum of 14' wide. Shared lane markings can be used on streets ≤ 35 mph, with either shared lane or standard lane dimensions.
4. The gutter pan is not considered part of the bicycle lane width. Bicycle lanes located next to parking should be a minimum of 5' or 6' wide.
5. The gutter pan is not considered part of the motor vehicle lane width in most circumstances.
6. Median zone requirements vary depending upon appropriate treatment (hardscape, landscape, drainage, curb and gutter, or street trees). Though the median width may vary, the median will typically be 17' 6", to allow for a turn lane and pedestrian refuge at intersections. The minimal 8' width will allow for landscaping and pedestrian refuge at appropriate locations. A 30' wide median should be provided to accommodate double left turn lanes when multi-modal analysis confirms the need.
7. Continuous two-way left turn lanes are not permitted on a boulevard.
8. Parking/transit stop zone is rare, but is allowed where appropriate.

RURAL BOULEVARD

PLAN VIEW



Not all traffic control devices shown

KEY ELEMENTS

- Most often functions as an arterial designed to carry vehicles at moderate speeds.
- Thoroughfare characterized by multiple lanes and including a street median.
- Wide sidewalks and on-street bicycle lanes are necessary to accommodate pedestrians and bicyclists due to higher speeds and higher traffic volumes for motor vehicles.
- Building setbacks will typically be deeper than on avenues.
- Transit stops and shelters may be located within the right of way, requiring connections to sidewalks.
- On-street parking is not required. It is allowed where appropriate, but rare due to the nature of the street and adjacent land uses.

STREET CROSS - SECTION ZONES

Sidewalk Zone: The pedestrian walk area is of sufficient width to allow pedestrians to walk safely and comfortably.

Green Zone: This zone serves to separate the sidewalk from the vehicles. This zone contains landscaping and trees or, in some circumstances, hardscape treatments. The green zone may be wider if providing an intermittent parking / transit zone.

Bicycle Zone: Accommodation for bicyclists either in a separate zone or within the shared vehicle zone.

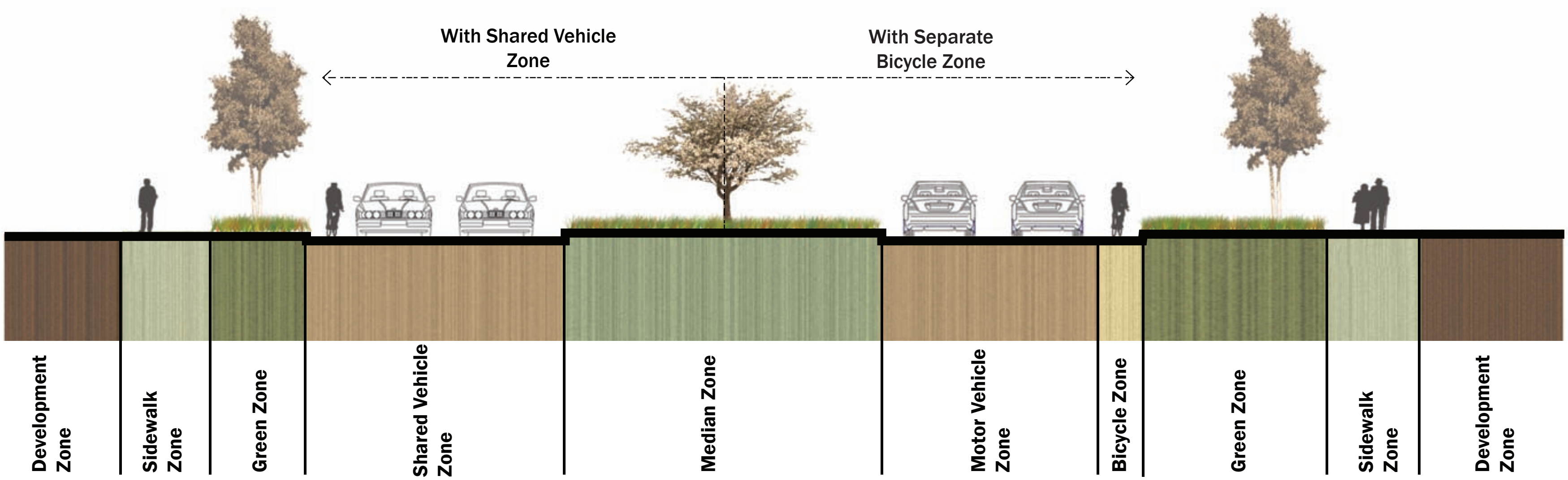
Motor Vehicle/Shared Vehicle Zone: The primary travel way for vehicles. A shared vehicle zone has mixed traffic (cars, trucks, buses and bicycles).

Median Zone: A landscaped zone located between the travel lanes as a center median. Median zones should consider provision of turn bays at intersections. The median zone may include hardscaping at pedestrian crossings.

Development Zone: Building setbacks vary, but are typically deeper than avenues. Building frontage may not always be directed to the street, but physical connections to the street from building entrances are important.

RURAL BOULEVARD

ILLUSTRATIVE STREET CROSS - SECTION



STREET COMPONENT DIMENSIONAL GUIDELINES

	Sidewalk Zone *(feet)*	Green Zone *(feet)*	Motor Vehicle/ Shared Vehicle Zone *(lane width- feet)*	Median Zone *(feet)*	Bicycle Zone *(feet)*
Rural Village / Rural Developed	6' - 8'	6' - 10' (see note 2)	10' - 12'	17' 6" - 30'	4' - 6' bicycle lanes (see notes 3 & 4)

NOTES

1. Sidewalk zone should typically be a minimum unobstructed width of 6'. In areas that are currently or are planned to be pedestrian-oriented or mixed use development, 8' wide unobstructed sidewalks can be provided.
2. Green zone may include landscaping, street trees, lighting, street furniture, and related pedestrian/bike/transit amenities. 8' minimum green zone is preferred, to allow for separation between pedestrians and vehicles, and space for street trees. Green zone may be wider if providing intermittent parking / transit stop zone. Parking/transit stop zone is rare, but allowed where appropriate.
3. 5' bicycle lanes are the preferred treatment. Steep grades may call for wider bike lanes. If bicycle lanes are not possible, shared lanes may be allowed. For a shared lane, the outside lane should be a minimum of 14' wide. Shared lane markings can be used on streets ≤ to 35 mph, with either shared lane or standard lane dimensions.
4. The gutter pan is not considered part of the bicycle lane width. Bicycle lanes located next to parking should be a minimum of 5' wide.
5. The gutter pan is not considered part of the motor vehicle lane width, in most circumstances.
6. Median zone requirements vary depending upon appropriate treatment (hardscape, landscape, drainage, curb and gutter, or street trees). Though the width may vary, the median will typically be between 17'-6" - 30', to allow for a turn lane and pedestrian refuge at intersections.
7. Continuous two-way left turn lanes are not permitted on a boulevard.

URBAN/SUBURBAN PARKWAY

PLAN VIEW

With Curb and Gutter   With Shoulder

Not all traffic control devices shown

KEY ELEMENTS

- Most often functions as an arterial designed with control of access to carry vehicles at moderate to high speeds.
- Urban or suburban thoroughfare often characterized by landscaping or natural vegetation along roadsides and medians.
- Land uses are set back from the street and are typically not oriented toward the parkway.
- Pedestrian and bicycle traffic usually provided for on separate multi-use paths ideally located adjacent to the facility.
- Convenient access to off-street transit stations, stops and park-and-ride lots.
- Trailer and semitrailer truck traffic is frequently present.

STREET CROSS - SECTION ZONES

Multi-Use Path Zone: A zone for pedestrians and bicyclists in a multi-use path separate from the motor vehicle zone. Please see *Multi-Use Path Zone typology* for more details.

Green Zone: Consists of a planting strip with trees to separate the multi-use path zone from the motor vehicle zone. On parkways, typically includes a clear zone.

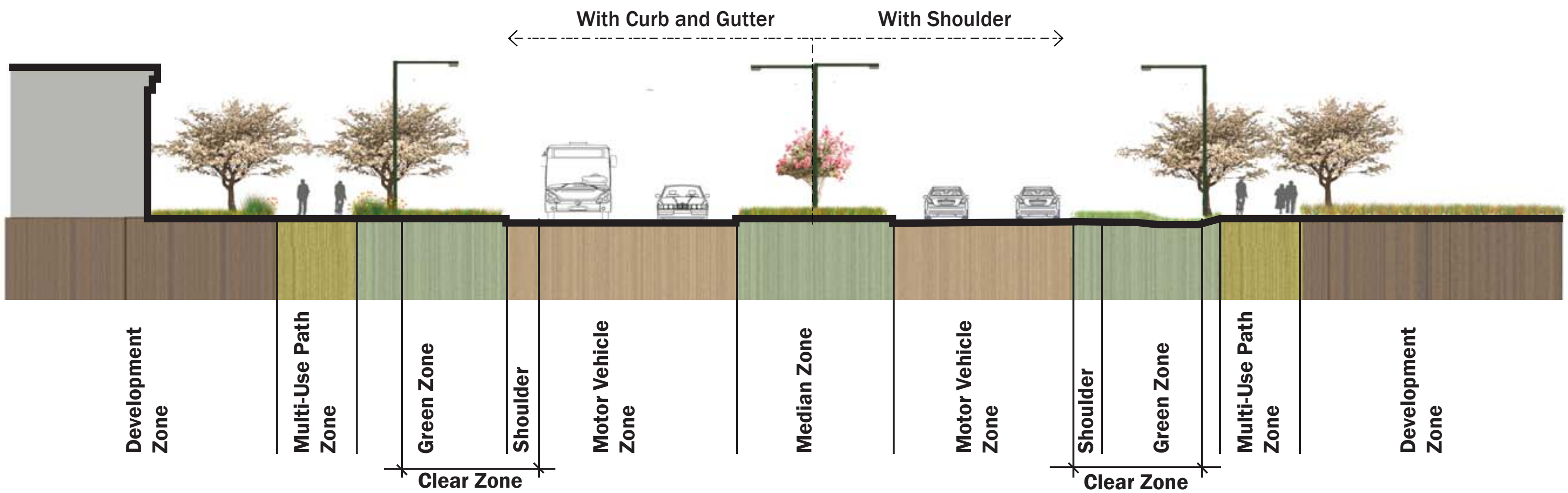
Motor Vehicle Zone: The primary travel way for motor vehicles.

Median Zone: A landscaped zone located between the travel lanes as a center median.

Development Zone: Deep setbacks due to the typically auto-oriented nature of the street. Access to this zone is limited and controlled.

URBAN/SUBURBAN PARKWAY

ILLUSTRATIVE STREET CROSS - SECTION



STREET COMPONENT DIMENSIONAL GUIDELINES

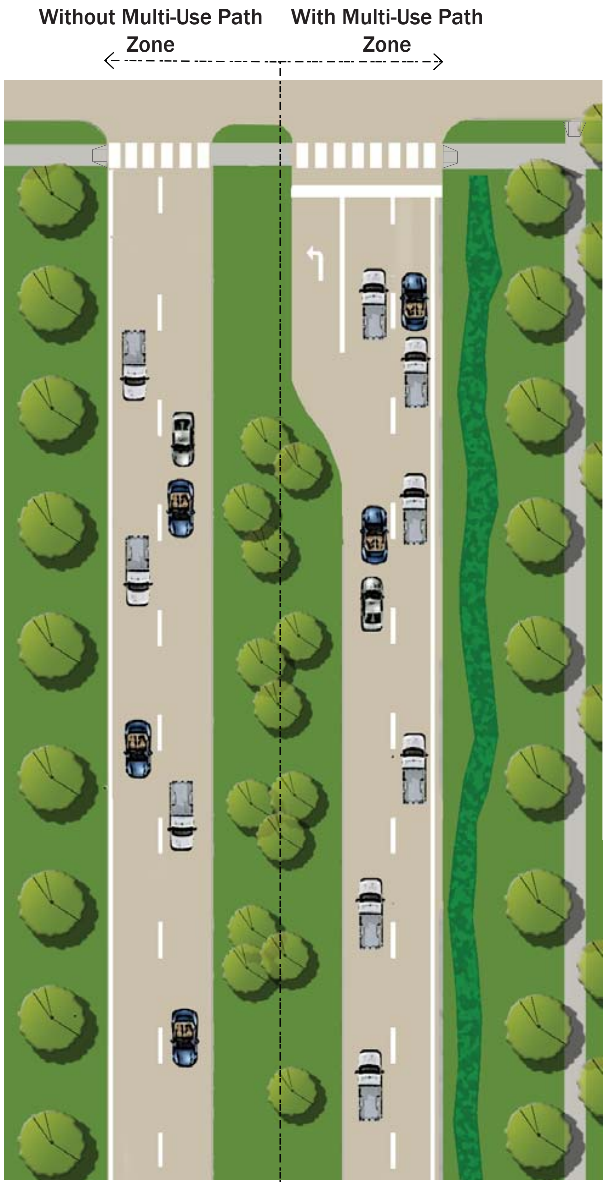
	Multi - Use Path Zone *(feet)*	Green Zone *(feet)*	Motor Vehicle Zone *(lane width- feet)*	Median Zone *(feet)*
Central Business District	**10' - 12' 12' - 20' in high volume pedestrian areas**	**See notes 1 and 2**	**11' - 12'**	**17' 6" - 32'**
Urban Center / Suburban Center	**10' - 12' 12' - 20' in high volume pedestrian areas**	**See notes 1 and 2**	**11' - 12'**	**17' 6" - 32'**
Suburban Corridor / Urban Residential / Suburban Residential	**10' - 12' 12' - 20' in high volume pedestrian areas**	**See notes 1 and 2**	**11' - 12'**	**17' 6" - 32'**

NOTES

1. **Green zone may include landscaping and, in areas beyond the clear zone, large-maturing trees.**
2. **Green zone should provide a minimum width equal to the clear zone requirement, typically 20' - 30'.**
3. **In the motor vehicle zone, the gutter pan is not considered part of the lane width.**
4. **Median zone requirements vary depending upon median treatment (landscaping, curb and gutter, or trees).**
5. **Continuous two-way left turn lanes are not permitted on a parkway.**
6. **Multi-use path is the preferred treatment for bicycles and pedestrians on a parkway. See multi-use path section.**
7. **Shoulders are allowable on an urban parkway, if deemed appropriate.**
8. **On shoulder sections the shoulder may be a combination of pavement and grass.**

RURAL PARKWAY

PLAN VIEW



Not all traffic control devices shown

KEY ELEMENTS

- Most often functions as an arterial designed with control of access to carry vehicles at moderate to high speeds.
- Rural thoroughfare often characterized by landscaping or natural vegetation along roadsides and medians.
- Land uses are set back from the street and are typically not oriented toward the parkway.
- Pedestrian and bicycle traffic usually provided on separate multi-use paths ideally located adjacent to the facility.
- Convenient access to on-street transit facilities and off-street stations and park and ride lots.
- Large truck traffic may be present.

STREET CROSS - SECTION ZONES

Green Zone: Consists of a planting strip with trees to separate the multi-use path zone from the motor vehicle zone. A portion of the green zone is the roadway shoulder. Parkways typically include a clear zone.

Motor Vehicle Zone: The primary travel way for through vehicles. A rural parkway would typically not have curb and gutter, and therefore the green zone would be relied on for drainage conveyance.

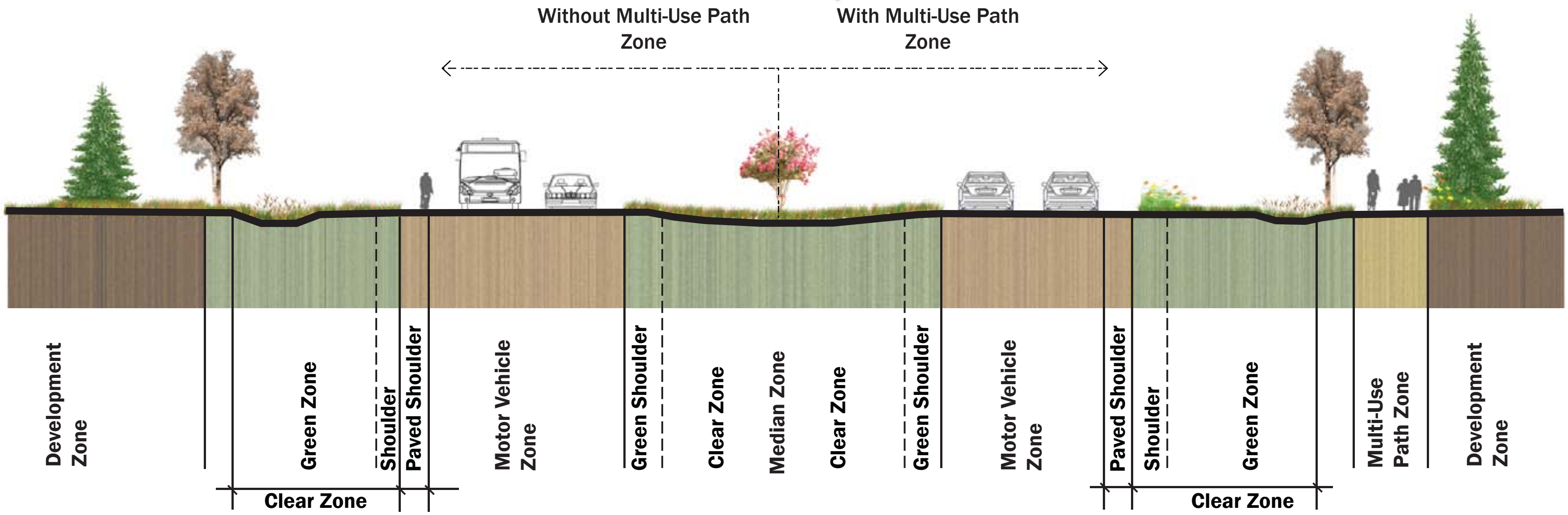
Median Zone: A landscaped zone located between the travel lanes in the center of the street. A wide median would be needed for drainage conveyance.

Multi-Use Path Zone: A zone for pedestrians and bicyclists in a multi-use path separate from the motor vehicle zone. Please see *Multi-Use Path Zone Typology* for more details.

Development Zone: Deep setbacks due to the typically auto-oriented nature of the street. Access to this zone is limited and controlled.

RURAL PARKWAY

ILLUSTRATIVE STREET CROSS - SECTION



STREET COMPONENT DIMENSIONAL GUIDELINES

	Multi-Use Path Zone *(feet)*	Green Zone *(feet)*	Shoulder *(feet)*	Motor Vehicle Zone *(lane width- feet)*	Median Zone *(feet)*
Village / Developed	10' - 12'	see notes 3 and 4	8' - 10'	11' - 12'	32' - 46'
Countryside	10' - 12'	see notes 3 and 4	8' - 10'	12'	32' - 46'

NOTES

1. Multi-use path is the preferred treatment for bicycles and pedestrians on a parkway. Multi-use path should be provided on each side behind the green zone, as appropriate. See multi-use path section.
2. Multi-use path may be in the right-of-way or in an easement.
3. Green zone may include landscaping and, in areas beyond the clear zone, large-maturing trees.
4. Median zone requirements vary depending upon median treatment (landscaping, curb and gutter, or trees).
5. Green zone should provide a minimum width equal to the clear zone requirement, typically 30'.
6. The shoulder may be a combination of pavement and grass. If a paved shoulder is provided, it may serve as a bicycle zone, though a multi-use path is preferred.

RURAL ROAD

PLAN VIEW

Not all traffic control devices shown

KEY ELEMENTS

- May function as an arterial, collector or local route, but with a range of speeds.
- A road outside of cities and towns serving a range of traffic levels in a country setting.
- Paved shoulders can be used to provide bicycles and pedestrians accommodation.
- Multi-use paths separated from the roadway may be appropriate treatment for bicycle and pedestrian accommodations.
- Accommodates bus facilities including turnouts as appropriate. Public transit stops and shelters should be clearly marked and placed within the right of way.

STREET CROSS-SECTION ZONES

Sidewalk Zone: Sidewalks on rural roads are rare. If sidewalk is provided it should be placed outside of the clear zone.

Green Zone: The landscaped area along the edge of a roadway and could include grass, landscaping or trees (as permitted). Serves as drainage conveyance.

Bicycle Zone: A zone for bicyclists separate from vehicular traffic.

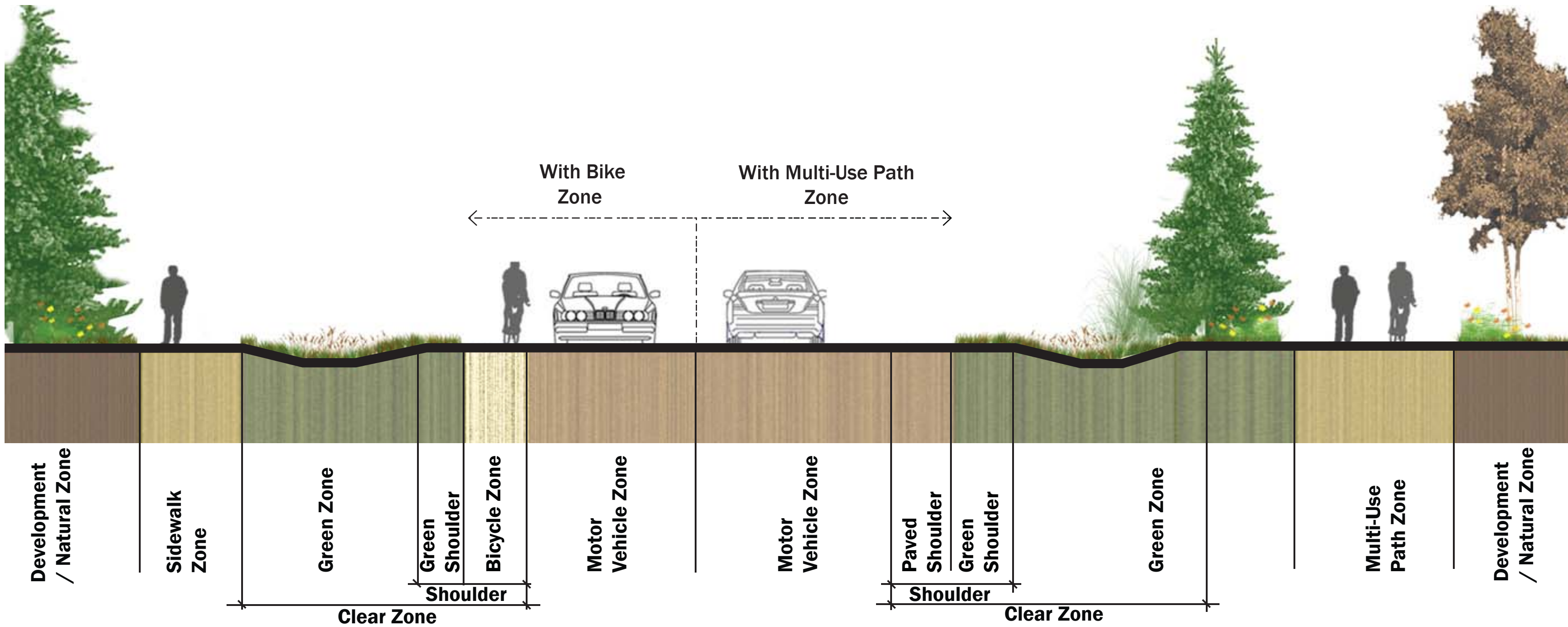
Motor Vehicle Zone: The primary travel way for vehicles.

Multi-Use Path Zone: A zone for pedestrians and bicyclists in a multi-use path separate from the motor vehicle zone. Please see *Multi-Use Path Zone Typology* for more details.

Development Zone / Natural Zone: Land uses are typically set back from the street. This zone may also consist of natural vegetation.

RURAL ROAD

ILLUSTRATIVE STREET CROSS-SECTION



STREET COMPONENT DIMENSIONAL GUIDELINES

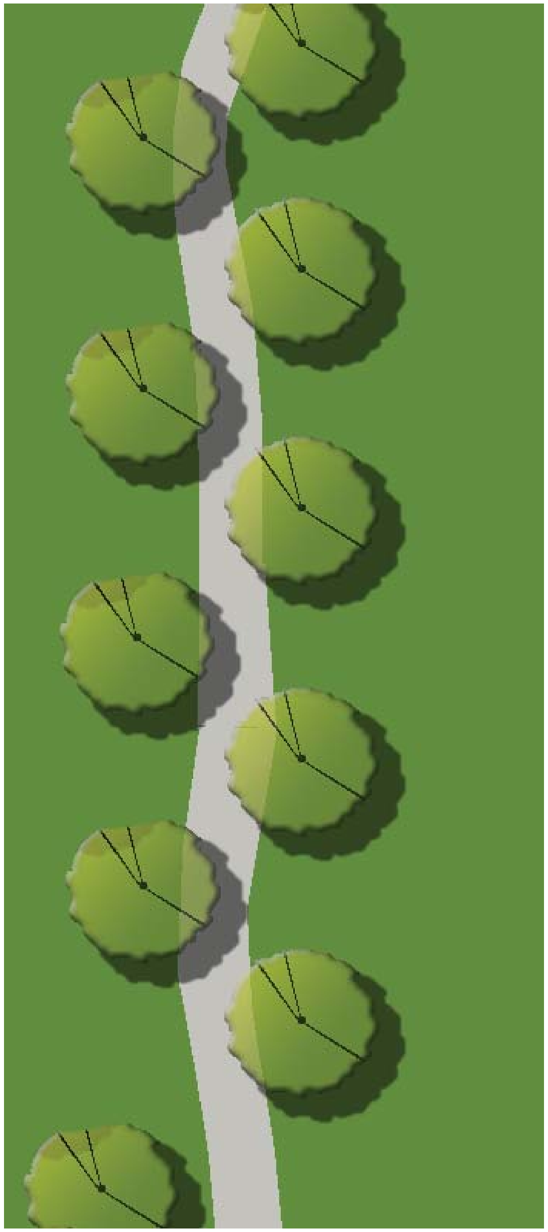
	Sidewalk Zone *(feet)*	Green Zone *(feet)*	Bicycle Zone *(feet)*	Motor Vehicle Zone *(lane width- feet)*	Shoulder Zone *(feet)*	Multi-Use Path Zone *(feet)*
Countryside	5' minimum	See note 2	4' - 6' bicycle lanes (see note 3)	10' - 12'	6' - 8'	10' - 12'

NOTES

1. Green zone is the grassed roadway shoulder and the ditch or fill slope. At intersections and intermediate locations it may include hardscaping to provide connectivity to pedestrian/bicycle/transit amenities.
2. The green zone and the shoulder for resurfacing, restoration, and rehabilitation (R-R-R) work on high-speed rural roads should be a minimum of 15' in width. The green zone and the shoulder for new construction work on high-speed rural roads should be 30' in width.
3. A 4' paved shoulder without standard bicycle markings is commonly used in the place of bicycle lanes. A steep grade may require a slightly wider paved shoulder. On rural roads with lower access densities, higher speeds, and higher volumes, a separate 10-12' multi-use path could be considered to provide pedestrians and bicycles accommodation.
4. In typical rural settings the roadway shoulder provides the pedestrian walking area.
5. If sidewalk is deemed appropriate, it should be located behind the ditch and outside of the clear zone.

MULTI-USE PATH

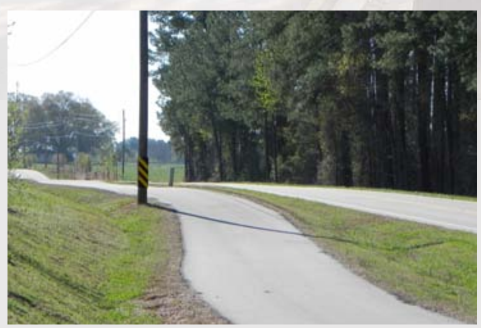
PLAN VIEW



Not all traffic control devices shown

KEY ELEMENTS

- Multi-use path can be provided as part of a parkway, rural road or greenway.
- Link multi-use paths (especially greenway trails) to make connections between homes, parks, schools, and shopping districts.
- Shade trees are recommended.
- Provide a green zone of 3’- 6’ on either side of the path.
- Pedestrian lighting should be considered in more urban environments.



PATH CROSS-SECTION ZONES

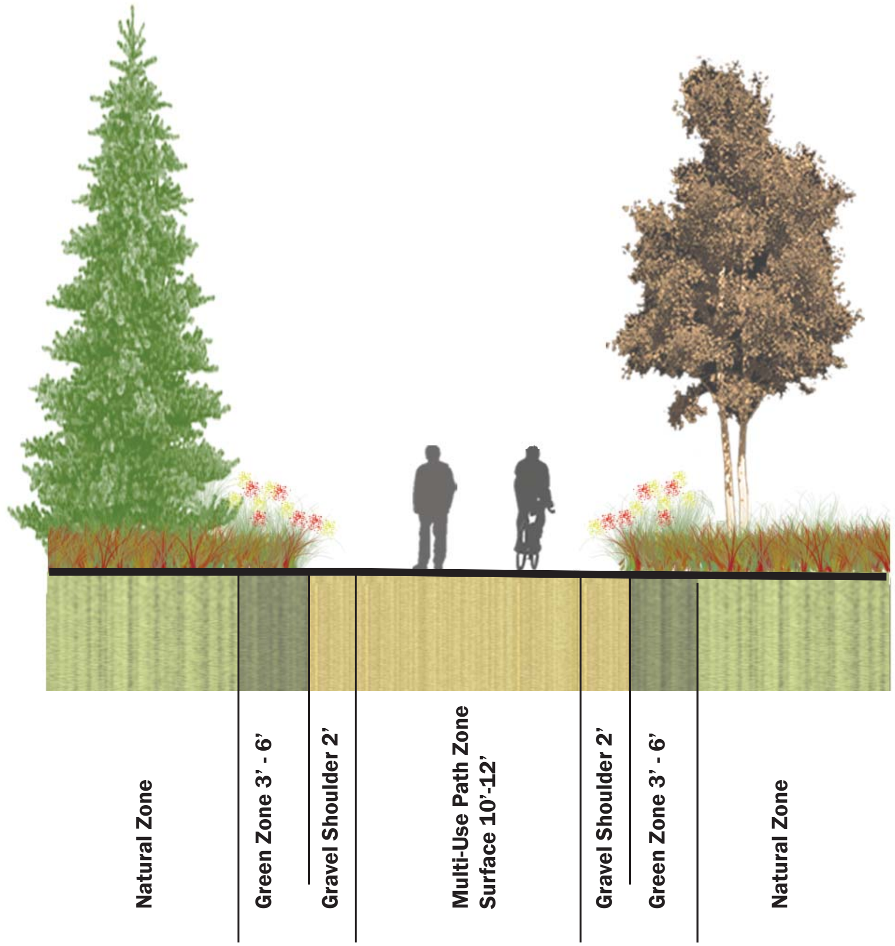
Natural Zone: Buffer and offset for trees and other vegetation.

Green Zone: This zone is a planting strip used to create lateral offset from edge of the multi-use path to trees and other objects.

Multi-Use Path Zone: A zone for pedestrians and bicyclists in a multi-use path separate from the motor vehicle zone. Please see *Multi-Use Path Typology* for more details.

MULTI-USE PATH

ILLUSTRATIVE PATH CROSS-SECTION



LOCAL / SUBDIVISION STREET: RESIDENTIAL

PLAN VIEW

KEY ELEMENTS

- Carries traffic at a low speed.
- Street within a neighborhood or residential development providing direct access to land use.
- Provides additional linkages and connections within and to the overall street network.
- On-street parking typically occurs at different levels depending on land use characteristics. Parking demand will affect street width.
- Pedestrian activity is expected, encouraged, and to be accommodated.
- Local streets provide important connections in the bicycle network.
- Bike lanes are typically not necessary due to low speed and volumes, but are allowed. In some cases, local streets can serve as parallel bicycle or transit route to heavier traveled streets.

STREET CROSS-SECTION ZONES

Development Zone: Density and setbacks will vary, but all should be oriented to the street to support pedestrian access and activity along the street.

Sidewalk Zone: The pedestrian walk area is of sufficient width to allow pedestrians to walk safely and comfortably.

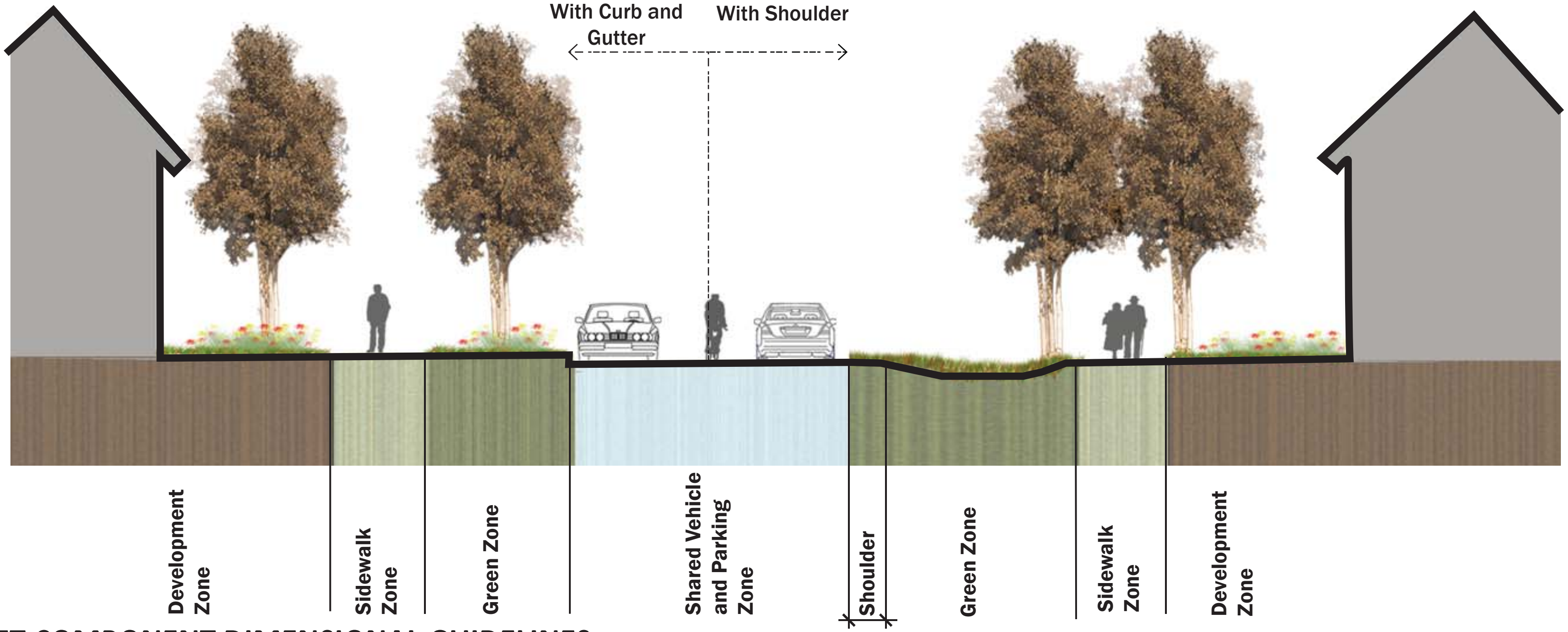
Green Zone: Consists of a planting strip (or, in very urban areas, a hardscaped area), with street trees between the sidewalk zone and the edge of street.

Shared Vehicle and Parking Zone: The primary travel way that includes mixed traffic (cars, trucks, buses and bicycles) and on-street parking. Local streets will be two lanes with varying provisions for parking.

* The discussion of local streets begins on page 59.

LOCAL / SUBDIVISION STREET: RESIDENTIAL

ILLUSTRATIVE STREET CROSS-SECTION



STREET COMPONENT DIMENSIONAL GUIDELINES

	Minimum Travelway F.O.C. to F.O.C. *(feet)*	Sidewalk Zone *(feet)*	Green Zone *(feet)*	Parking Zone *(feet)*	Lane Width *(feet)*	Shoulder *(feet)*
Local / Subdivision (Traditional Neighborhood Guidelines - Lane)	18'	5' - 6'	4' - 8'	very low demand	9' with no parking	4' - 6'
Local / Subdivision (Low Parking Demand)	24'	5' - 6'	4' - 8'	low demand	10' with low demand parking	4' - 6'
Local / Subdivision (Parking On 1 Side)	26'	5' - 6'	4' - 8'	7' on one side	9' with parking/ 13' with no parking	4' - 6'
Local / Subdivision (Parking On 2 Sides)	34'	5' - 8'	4' - 8'	7' on both sides	10' with one parked vehicle / 9' with two parked vehicles	4' - 6'

NOTES

1. Minimum travelway measured from Face of Curb (FOC) to FOC.
2. Median typically not provided on local streets unless for aesthetic reasons. If provided, lane widths will be increased by 2' - 5'.
3. Shoulder zone on local street typically has grass.

LOCAL / SUBDIVISION: OFFICE, COMMERCIAL AND INDUSTRIAL

PLAN VIEW

Not all traffic control devices shown

KEY ELEMENTS

- Carries traffic at a low speed.
- Street providing local access to adjacent office, commercial, or industrial development.
- Provides additional linkages and connections within and to the overall street network.
- On street parking typically occurs although at different levels depending on land use characteristics. Parking demand will affect street width. In industrial areas, this can include parking for larger vehicles.
- Pedestrian activity is expected, encouraged, and to be accommodated on these streets.
- Bike lanes typically not required due to low parking volumes.

STREET CROSS-SECTION ZONES

Development Zone: Development types and setbacks will vary, but all should be oriented to the street to support pedestrian access and activity. The most pedestrian oriented development types will have small setbacks, entrances directly onto the sidewalk zone, and will front streets that include on-street parking.

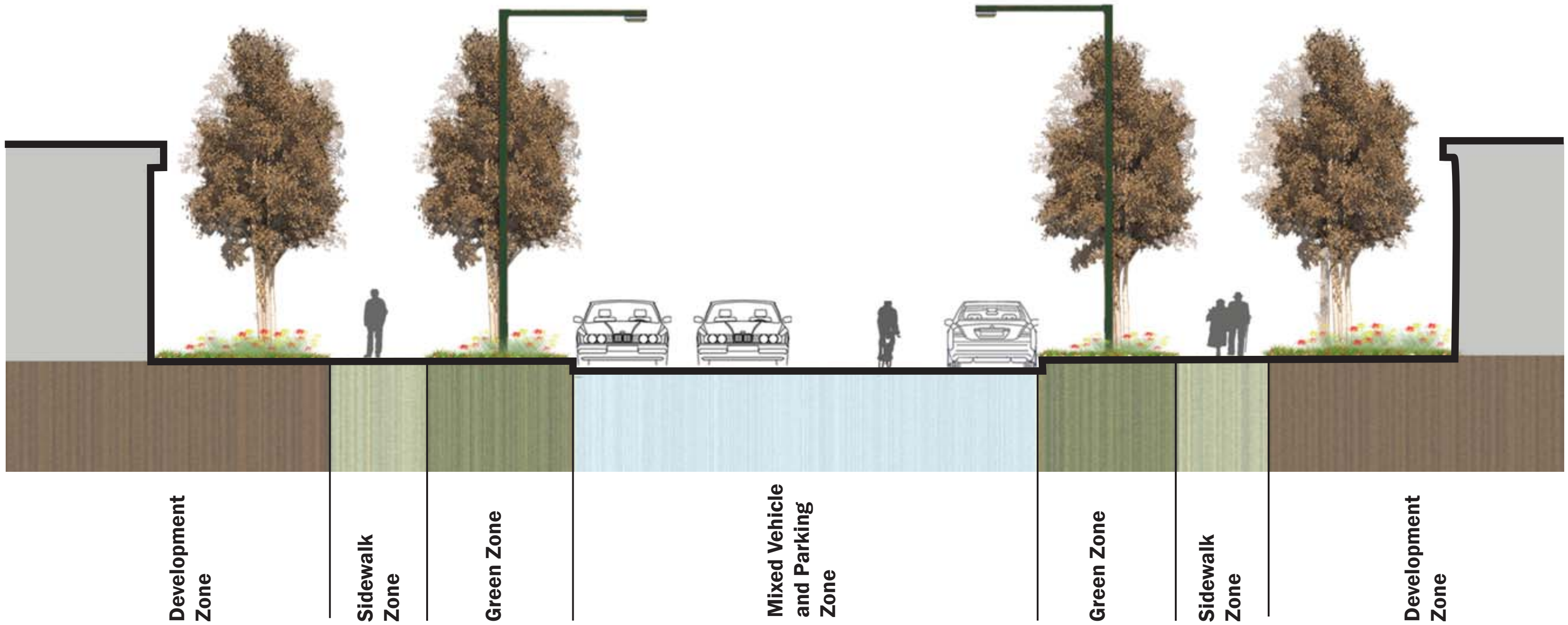
Sidewalk Zone: The pedestrian walk area is of sufficient width to allow pedestrians to walk safely and comfortably.

Green Zone: Consists of a planting strip (or, in very urban areas, a hardscaped area), with street trees between the sidewalk zone and the edge of street.

Shared Vehicle and Parking Zone: The primary travel way that includes mixed traffic (cars, trucks, buses and bicycles) and on-street parking. Local streets will be two lanes with varying provisions for parking.

LOCAL / SUBDIVISION: OFFICE, COMMERCIAL AND INDUSTRIAL

ILLUSTRATIVE STREET CROSS-SECTION



STREET COMPONENT DIMENSIONAL GUIDELINES

	Minimum Travelway (FOC to FOC) *(feet)*	Sidewalk Zone *(feet)*	Green Zone *(feet)*	Parking Zone *(feet)*	Lane Width *(feet)*
Local Office / Commercial (Parking on 1 Side)	**26'**	**5' - 6'**	**4' - 8'**	**7' on one side**	**9' with parking/ 12' with no parking**
Local Office / Commercial (Parking on 2 Sides)	**40'**	**6' - 8'**	**4' - 8'**	**7' on both sides**	**12' with parking on both sides**
Local Industrial Streets (Parking on One Side)	**34'**	**5' - 6'**	**4' - 8'**	**8' on one side**	**12' marked**

NOTES

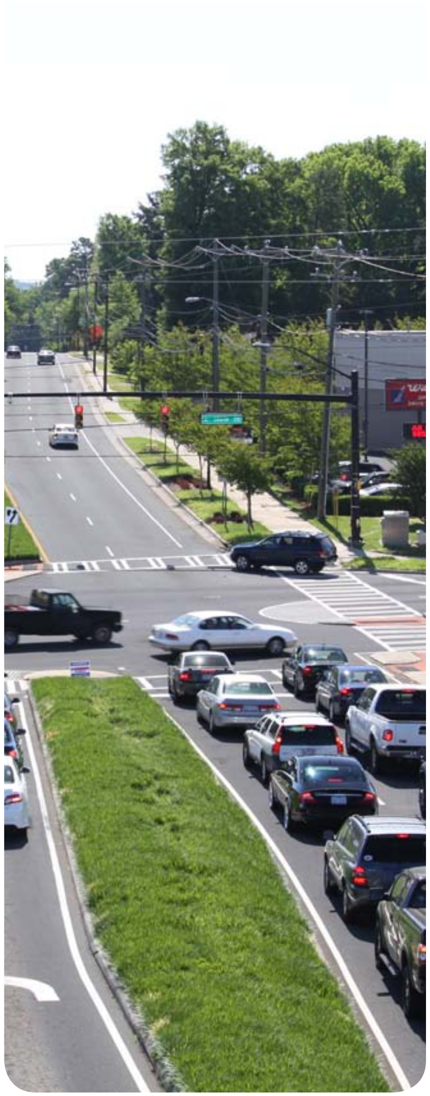
1. Minimum travelway measured from Face of Curb (FOC) to FOC.
2. The gutter pan can be used for parking, but not for vehicular or bicycle traffic.
3. Median typically not provided on local streets unless for aesthetic reasons. If provided, lane widths will be increased by 2' to 5'.

5: Planning and Designing Complete Intersections

Complete intersections make it possible to achieve the goals of complete streets. A primary goal of planning, designing, and creating complete streets is to make it possible for motorists, pedestrians, bicyclists, and transit riders to all travel safely from their origins to their destinations. Another primary goal of complete streets is to incorporate safety, mobility, accessibility, quality of life, and sustainability perspectives into the planning, design, and operations of streets.

If motorists, pedestrians, bicyclists, and transit riders wanted or needed only to travel along streets, this chapter would not be necessary or important. However, people do want and need to travel not just along streets, but across them. Since each intersection is where two or more streets meet, each intersection represents a point of both opportunity and of conflict for street users. Congestion, and attempts to alleviate congestion by providing more lanes, typically occurs at intersections. Intersections are also the places where bicyclists and pedestrians are expected to cross streets. This is why intersections are particularly important for all users.

Intersection design is also typically more difficult because working through the design and quality-of-service tradeoffs among modes can be more difficult than along segments. "Complete" intersections need to operate safely and comfortably for pedestrians, bicyclists, motorists, transit and, depending on the context, trucks. That is why NCDOT and communities throughout North Carolina will be changing stakeholders' expectations about the physical and operational design of intersections.



Differing User Expectations

The sometimes competing interests of the different street users can be significant at intersections. At intersections all users will be competing for "time" to traverse the intersection. Motorists, bicyclists, transit users, and pedestrians all prefer to minimize their travel time across or through an intersection. Users may also be competing for "space" and different users may find that specific factors and design elements can make their crossing more or less comfortable. Specific expectations consist of the following:

- Motorists and bicyclists will be interested in maintaining a smooth flow through intersections without experiencing noticeable delays or even stopping.
- Pedestrians will also not want to have to wait long for an opportunity to safely cross the street.
- Pedestrians will be looking for short crossing distances and no or very few conflicts with turning vehicles to make the crossing quicker and more comfortable.
- Visually and physically impaired pedestrians will want to safely navigate the intersection.
- Bicyclists will also want short crossings, high visibility to motorists, and no or few conflicts with motor vehicles and pedestrians.

A key aspect of creating complete intersections is designing to promote safe and comfortable crossings for each travel mode, often by introducing "order" to the various crossings. Intersection users in urban and suburban settings will experience delays and conflicts between motor vehicles, pedestrians and bicyclists, and driver expectations need to shift toward taking turns with the other modes in these contexts. Given this, the speed and ease with which bicyclists and pedestrians move through an intersection is affected by signal timing, number of lanes, lane widths, presence or absence of pedestrian refuge islands, traffic calming features, landscaping, traffic volumes, and other factors. Appropriate pedestrian and bicycle signage, flashing beacons, crosswalks, and pavement markings should be used to indicate to motorists that they should see and expect to yield to pedestrians and bicyclists.

Principles for Creating Complete Intersections

When designing intersections, planners and designers should begin with an understanding of the objectives and priorities related to the land use context, network context, and any design trade-offs related to prevalent vehicle type, conflicts, pedestrian and bicyclist comfort, accessibility, and efficiency of public transit services. The safety of pedestrians and bicyclists is a key priority when designing and maintaining intersections. Designing "complete" intersections with appropriate treatments for all users is performed on a case-by-case basis, due to the many possible intersection configurations. A later section of this chapter describes principles and expectations for specific intersection types, but there are general principles that apply to all types of intersections. These general principles for designing intersections consist of the following:

- To encourage and support bicycle and pedestrian travel, intersections should be designed to minimize crossing distance, crossing time, and conflicts between motor vehicles and other users.
- The basic design parameters are set by the size (number of lanes) of the intersection and, therefore, intersections should be designed to be as small as practical, particularly in urban areas and towns.
- The design speed for the intersection should be appropriate for the area type and the context. Lower speeds allow the motorist more time to perceive and react to conflicts at intersections. If crashes do occur, they will generally be less severe if speeds are lower.
- Intersections should be designed so motorists learn to expect bicyclists and pedestrians.
- Because an intersection is part of the overall network and context, the design should extend beyond the actual intersection to the street approaches, with appropriate designs and facilities carried to and through the intersection.
- Intersection approaches should allow motorists, pedestrians, and bicyclists to observe and react to each other. Always ensure maximum visibility of pedestrians and bicyclists by providing adequate sight distance at crosswalks, weaving, and merging areas, and installing appropriate pedestrian and bicyclist pavement markings, signage and signals.
- Channelizing islands to separate conflicts can be important design features within intersection functional areas. Appropriately-designed islands can break up pedestrian crossing maneuvers, provide a pedestrian refuge area, minimize conflict points, and shorten the crossing distance.

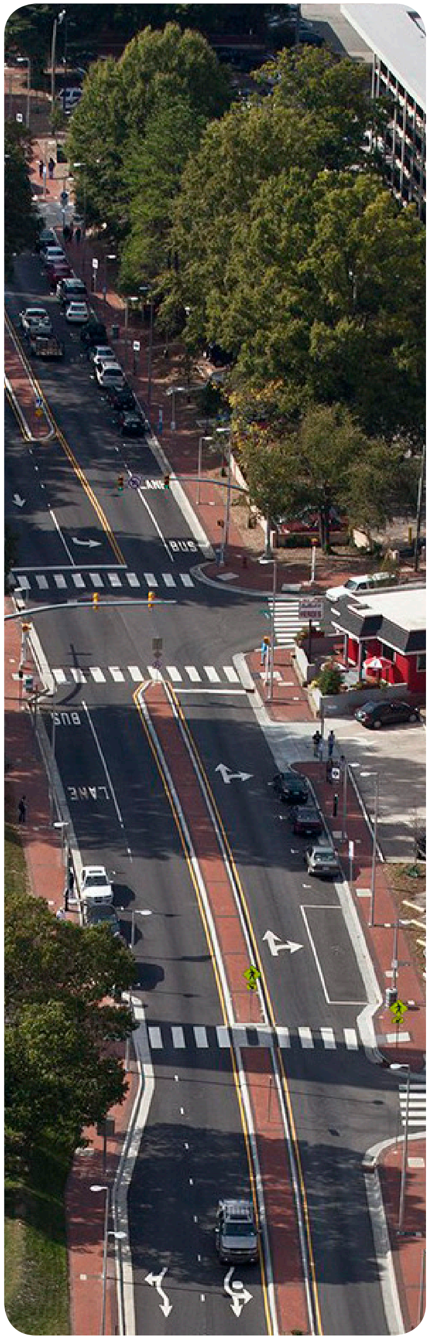
Level of Service and Quality of Service for Complete Intersections

Intersections should be designed to provide safe and adequate Level of Service (LOS) for motor vehicles and Quality of Service (QOS) for pedestrians and bicyclists. Factors affecting QOS for pedestrians and bicyclists consist of:

- crossing distance
- conflicts with turning vehicles
- motor vehicle volumes
- motor vehicle speeds

Motorist LOS at Intersections

Designing for higher QOS for pedestrians and bicyclists is described in the following sections, but the need to provide additional design elements often results first from how the intersection is designed from a motor vehicle LOS/capacity perspective (i.e., how many lanes does the intersection have?). Complete streets are expected to serve all users, including the motorist, and a significant aspect of designing good complete street networks is to identify the appropriate number of lanes needed for motor vehicle capacity, while keeping in mind the desire to keep intersections as small as possible for other users' QOS.



The amount of vehicular traffic that can approach and pass through an intersection depends on various physical and operational characteristics of the streets, characteristics of the traffic stream, and traffic control measures. The geometrics and dimensions of the street involved, the amount of pavement available, and the signal green time for moving traffic, and the manner in which the traffic is handled are all fundamental factors influencing the traffic-carrying capacity of intersections along those streets. Therefore, approach width in feet, parking conditions, type of operation (one-way or two-way), and signal phasing and timing are used in procedures to establish basic conditions in which intersection capacity can be evaluated.

Various procedures are used to analyze signalized intersection capacity and LOS. The Highway Capacity Manual (HCM) provides the basis for NCDOT's analysis. Both the morning peak (a.m.) and afternoon peak (p.m.) should be considered in this analysis. Intersections are evaluated based on vehicle delay, volume-to-capacity ratio (v/c), and queue lengths. NCDOT requires the use of a peak hour factor in this evaluation, because the HCM bases its analysis procedures on a 15 minute analysis period. When analyzing urban street intersections, the duration of traffic Level of Service (LOS) analysis may need to expand when congestion is projected to exceed one hour. This expanded analysis is intended to provide additional information about the nature of congestion at the intersection, to aid NCDOT and the local community in making capacity decisions for that intersection. Congestion will be considered in relation to the surrounding network, land use and urban design context, street type, constraints, and other variables to decide the appropriate amount of capacity.

In urban areas, if an intersection's v/c for both morning (a,m,) and afternoon (p.m.) peak hour (existing and future) conditions is less than 0.90 for each lane group, no further traffic analysis is usually necessary. Otherwise, additional analysis evaluating delays, queue lengths and v/c is expected. These analyses will help identify the critical lane groups, and determine whether operational or, particularly, physical capacity increases are necessary for those critical lane groups. **Note that the 0.90 v/c is specifically not intended as a "target" for each lane group – but rather a "trigger" for further analysis and collaborative decision making.**

Intersection size, and specifically the width of each street approach, affects functionality for all users. This is why the width, allocation to motor vehicles or bicyclists, and placement of channelization items within the pavement needs to be "managed" for 24-hour use. The results of the analysis described above (used to determine the need for physical capacity increases) should be considered in light of land use, network, and street context. This will allow the best utilization of the space available (or provided) and best match between the intersection, the context, and all users.

When deciding how many lanes for motor vehicles will be provided, the designers should consider network context, street type, and land uses or area type. This design philosophy will result in the following types of recommendations:

- For intersections near or at a freeway ramp, the overriding objective is simply to not degrade the freeway's flow. The most important consideration for the design input team will be to recommend the sufficient number of traffic lanes for each intersection affecting the flow of traffic from a freeway off-ramp to prevent traffic from queuing at the off-ramp into the freeway travel lanes. In these cases, there would be the least amount of flexibility in determining the number of lanes and capacity required, regardless of the surface street type – throughput for the freeway takes precedence. Each intersection would still be designed to provide high QOS for pedestrians and bicyclists, particularly in intensive urban areas, and particularly on avenues and boulevards (main streets would not typically be located adjacent to freeway ramps).
- For intersections on a Strategic Highway Corridor, the decision of "how much capacity is provided at an intersection?" will also consider the existing and future street network, area type, and context, while maintaining the objective of providing for adequate mobility/throughput function for motorists. Generally speaking, the more robust the surrounding network, the less emphasis placed on throughput for the corridor/intersection. In addition, the area/street type combinations shown in Table 1 will be considered and are described from the context with the highest emphasis on throughput to the context with the lowest emphasis on throughput.

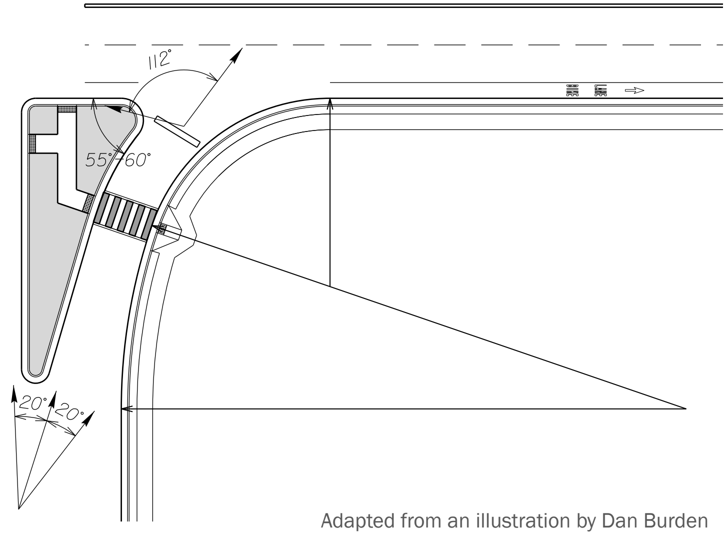
  Discussion/analysis, based on this chapter, between NCDOT and local agencies will be required when designing intersections. Throughput for motor vehicles is still an important objective, but is balanced to reflect the network and context, based on collaboration between NCDOT and the locality. As the capacity decisions that affect number of lanes are made, the design input team should also be working to ensure high QOS for bicyclists and pedestrians.
- Intersections not on a Strategic Highway Corridor or affecting a freeway ramp will also be designed based on their network, context and street type, as described above. The number and type of (through and turning) lanes will still result from collaborative decisions between NCDOT and local agencies and will predominantly reflect the local agencies' vision for the context and designation of street type. Based on local vision and expectations regarding throughput, planners and engineers will generally be striving to design main streets and avenues by carefully limiting the number of motor vehicle lanes, while providing more traditional emphasis on throughput for boulevards and, particularly, parkways.

Table 1: Throughout Expectations for Different Contexts

Emphasis on Throughput	**Area Type or Context**	**Street Type**
Highest Emphasis on Motor Vehicles	Rural or outlying areas	Parkways and Rural Roads
	Outside urban loops	Parkways and Boulevards
	Suburban Corridors	Parkways
	Suburban Corridors	Boulevards
	Urban and Suburban Residential	Boulevards
	Corridors/Urban/ Suburban Residential	Avenues
Lowest Emphasis on Motor Vehicles	Centers/CBDs	Boulevards
	Centers/CBDs	Avenues
	Centers/CBDs	Main Streets (not typically on strategic highway corridors)

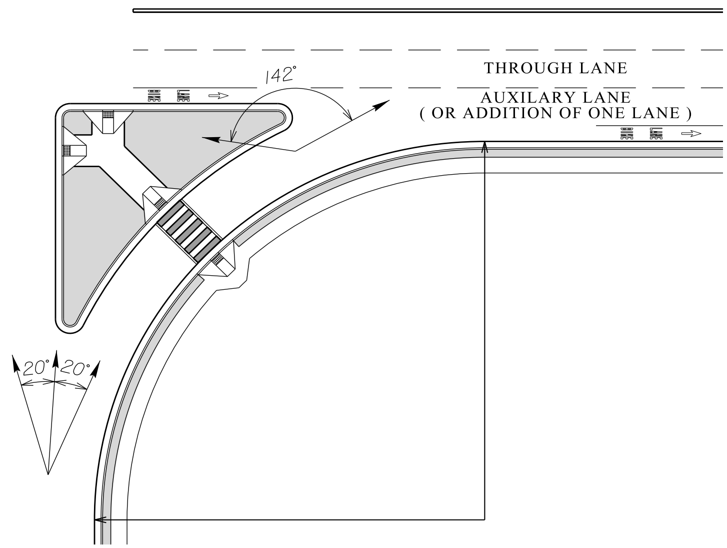
By applying the appropriate and necessary technical analyses and considering the facility type and context in decision making, design teams can provide for complete intersections that function appropriately for all users.

Figure 7: Tight Angle Channelization for Right Turns to Support Pedestrian Travel



Adapted from an illustration by Dan Burden

Figure 8: Wide Angle Channelization for Right Turns for Use on Parkways Only



Adapted from an illustration by Dan Burden

Pedestrian Quality of Service (QOS) at Intersections

When planning for and designing complete intersections, specific design elements will affect how well the intersection functions for pedestrians. As previously described, pedestrians will benefit from, among other things, shorter crossing distances and fewer conflicts with vehicles. For pedestrians, improving quality of service (providing safe and comfortable crossings) at signalized intersections can be achieved by applying the following designs:

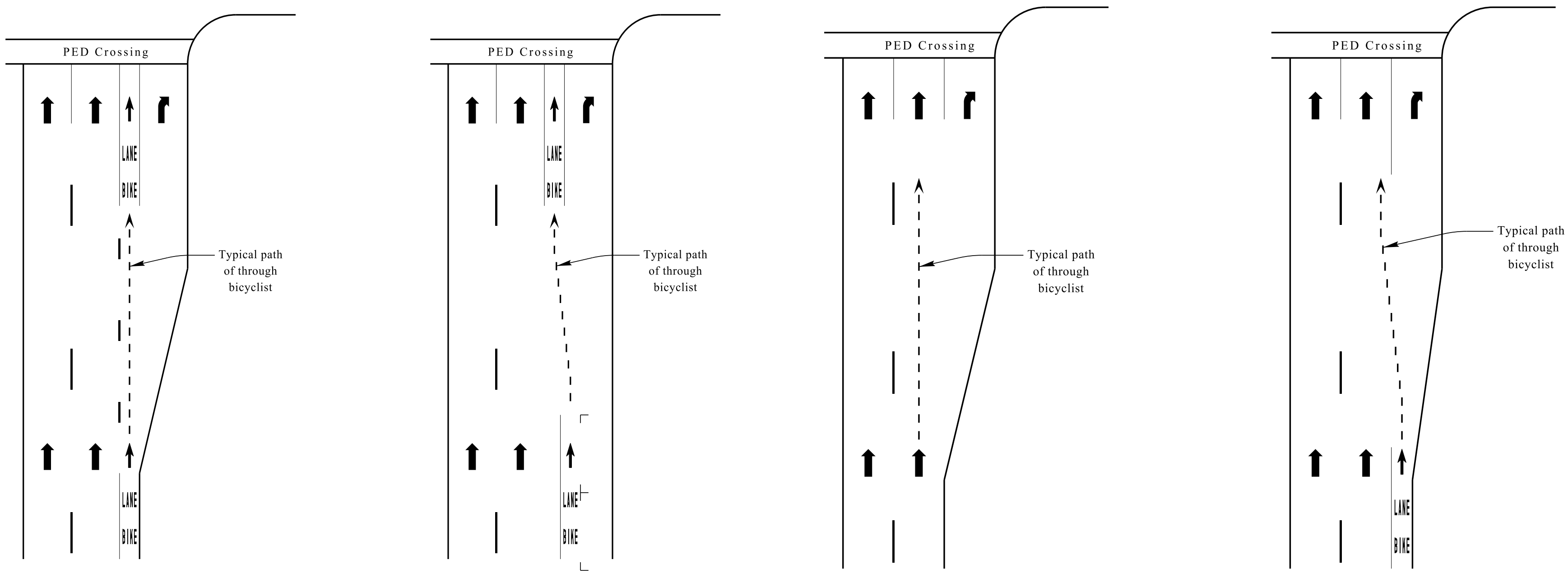
- If the street is four lanes or fewer traffic lanes wide, then a pedestrian refuge for the crossing is not required, but may be beneficial in some contexts.
- If the street is five or more traffic lanes wide, and the crossing distance is greater than 50 feet, construct a pedestrian refuge island in the median and/or in the right turn lane channelization. This is a total lane count, including through lanes, turning lanes and auxiliary lanes.
- If right turn lanes are provided, then include pedestrian refuge islands to separate right turn lanes from the through lanes (assuming the crossing is more than four lanes and is over 50 feet).
- When constructing channelized right turn lanes, design the curb radii and the channelization to reduce the turning angle (slowing the turning vehicles and increasing the visibility of pedestrians to turning motorists) and include a pedestrian refuge island (shown in Figure 7). Parkways may require the use of wide angle channelization for right turns (shown in Figure 8).
- If the street is seven or more lanes wide, construct multiple refuge islands. The location for multiple refuge islands will depend on the turn lane configuration, volumes, intersection geometry, etc. The intent is to ensure that pedestrians cross no more than five lanes and/or 50 feet without providing a refuge island to break up the crossing distance.
- Include high visibility crosswalks at signalized intersections.
- Manage cycle lengths and include adequate timing for pedestrian crossings.
- Include countdown pedestrian signals at signalized intersections.
- Include the smallest applicable curb radii (determined by prevalent design vehicle). See the section “Turning Paths for Design Vehicles” for more details on applicable curb radii.
- Provide curb extensions when appropriate to shorten the pedestrian crossing distance, and for on-street parking, traffic calming, bus stops, etc.

Bicyclist Quality of Service (QOS) at Intersections

Because they are an integral part of the street network, complete intersections must also provide for the safety and comfort of bicyclists, as they share space with motorists and pedestrians. For bicyclists, improving multi-modal quality of service at signalized intersections can be achieved by applying the following designs:

- Appropriately designed bicycle facilities (planned or existing) along the approaching street segments (as described below) should be extended across the intersection.
    - For avenues and boulevards, the preferred bicycle facilities are typically (in order of preference):
        - Bicycle lanes;
        - Edge lines;
        - Off-street multi-use (shared use) path (in rare circumstances where access is extremely limited along the street, e.g. where there are large parks with few or no driveways along the street); and
        - Wide outside lanes.
    - For main streets, the preferred bicycle treatment is a shared lane (typically with shared lane markings).
    - For parkways, the preferred bicycle treatment is an off-street multi-use (shared use) path.
- If the intersection project is relocating and/or moving the line of curb and gutter, then provide bicycle facilities in accordance with the street type, area context, objectives, plans, policies and priorities (as listed above, and described in Chapters 3 and 4).
- If the intersection project is not relocating/moving the line of curb and gutter, then provide sufficient setback or space in the green zone (planting strip or hardscaped area) for future bicycle lanes or other facility accommodations. The specific facility will be defined in accordance with street type, area context, objectives, plans and policies; therefore, providing for future continuity of the bicycle facility along the corridor.
- Provide bicycle sensitive detection at signalized intersections for the intersection approaches/movements that have lower motor vehicle volumes. NCDOT will work with local agencies to assess or identify priority locations for detection, for example: where signed bike routes cross an intersection, where nearby land uses serve as major destinations, or where there are no or few other, nearby network connections for bicyclists.
- Provide bicycle stop bars (which are located ahead of the motor vehicle stop bar) to allow motorists to see bicyclists at the intersection. NCDOT will collaborate with local agencies to identify appropriate locations for bicycle stop bars, for example: where there are bike lanes provided approaching the intersection, where there are right-turning motor vehicles.

Figure 9: Bicycle Treatments for Exclusive Right Turn Lanes



(A) Straight alignment - Cyclists travel straight and turning motorists yield to cyclists (BEST CONDITION)

(B) Alignment shift - Cyclists merge left and turning motorists merge right

(C) No bike lane - Cyclists share lane with motorists

(D) Bike lane ends - Cyclists shift into motor vehicle lane

- Consider providing bike boxes where there are bike lanes approaching the intersection, and for example there is likely to be frequent bicycle traffic, or the dominant motor vehicle traffic turns right and the bicycle traffic continues straight or turns left.
- Additional treatments not specified above and included in AASHTO, NACTO, or other guidance will be considered where appropriate (as determined through collaborative discussions between NCDOT and the locality).

Additional considerations for bicyclist QOS include designing for safer turning movements. For example, a left turn phase removes potential left turn conflicts from the path of a bicyclist. Left turns made on a green arrow only (protected phase only) provide a higher QOS than a green ball/ green arrow phase (protected-permitted phase).

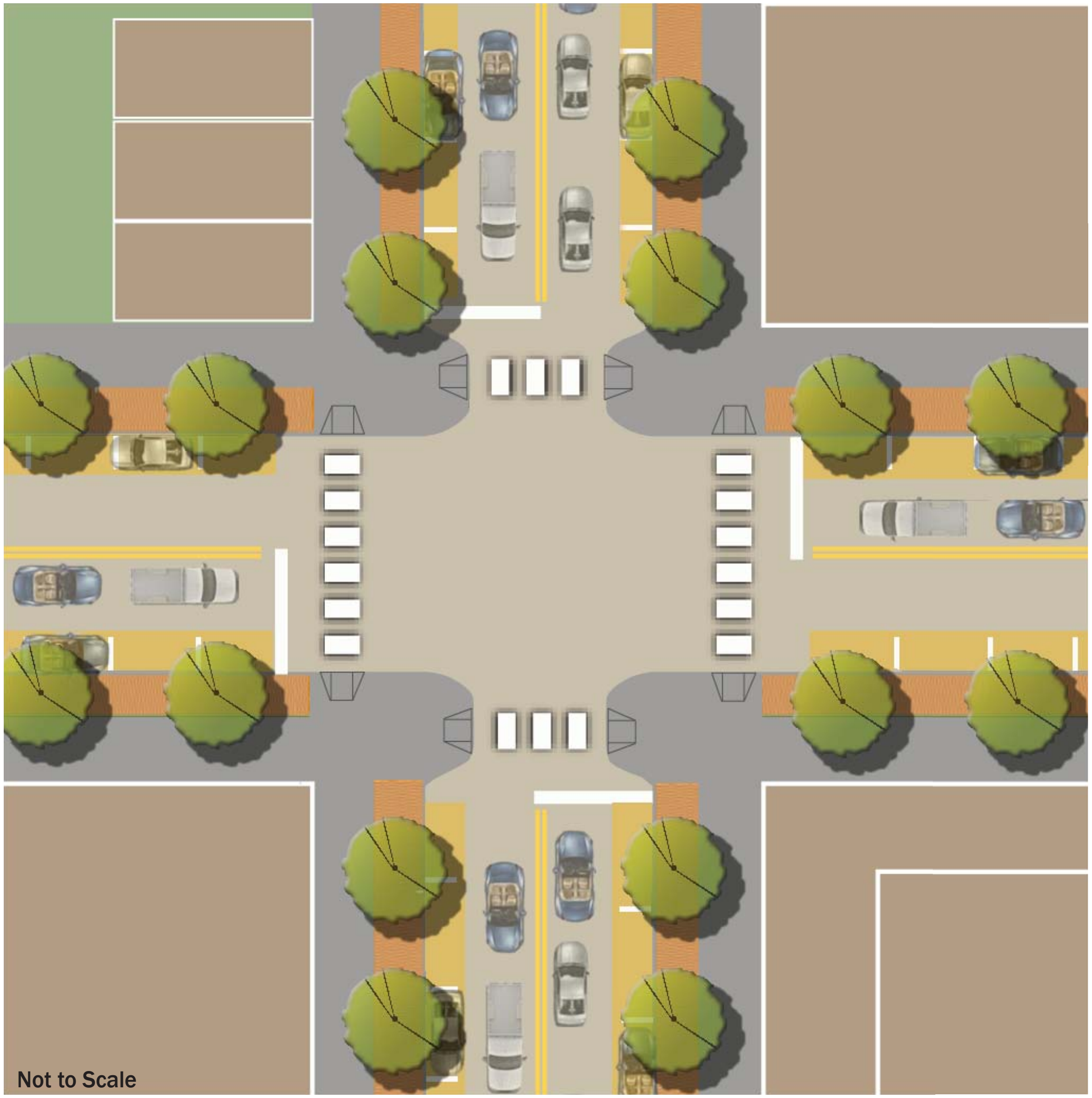
Another potential conflict exists where motor vehicles are turning right and bicyclists are traveling straight ahead on an intersection approach. The preferred method of resolving this conflict when there is a right turn lane and a bicycle lane, is by the motor vehicle merging right (with the cyclist traveling straight through and right turning vehicles yielding to the cyclist), as shown in A and B in Figure 9 above. If the bike lane ends, or there is no bike lane, the preferred method is for the bicyclist to “take” the lane, as shown in C and D above.

Intersection Design Expectations for Specific Street Types

This chapter has, thus far, described how to analyze and design intersections from the perspective of different users (to provide for motorist LOS and bicyclist and pedestrian QOS) and contexts. This section expands those concepts for direct application to the different complete street types, in order to ensure that the street type and context are adequately considered during collaborative design efforts.

Main streets and parkways represent the two "extremes" in terms of balancing users' expectations. Between main street and parkway intersections are intersections for boulevards and avenues. Boulevards and avenues serve a wide variety of land uses and contexts while providing important travel functions and network connections for all users. The mix of possible land uses, cross-sections, and intersection types, along with the desire to provide a balance among all modes, makes boulevard and avenue intersections the most complicated to design.

MAIN STREET INTERSECTION



STREET ZONES

Development Zone: Development should be pedestrian-oriented with narrow setbacks and an active street environment.

Sidewalk Zone: The pedestrian walk area is of sufficient width to allow pedestrians to walk safely and comfortably. Pedestrians are the priority on a main street.

Green Zone: Consists of the area between the sidewalk zone and curb. Includes street trees and other landscaping, as well as interspersed street furnishings and pedestrian-scale lighting in a hardscaped amenity zone.

Motor Vehicle/Shared Vehicle Zone: The primary travel way for vehicles. A shared vehicle zone has mixed traffic (cars, trucks, buses and bicycles).

Parking/Transit Zone: Accommodates on-street parking and transit stops. Width and layout may vary.

MAIN STREET INTERSECTION

KEY ELEMENTS

With the proper application of complete streets principles and practices, main street intersections will be located in a pedestrian-oriented context. Main street intersections will favor the pedestrian orientation of the main street leg, whether the intersecting street is a local/subdivision street, an avenue or a boulevard. Therefore, main street intersections:

- Place emphasis on pedestrian travel and their needs;
- Include high visibility crosswalks;
- Do not provide separate bicycle lanes due to lower speeds and volume of traffic;
- Provide countdown pedestrian signals;
- Generally do not include separate right or left turn lanes;
- Allow on-street parking;
- Have bus stops located at the far side of the intersection; and
- May include curb extensions (bulb-outs) to reduce crossing distances, increase visibility of pedestrians, allow for easier access to transit, and/or for recessed parking.

Main street intersections are typically not part of the State's strategic highway system. This allows maximum flexibility in the design, and capacity decisions can be based on local considerations and prevailing traffic conditions. Throughput for motor vehicles is less emphasized than is high pedestrian QOS to reflect the land use and street context.

PARKWAY INTERSECTION

STREET ZONES

Development Zone: Deep setbacks due to the typically auto-oriented nature of the street. Access to this zone is limited and controlled.

Multi-Use Path Zone: A zone for pedestrians and bicyclists in a multi-use path separate from the motor vehicle zone.

Green Zone: Consists of a planting strip with trees to seperate the multi-use path zone from the motor vehicle zone.

Motor Vehicle Zone: The primary travel way for motor vehicles.

Median Zone: A landscaped zone located between the travel lanes as a center median.

Development Zone is outside the limits of the area shown

PARKWAY INTERSECTION

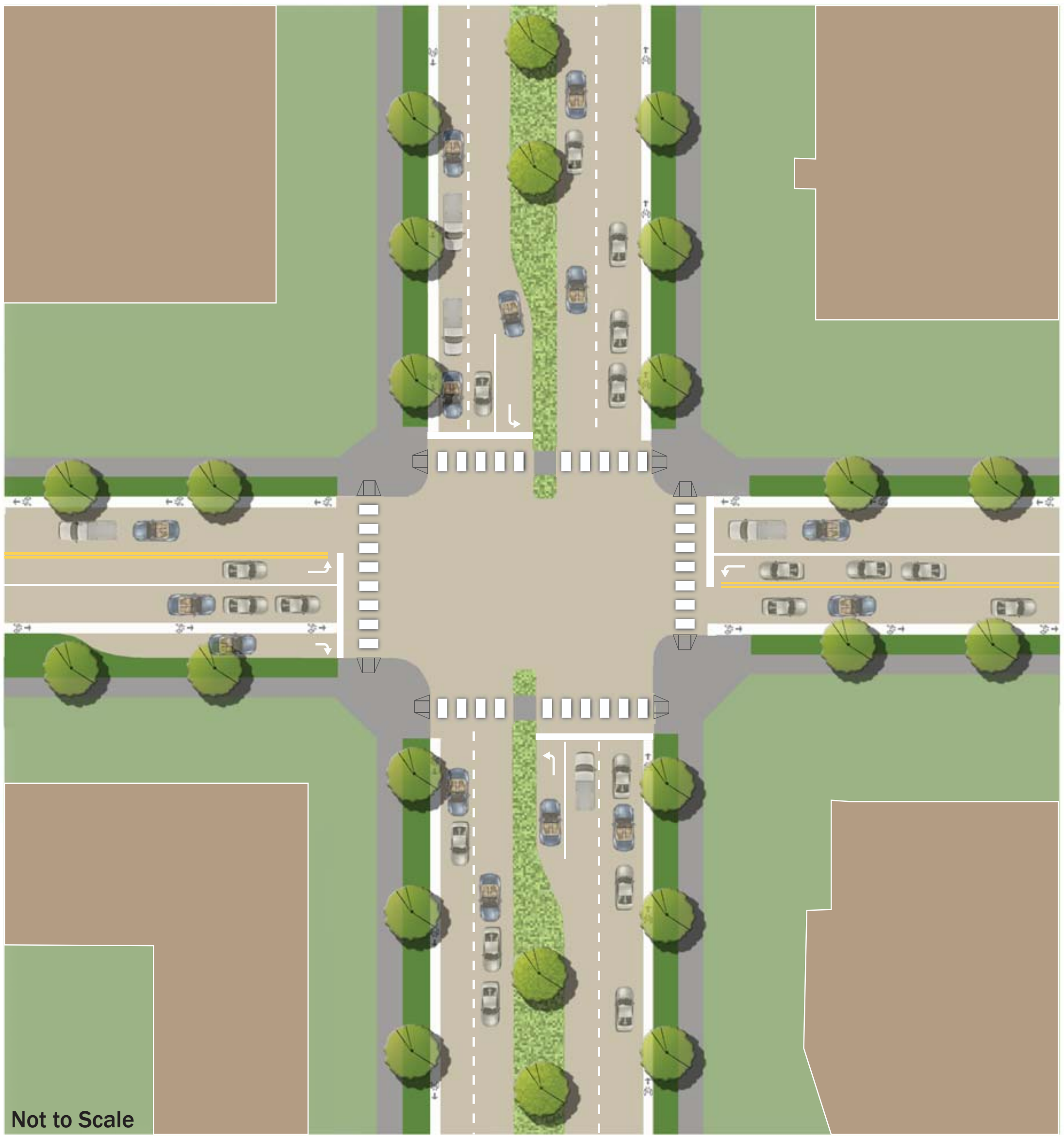
KEY ELEMENTS

Parkway intersections serve high volumes of motor vehicle traffic at relatively high speeds. Throughput and reduced travel delay for motorists is a key goal for designing parkway intersections. Adjacent land uses are generally auto-oriented in both type and design, with access control more prevalent than for any other street type. Therefore, parkway intersections:

- Will not typically intersect with main streets;
- Will have multiple lanes;
- Will always include a median;
- Include a refuge island within the pedestrian crossing (median and right lane channelization);
- Will allow dual left turn lanes;
- Will allow dual right turn lanes (parkway to parkway right-turn lanes will use the wide angle channelized right-turn design (Figure 8) and the parkway to boulevard/avenue will use the tighter angle channelized right turn design (Figure 7)). Dual right turns under signal control using the tight angle channelization design could be considered to provide additional capacity and improved pedestrian QOS;
- Are designed for the safety of all users, even though motor vehicle level of service is emphasized;
- Include multiple refuge islands if the street is 7 or more lanes wide. The location for multiple refuge islands will depend on the turn lane configuration, volumes, intersection geometry, etc. The intent is to ensure that pedestrians cross no more than 5 lanes and/or 50 feet without providing a refuge island to break up the crossing distance;
- Provide countdown pedestrian signals;
- Include high visibility crosswalks at locations where multi-use (shared use) paths cross through the intersection or where sidewalks on the intersecting street will connect destination land uses on either side of the parkway;
- Do not typically allow bicycle lanes because bicycle and pedestrian traffic is typically supported by a separate multi-use (shared use) path, ideally located adjacent to the parkway; and
- Will have longer distances between intersections than any other street type.

Parkway intersections are likely to be part of the State's strategic highway network. The intersection analysis and design for parkways will address future delays, queues and capacity. The recommended number of lanes, signal timing, and length of storage for future traffic conditions will typically favor throughput for motorists.

BOULEVARD INTERSECTION



STREET ZONES

Development Zone: Building setbacks vary but are typically deeper than on avenues. Building frontage may not always be directed to the street but physical connections to the street from building entrances are important.

Sidewalk Zone: The pedestrian walk area is of sufficient width to allow pedestrians to walk safely and comfortably.

Green Zone: This zone serves to separate the sidewalk from the vehicles. This zone contains landscaping and trees or, in some circumstances, hardscape treatments.

Bicycle Zone: A zone for bicyclists separate from vehicular traffic.

Motor Vehicle Zone: The primary travel way for motor vehicles.

Median Zone: A landscaped zone located between the travel lanes as a center median or as side medians that separate one-way parallel lanes. Median zones should consider provision for turn bays at intersections. May include hardscaping at pedestrian crossings.

BOULEVARD INTERSECTION

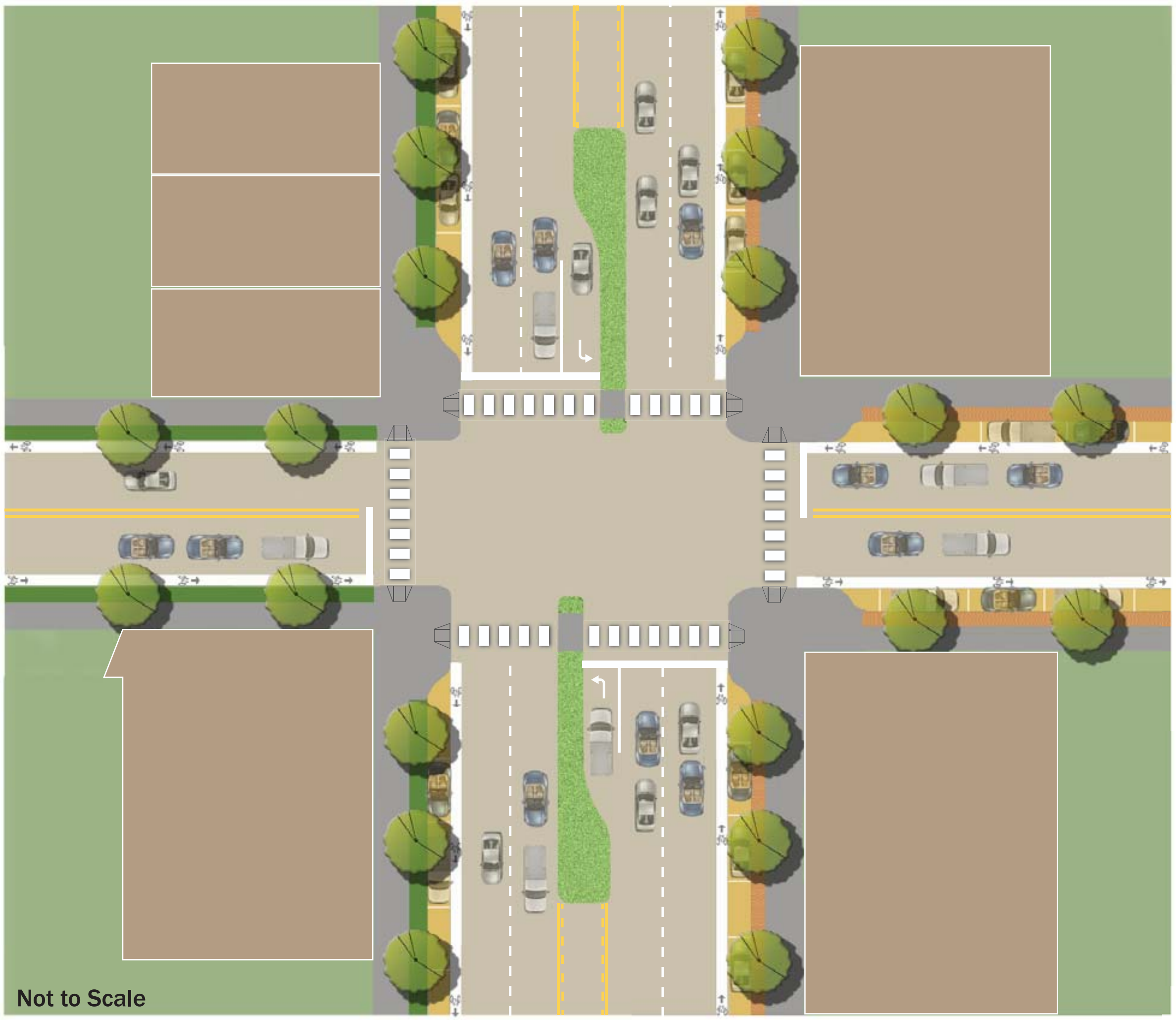
KEY ELEMENTS

Boulevard intersections serve moderate to high volumes of motor vehicle traffic but at low or moderate speeds to reflect context and to provide safety and comfort for bicyclists and pedestrians. Therefore boulevard intersections:

- Are likely to have more lanes than avenues;
- Will always have a median, but the distance between median openings and intersections will be closer than on parkways;
- Must be designed with care, because higher speeds and volumes of the boulevard must not overwhelm the needs of the pedestrians and bicyclists along the other legs of the intersection;
- Will typically have left-turn lanes;
- Will allow right turn lanes and right turn corner islands (boulevard to avenue/boulevard will use the tighter angle channelized right turn design (Figure 7));
- Allow dual left turn lanes onto parkways (dual left turn lanes should be avoided onto avenues and other boulevards). The preferred option is to try the longest possible storage lane and green time (carefully evaluating the tradeoffs of extending the storage lane and green time) for a single left-turn lane first and/or provide additional connections in the surrounding street network;
- Include a refuge island within the pedestrian crossing (median and right lane channelization) if the street is five or more traffic lanes or the crossing distance is greater than 50 feet (this is a total lane count, including through lanes, turning lanes and auxiliary lanes);
- Include multiple refuge islands if the street is 7 or more lanes wide. The location for multiple refuge islands will depend on the turn lane configuration, volumes, intersection geometry, etc. The intent is to ensure that pedestrians cross no more than 5 lanes and/or 50 feet without providing a refuge island to break up the crossing distance;
- Will carry bicycle lanes through the intersection (5 foot minimum width or 6 foot preferred width bicycle lanes);
- Allow far side bus stops;
- Include high visibility crosswalks; and
- Include pedestrian countdown signals.

Boulevards can be part of the State's strategic highway system or part of the local street network (non-strategic highway system). Therefore, more analysis and discussion between NCDOT and local agencies will be required when determining the appropriate levels of physical and operational capacity. Throughput for motor vehicles is important on boulevards, but is balanced with bicycle and pedestrian QOS to reflect the context, based on collaboration and communication between NCDOT and the locality.

AVENUE INTERSECTION



STREET ZONES

Development Zone: Development should be oriented toward the street with good functional and visual connection to the street.

Sidewalk Zone: The pedestrian walk area is of sufficient width to allow pedestrians to walk safely and comfortably.

Green Zone: The landscaped (shown in green) or hardscaped (shown in orange) area along the edge of a street. Pedestrian or decorative lighting may be provided when appropriate for adjacent land uses.

Bicycle Zone: Accommodation for bicyclists in a zone separate from the motor vehicle zone.

Motor Vehicle Zone: The primary travel way for motor vehicles.

Parking/Transit Zone: On-street parking is optional and should be considered in relation to providing convenient access to adjacent land uses. Parking zone width and layout may vary.

Access Zone: A landscaped zone or turning zone located between the travel lanes as a center median or turn lane. Avenues typically do not include a continuous median.

AVENUE INTERSECTION

KEY ELEMENTS

Avenue intersections reflect a somewhat lower emphasis on throughput than boulevard intersections. Therefore, avenue intersections:

- Require careful review and analysis of potential capacity increases; design decisions will assess and compare the trade-offs of safe, efficient, and comfortable travel for motorists, pedestrians and bicyclists, with the decision sometimes allowing for longer queue lengths or delays as a tradeoff for providing better QOS for other users;
- Generally do not have medians, but when provided they should be a minimum width (at the intersection) of 6 feet or a preferred width of 8 feet along corridors with anticipated heavy pedestrian traffic; the more likely avenue design uses intermittent islands for pedestrian crossing opportunities, landscaping, and to “break up” long two-way-left-turn lanes;
- Will rarely have separate right-turn lanes;
- Will typically include left-turn lanes;
- Will have closer intersection spacing than either boulevards or parkways;
- Typically should not allow dual left-turn lanes. The preferred option is to try the longest possible storage lane and green time (carefully evaluating the tradeoffs of extending the storage lane and green time) for a single left-turn lane first and/or provide additional connections in the surrounding street network;
- Are not required to provide pedestrian refuge islands if the street is four or fewer travel lanes wide;
- Include a refuge island within the pedestrian crossing (median and/or right-turn channelization) if the street is five or more traffic lanes and the crossing distance is greater than 50 feet (this is a total lane count, including through lanes, turning lanes and auxiliary lanes);
- Will carry bicycle lanes through the intersection (5 foot preferred width, 4 foot minimum width), with a “receiving” bicycle lane (or accommodation) on the opposite side of the intersection. If there is no receiving lane or advanced bicycle stop bar, the bicycle lane should be dropped just prior to the actual intersection, to allow the bicyclist to safely merge;
- Allow for far side bus stops;
- Include high visibility crosswalks; and
- Include countdown pedestrian signals.

Avenues may or may not be part of the strategic highway system. Motor vehicle throughput is less emphasized than for boulevards, particularly for avenue to avenue/main street intersections. The number of through and turning lanes for avenue intersections will result from collaborative decisions and reflect the local agency’s vision for context and street type.

Unsignalized Intersections

The previous discussion described how to analyze and design signalized intersections to be "complete" and function well for all users. Unsignalized intersections present some challenges for bicyclists and pedestrians that are similar to those for signalized intersections, such as large turning radii and exclusive right turn lanes, which increase turning speeds and crossing distances (Caltrans Complete Street Intersections, California Department of Transportation, 2010). However, the unsignalized intersection of a minor street with a major street can provide additional challenges for pedestrians and bicyclists. For example (adapted from Caltrans, 2010):

- Because traffic on the major street is not controlled by signals, pedestrians and bicyclists might experience long delays before there is a large enough gap in traffic to allow them to cross the street. This can be particularly challenging for pedestrians who have difficulty judging gaps in traffic or who cannot move quickly.
- The major street, particularly if it is a boulevard, may not be designed to cue motorists to look for and/or expect pedestrians and bicyclists crossing at the minor street.
- Medians in the major street might not be designed to provide a refuge for crossing pedestrians. For example, the median would need to be wide enough to allow for a pedestrian refuge, even where there is a left turn lane. If the median does include a left turn lane, it may further complicate the crossing for pedestrians and bicyclists if it is continuously occupied by turning vehicles.
- Longer crossing distances, in conjunction with high motor vehicle volumes and speeds for some street types make it more difficult to cross an uncontrolled crossing.

In addition to the types of treatments described elsewhere for signalized intersections, the following types of design treatments should be applied to improve the comfort and safety of pedestrians and bicyclists at unsignalized intersections:

- For main streets, do not include separate right or left turn lanes to minimize the crossing distance for pedestrians;
- For avenues, do not include separate (exclusive) right turn lanes at unsignalized intersections, to help reduce speeds and crossing distances;
- For main streets, avenues, and boulevards construct the smallest applicable intersection curb radii to help slow turning traffic and reduce the crossing distance for pedestrians;
- For main streets and some avenues, include curb extensions to reduce the crossing distances;
- Depending on the traffic volumes and speeds on avenues, include pedestrian refuge islands even when there are 4 or fewer traffic lanes (as compared to the recommendations for signalized intersections, where refuges are recommended at 5 or more lanes);
- For boulevards, construct pedestrian refuge islands in the median and right turn corner islands for pedestrians to shorten the crossing distances and allow the crossing to occur in stages. Avenues will not typically include continuous medians or exclusive right turn lanes at unsignalized intersections;
- Minimize distances across the minor street by limiting the number of (turning) lanes on the minor leg and/or providing raised pedestrian refuges or medians that can serve as refuges;
- Include signing and striping to increase visibility and driver awareness of pedestrian crossings (include high visibility crosswalks on the minor legs, particularly in urban or center

contexts). For unsignalized main street intersections, include high visibility crosswalks on all legs; for unsignalized avenue intersections (and some boulevards) include high visibility crosswalks on the minor leg, and consider them for the major leg in urban and suburban centers, or where complementary land use types exist in close proximity (as described in the "Mid-Block Crossings" (p. 120) section of this chapter);

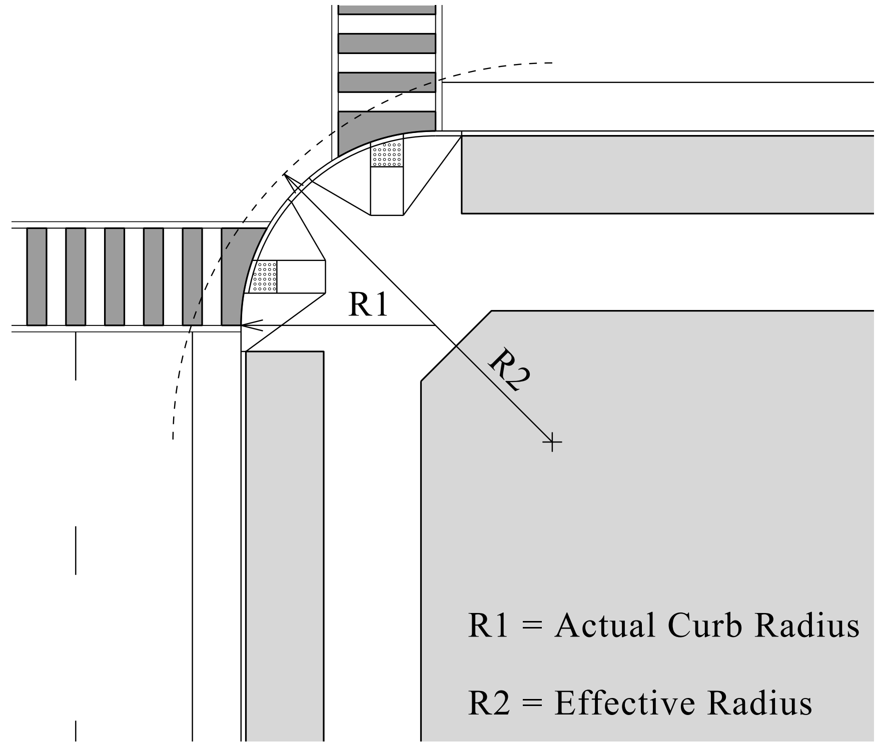
- On boulevards (or any avenues that might have medians), provide a bicycle passage through the median at the unsignalized intersection;
- Include pedestrian flashing beacons, as described in the section on "Mid-Block Crossings", (p. 120); and
- Improve visibility by restricting parking for at least one car length on each side of the crossing.

Turning Paths for Design Vehicles

Curb returns are the curved curb islands formed by the intersection of two streets. The curb return's purpose is to guide turning motor vehicles and separate vehicle traffic from pedestrian traffic at the intersection corners. The radius of the curve varies depending on the type of motor vehicle the designer is trying to accommodate. Radii should be minimized, to allow the necessary dimension for traffic, while minimizing impacts on pedestrians, bicyclists, and adjacent land uses. Smaller curb radii narrow the overall dimensions of the intersection, shortening pedestrian crossing distance and reducing the right-of-way requirements. The presence of a bike lane or parking lane creates an "effective radius" that allows a smaller curb radius to be constructed than otherwise would be required for some motor vehicles because they provide extra maneuvering space for the turning vehicles. On boulevards and parkways, large vehicles may encroach entirely on adjacent travel lanes (lanes that are in the same direction of travel).

The designer must consider lane widths, curb radii, location of parking spaces, grades and other factors while designing intersections. Designers are discouraged from using a combination of minimal dimensions unless the resulting design can be demonstrated to

Figure 10: Effective Curve Radius at an Intersection



Source: Kimley-Horn and Associates, Inc., adapted from the Oregon Bicycle and Pedestrian Plan

be operationally practical and safe. Key concepts for providing appropriate curb radii at intersections consist of:

- Minimizing curb radii to reduce turning speeds, reduce crossing distances for pedestrians, improve visibility of pedestrians, and allow for the installation of the safest ramp at crosswalk locations;
- Using prevalent (expected under normal circumstances) vehicle type for the recommended design;
- Assuming the appropriate turning speeds for all design vehicles; and
- Allowing for encroachment into adjacent travel lanes on multi-lane streets and use of full street width on local streets.

Additional factors to consider for intersection design include:

- The overall street pattern – depending on the size and layout of the adjacent street system, it may be appropriate to design smaller radii at most intersections, while accommodating larger vehicles at fewer select locations along designated routes (at these locations consider using mountable curbs like those shown in the photo, to accommodate larger vehicles while maintaining smaller radii and lower turning speeds);
- The presence of raised median or pedestrian refuge island – may require larger radii to prevent vehicles from encroaching onto the median. Alternatively, particularly for "gateway" medians on local streets, medians may have aprons to allow larger vehicles to turn without damaging landscaping or curbs;
- Skewed or oddly shaped intersections – may dictate larger or smaller radii than the guidelines would otherwise indicate; and
- Lane configurations or traffic flow – intersections of one-way streets, locations where certain movements are prohibited (left or right turns), or streets with uneven number of lanes (two in one direction, one in the other) will also affect the design of curb radii.

The presence or absence of on-street parking will directly affect the curb radii required to accommodate the design vehicle. Table 2 may be used where full time on-street parking is allowed and accommodated on both streets at an intersection (assumes that the parking is not recessed by using curb extensions at the intersection).

Table 2: Curb Radii with Permanent Full-Time On-Street Parking (in feet)

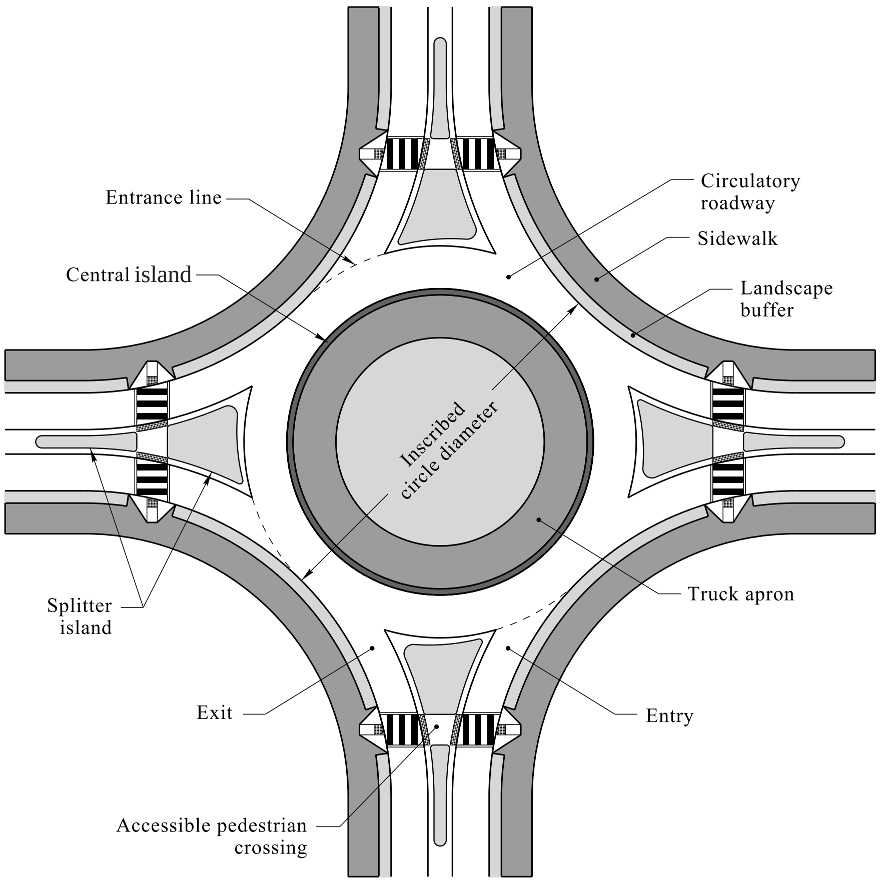
FROM/TO	Local	Main	Avenue	Boulevard	Parkway
Local	15	20	25	30	--
Main	20	20	25	30	--
Avenue	25	25	25	30	--
Boulevard	30	30	30	35	--
Parkway	--	--	--	--	--

This table should not be used where parking is either part-time only or occurs infrequently.

Other Types of Intersections

In addition to the signal-controlled and unsignalized intersections, other types of intersections may be included as part of a complete street network, and should be designed to both reflect the context and to be safe and comfortable for all users. These include, but are not limited to, roundabouts and grade-separated intersections (interchanges). In addition, mid-block crossings, at-grade rail crossings, and intersections with greenways are important for providing a network to support bicycling and walking. The following sections describe important design considerations for these types of intersections and crossings.

Figure 11: Single Lane Roundabout



Roundabouts

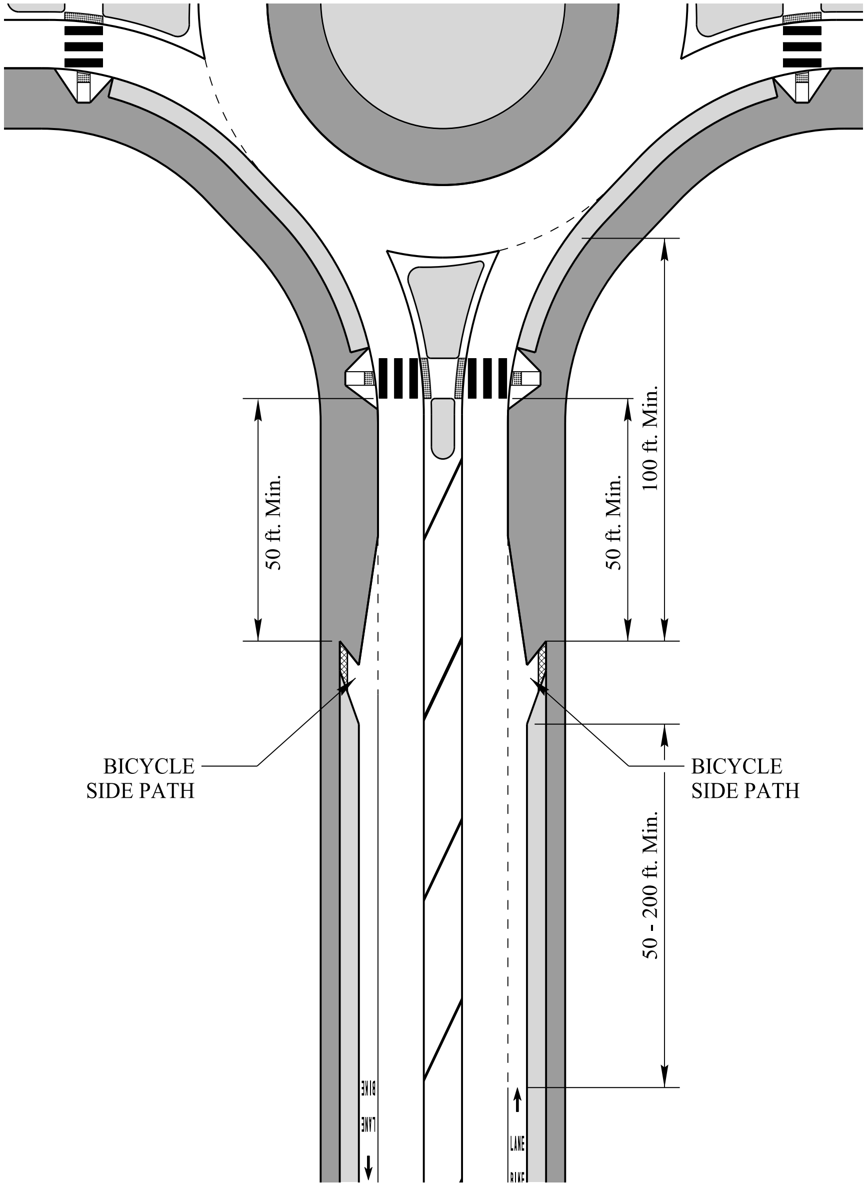
Roundabouts are a type of yield-controlled intersection characterized by a generally circular shape and design features that create a low-speed environment. A roundabout requires entering traffic to yield the right of way to traffic already in the roundabout. This yield control keeps traffic flowing and can prevent traffic backups as well as delays for motorists, bicyclists, and pedestrians. When operating within their capacity, roundabout intersections typically operate with shorter vehicle delays than other intersections, especially during non-peak traffic times. For this reason, roundabouts support motor vehicle capacity objectives and, when properly designed, also support bicyclist and pedestrian quality of service objectives. For example, certain traffic conflicts for bicyclists are reduced or eliminated, such as those that result in left and right-turn hook crashes. Likewise, conflicts for pedestrians are managed by breaking up the crossing and reducing traffic speeds.

The size, geometry, and applicability of a roundabout is determined by many variables, including: street and area type, available space, layout of the existing intersection, intended objectives (capacity improvements, traffic calming, e.g.), traffic volume (number of lanes), the sizes of the vehicles using the roundabout, and the need to design appropriately for speeds that provide safe accommodation for all users. Each roundabout must be designed to the dimensions and configuration that supports safety and mobility for all users while achieving the specific objectives described collaboratively by NCDOT and the local area representatives.

Roundabouts can help address safety and congestion concerns at intersections. They are designed to enhance traffic efficiency, safety and aesthetics, and minimize delay for all users including motorists, pedestrians and bicyclists. The benefits to bicyclists and pedestrians are easiest to obtain with single-lane roundabouts. Multiple-lane roundabouts can provide difficulties for pedestrians and bicyclists if not carefully designed. Therefore, single lane roundabouts are preferred to multi-lane roundabouts in most situations. When designing roundabouts, the design input team should strive to provide for (among other important design considerations) the following (portions taken or adapted from Caltrans 2010 report, pp. 71-75, and Los Angeles County "Model Design Manual for Livable Streets," 2011):

- Apply roundabouts where the context and design objectives allow, but avoid their use for capacity improvements where there are very unequal traffic volumes between the intersecting streets (particularly where one has a very high volume);
- Construct crosswalks (and pedestrian refuges) at least one car length from the roundabout entrance (Los Angeles County, 2011, p. 5-23);

Figure 12: Roundabout with Bicycle Lanes on the Approach



1.) For Single Lane Roundabouts: Bicyclists take the lane at the roundabout.

2.) For Multi-Lane Roundabouts: Bicyclists either take the side path or take the lane and enter the roundabout.

- Construct the smallest diameter roundabout necessary, with the minimum number of lanes to meet capacity needs based on the context and street type (as described under “Motor Vehicle LOS” in this chapter). Single-lane roundabouts are preferred;
- Construct roundabouts to keep the internal circulation speed low enough to minimize the speed differential between motor vehicles and bicycles – the goal should be to keep approaches and internal circulation speeds low;
- Construct splitter islands at all entrances, and design them to slow vehicle speeds through deflection, guide motorists and cyclists properly into the roundabout, and to be wide enough to serve as pedestrian refuge islands at crosswalks;
- Particularly for multi-lane roundabouts, provide a separate bike path to allow bicyclists to leave the street prior to the roundabout and re-enter after the roundabout – design carefully to avoid bicyclist and pedestrian conflicts at these points; and note that bicyclists may also “take the lane” prior to entering the roundabout;
- For single lane roundabouts, the bicyclist should generally “take the lane”, so provide for a transition from any approaching bicycle lane prior to the roundabout;
- Consider reducing entrance speeds by providing speed tables at crosswalks (from Caltrans, 2010, p. 75);
- Particularly for multi-lane roundabouts, reduce “dual threat” conflicts for all pedestrians and crossing difficulties for elderly, disabled, or visually-impaired pedestrians by considering pedestrian hybrid signals at each approach to the roundabout;
- Even for single lane roundabouts, consider accessible pedestrian signals to make crossings safer and more comfortable for the elderly, disabled, and particularly the visually impaired;
- Provide a strong vertical element in the roundabout center, to help define the roundabout, reduce approach speeds; provide landscaping in the center for those reasons, and to make clear that pedestrians should not cross through the roundabout; and

- Provide for large vehicle movements by constructing a mountable apron for the roundabout center – ensure that the apron is not comfortably mountable by passenger cars.

Additional guidance for designing roundabouts can be found at: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_672.pdf

Interchanges

Interchanges, or other grade separated crossings, often provide the only connection across a freeway for long distances. Since these connections are critical parts of the transportation network, they should be designed to provide for comfortable and safe pedestrian and bicycle travel. In keeping with NCDOT's complete streets objectives, interchanges or other grade-separated intersections over freeways or parkways will include bicycle and pedestrian accommodations on the surface street, whether above or below the freeway or parkway. Furthermore, interchanges will be designed as multi-modal intersections where on-ramps and off-ramps intersect the surface street. Earlier sections of this chapter describe how motor vehicle capacity decisions are made at these types of intersections, as well as pedestrian and bicyclist QOS expectations for intersections, which will apply at interchanges' intersections with surface streets.

The types of challenges that pedestrians and bicyclists face at interchanges are generally related to high traffic speeds, multiple (and often changing or transitioning) lanes, and turning angles for motor vehicles that support higher speeds and also reduce driver visibility and awareness of bicyclists and pedestrians. Therefore, in keeping with the bicycle and pedestrian QOS objectives for complete streets, the following guidance should be applied:

- Include bicycle and pedestrian facilities on the surface street that intersects with freeways, interstates, or parkways (see Chapter 7, "Structures", for more information);
- Design interchanges as multi-modal intersections where on-ramps and off-ramps intersect the surface street, particularly for avenues and boulevards (main streets would not typically intersect at freeway ramps);

- Avoid free-flow on and off ramps, particularly at interchanges with avenues or boulevards;
- Consider channelized right turn lanes and/or dual right turn lanes under signal control, rather than free-flow right turn lanes;
- Construct turning angles onto and off of freeway ramps as close to 90-degrees as possible;
- Design for short pedestrian crossings and construct pedestrian refuge islands for longer crossings (3 or more lanes or multiple right-turn lanes, etc.);
- Provide high visibility crosswalks in urban and suburban areas;
- Where bicyclists travel among moving vehicles for more than 200 feet adjacent to auxiliary lanes, install a painted or raised buffer (adapted from Caltrans, 2010, p. 75); and
- Where bicyclists must change lanes or, in doing so, cross a traffic lane, allow flexibility to transition when and where it is safe (adapted from Caltrans, 2010, p. 75); generally, it is preferable to provide for highly visible transition areas, and to continue the through bicycle lane to the left of any turning (auxiliary) lane.

Mid-Block Crossings

When designing for complete street networks, it is vital to consider how pedestrians will be able to safely and comfortably cross those streets and to provide opportunities to do so. As described in the section on "unsignalized intersections", there are many challenges that pedestrians face when trying to cross at locations that are not signalized intersections. These challenges increase as traffic speeds, traffic volumes, and the number of traffic lanes increase. For example, adequate gaps in traffic become scarce, crossing distances discourage pedestrians (particularly those who may not be able to walk as quickly as others), pedestrians may be less visible to motorists when there are multiple lanes, and multiple types of conflicts with through and turning vehicles may occur.

In recognition of the need for pedestrians to safely cross streets without major deviation from their direction of travel, complete street networks should typically provide for a greater number and variety of crossings. This can occur by providing more signalized intersections in the network and/or by providing other types of crossings, in support of the complete streets and area types described in these guidelines. This means that:

- Main streets typically will not need mid-block crossings because the block structure should support more closely spaced signals and the street widths and speeds lessen the need; mid-block crossings should, however, be strongly considered on main streets if the block is more than 600 feet long;
- Parkways will not include mid-block crossings due to higher speeds and volumes of traffic and land uses that are oriented away from the parkway. Crossings that are not at intersections or interchanges should be grade-separated;
- Avenues and boulevards may include mid-block crossings, particularly at or near locations that will likely generate higher than average pedestrian activity or where complementary types of land uses are located across the street from each other (and where the closest signalized intersection is more than 300 feet away). Examples of such locations and land uses include, but are not limited to:

- Urban/suburban centers;
- Transit stops, particularly those located across from neighborhood entrances or any of the types of land uses described below;
- Where signed bicycle routes cross the street or are nearby;
- Where greenways cross the street or are nearby;
- Concentrations of neighborhood type retail uses such as restaurants, coffee shops, grocery stores, cafes, etc.
- The above types of uses or neighborhood services such as dry cleaners, drugstores, and health clubs, particularly when these are located in close proximity to housing;
- Higher density residential uses;
- Vertical mixed-use or concentrated multi-use developments; and
- Institutional uses such as parks, libraries, schools, places of worship, or concentrations of public service offices.

Once the NCDOT and the local area representatives have decided to further consider a mid-block crossing, then the designers should use the following guidance:

- Provide the crossing on the shortest path between the most likely pedestrian destinations, taking care to consider sight lines, offset intersection, driveways, etc.;
- Provide the appropriate treatment for the mid-block crossing, by generally providing additional elements, in combination, as volumes and speeds increase (note that this is guidance and each crossing should be designed to achieve the best crossing for the context; e.g. some crossings may require more treatments, even when volumes are below 12,000 AADT):
    - For traffic volumes up to 12,000 AADT, provide pedestrian crossing signs, pedestrian paddles, and high visibility pavement markings;
    - For traffic volumes up to 12,000 AADT, also consider adding curb extensions and/or raised crosswalks (take care that curb extensions do not block any bicycle facility on the street);

    - For traffic volumes above 12,000 AADT, a raised median or refuge island should also typically be provided with the crossing;
    - For traffic volumes above 15,000 AADT, consider providing rapid flashing beacons or pedestrian beacons in conjunction with raised medians, pedestrian refuges, and/or high visibility pavement markings (see MUTCD for additional information);
    - Design pedestrian refuges at designated mid-block crossings to be accessible;
    - Include a vertical element (such as landscaping, paddles, or other) on pedestrian refuges to ensure visibility to motorists;
    - Use the “z crossing” or angled crossing design for the pedestrian refuge to ensure that pedestrians are facing oncoming traffic.

Properly designed and visible midblock crossings, with signals and warning signs help to alert drivers to potential pedestrians, protect crossing pedestrians, and encourage and support walking. Mid-block crossings are, therefore, an important tool that NCDOT and communities can use to expand the complete street network.

Greenways and Multi-Use Paths

Greenways and other types of multi-use paths can contribute significantly to a "complete" transportation network. They can offer important connections for bicyclists and pedestrians in urban, suburban, and rural contexts. Unless they are located directly adjacent to a street, they should not be considered a substitute for a complete street, but rather a supplement to the complete street network. For example, parkways and rural roads would be the most likely street types to have a multi-use path alongside the roadway. Other types of streets, such as boulevards or avenues, occasionally have a greenway (or multi-use path) located adjacent to one side of the street (with appropriate facilities on the other side).

Where multi-use paths run parallel to (and nearby) an adjacent street, the following guidance should be applied at intersections:

- Bring the adjacent path as close as possible to the intersection to ensure visibility between the motorists and bicyclists and pedestrians;
- Provide as direct a path as possible for the bicyclists and pedestrians through the intersection;
- Use high visibility pavement markings at the crossings; and
- Provide adequate signal green time for crossing for signalized intersections.

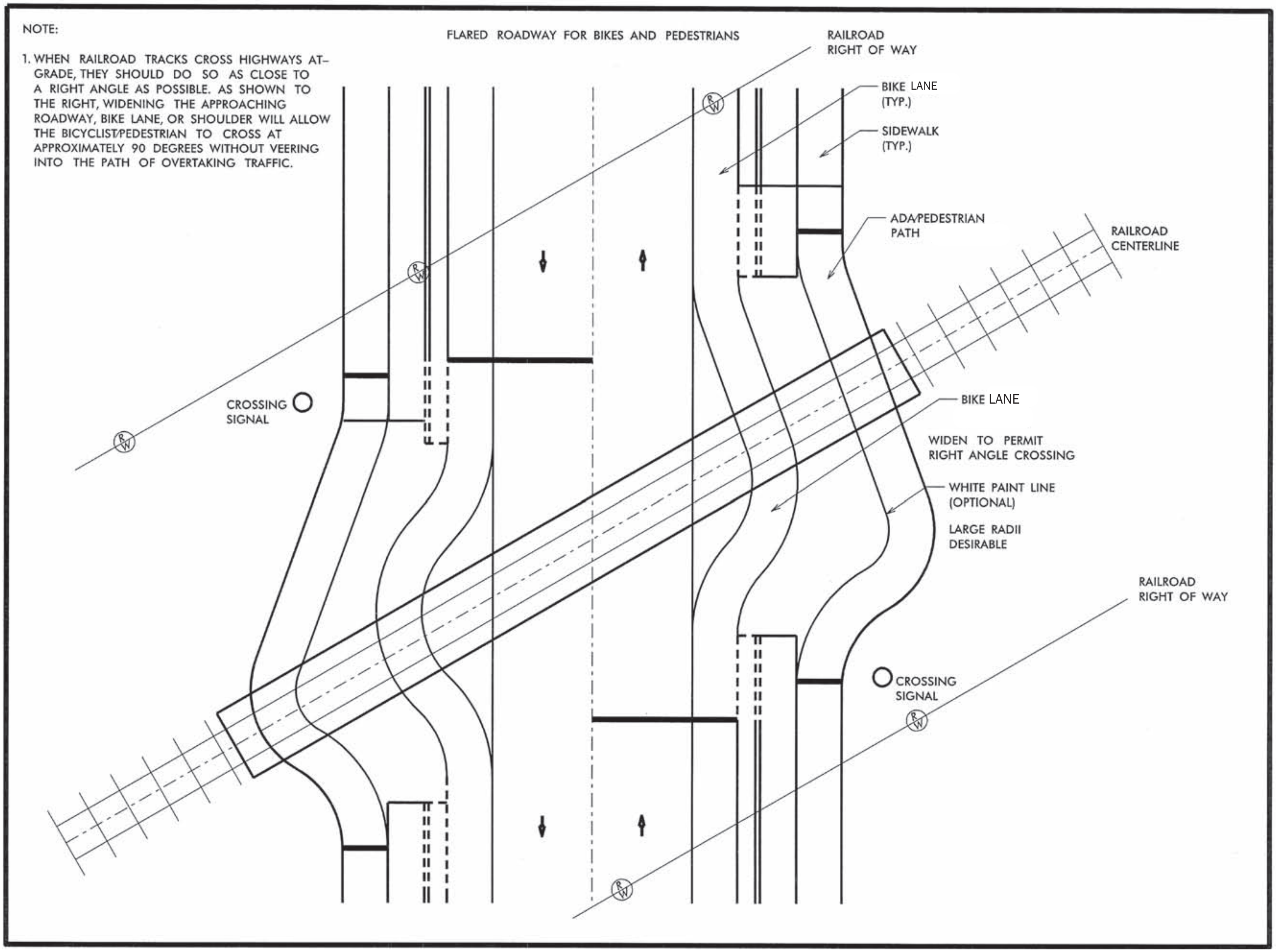
Where multi-use paths cross streets as intersections, the following guidance should be applied:

- Align crossing approaches as close to perpendicular to the street as possible, to improve visibility and sight lines;
- Carry the width of the multi-use path through the curb ramp and crosswalk to increase safety for pedestrians and bicyclists;
- Provide high visibility pavement markings at all crossings;
- Provide accessible curb cuts and tactile warnings;
- Consider raised crossings for low-volume streets;
- Provide refuges at the crossing for higher-volume streets;
- Design crossing refuges to be accessible and use the "z-crossing" or angled crossing design for visibility;
- Consider pedestrian/bicycle signals for streets with high traffic volumes or for crossings likely to have high pedestrian and/or bicycle activity;
- Provide for appropriate signage and wayfinding for those using the greenway and to alert motorists approaching the crossing;
- Ensure that grades approaching and leaving the surface street are appropriate for all levels of bicyclists and meet accessibility standards; and
- For crossings on high-volume streets, consider grade-separated crossings where appropriate for the context.

At-Grade Railroad Crossings

Commuter and light rail systems, as well as passenger and freight railroads cross streets at-grade, thereby affecting motorists, bicyclists, and pedestrians at the crossing. Proper care must be taken to provide a safe and convenient crossing for all users, particularly as opportunities (network) to cross the tracks might be limited in some locations. The appendix includes sample street cross-sections for the

Figure 13: Rail Crossing for Sidewalks and Bicycles



incorporation of sidewalks and bicycle lanes at level or at-grade railroad crossings. Note that the treatments, dimensions and cross-sections shown in the appendix may require modifications based on the specific street type and the context for each crossing. Specifically, the designer or design input team should strive to continue the approach cross-section (which is based on complete street type and context) through the crossing and not to taper or narrow the street (and sidewalk) width across the railroad tracks. If the sidewalk alignment shifts at the crossing, the taper (lateral shift) should be a minimum of 20:1.

The pedestrian and bicycle crossings should have clear lines of sight and good visibility so all users can see approaching trains. To ensure appropriate visibility, parking is not allowed in the railroad right of way. Sight triangles of 50 feet by 100 feet will be provided at the railroad and street right of way (sight triangles are measured from the centerline of the railroad track). Railroad gate placement will be coordinated with the placement of sidewalks and bicycle lanes at the crossing.

In addition to the need to continue the appropriate street cross-section across the tracks and to provide for safe crossings, there are two other main considerations for bicyclists and pedestrians with at-grade crossings. First is to consider the effect of the crossing angle, and second is to consider the roughness of the crossing. Pedestrian and bicycle crossings at such crossings should be designed to avoid situations in which wheels and tires do not hit the top of the rail and drop into the flange way. Pedestrians and bicyclists are better accommodated when the street crosses the tracks at 90 degrees. If the skew angle is less than 45 degrees, special attention should be given to the sidewalk and bicycle alignment to improve the approach angle to at least 60 degrees. This lessens the chance of bicycle wheels or any other wheels getting caught in the flange of the railroad tracks (see Figure 13).

The objective for "complete" crossings is to provide as smooth a surface as possible. Four common materials used for the railroad crossings are concrete, rubber, asphalt and timber. Concrete performs best, even under wet conditions.

For the sidewalk approaching the crossing, ADA detectable warning domes shall be provided 17 feet from the railroad track centerline. The sidewalk approaching the crossing will be asphalt within 13 feet of the railroad centerline.

Access Management

Access management is a set of techniques used to control access to streets. Specifically, access management refers to the regulation of intersections, driveways and median openings to or along a street. The benefits usually identified with access management include improved movement of through traffic, reduced crashes, and fewer vehicle conflicts. For implementing complete streets, however, these benefits should be considered in relation to the multiple objectives of improving access, safety and functionality for all users. Access management can be compatible with complete streets, but it must be applied to best match the street and context. Proper application is necessary to provide the intended benefits without unintended consequences for pedestrians, bicyclists, or motorists. For example, along some types of streets, the benefit of "improved movement of through traffic" should be balanced so as to not result in higher motor vehicle speeds (which can inhibit pedestrian and bicycle traffic and also result in more severe crashes). Some forms of access management can inhibit network connections across streets and result in the concentration of traffic through one, or a few, very large intersections thereby increasing congestion or making it difficult to comfortably serve pedestrians and bicyclists. Therefore, varying street types and contexts will assume varying levels or types of access management.

This means that:

- **For main streets**, the objective is to provide direct access to land uses, but with the focus on providing slow speeds for this pedestrian-oriented street. Therefore, main streets typically:
    - will have few driveways (due to relatively short blocks, good network structure, and the desire to limit conflicts between turning vehicles and pedestrians along the street);

- Will never (or only in rare circumstances) have right-turn lanes, either into driveways or at intersections;
- Will never (or only in rare circumstances) have medians; and
- The distance between intersections should be shorter than for other street types.

- **For parkways**, the objective is to carry high volumes of motor vehicle traffic at relatively high speeds over longer distances through or within an urban or suburban area. Therefore, parkways will have high levels of access management. Parkways typically:
  - Will seldom (or only in rare circumstances) have driveways or entrances directly to land uses off of the parkway;
  - Will typically have right turn lanes at intersections and into any driveways;
  - Will always include a median; and
  - Will have longer distances between intersections than other street types.

Between these two street types are the avenues and boulevards, where the modal balance is more mixed and the application of access management techniques is more varied. This means that:

- **For avenues**, the objective is to provide for access to land uses, activity and friction along the street, and motor vehicle speeds that are not excessive. Therefore, avenues typically:
  - Will have driveways for direct access to land uses (although shared driveways are still encouraged);
  - Will almost never have right turn lanes into driveways/entrances and rarely at intersections;
  - Will seldom have medians and are much more likely to include intermittent landscaped islands/pedestrian refuge islands in combination with a two-way left turn lane; and
  - Will have closer spacing of intersections than either boulevards or parkways.
- **For boulevards**, the goal is still to balance the modes, although the balance shifts more towards motor vehicle capacity while remaining safe and functional for pedestrians and cyclists.

  Therefore, boulevards typically:
  - Will have fewer driveways than avenues (more shared driveways);
  - Will sometimes have right-turn lanes into driveways and at intersections;
  - Will always have medians; but
  - The distance between median openings and intersections will be shorter than for parkways.

The following section describes the typical approaches to providing access management. To most effectively blend the advantages of access management with other complete street objectives, NCDOT and the locality should work together to assess each street type and land use context to determine the most appropriate application.

Distance between traffic signals - Managing the distance between traffic signals can improve the flow of traffic and reduce congestion. “Managing the distance” means spacing the signals to provide the most appropriate pace of traffic through the corridor (with appropriateness determined by the street type and context). In some cases, as with parkways and many boulevards, this means longer distances between signals than for avenues. For main streets and avenues, this means shorter distances between signals than for boulevards to ensure that the "pace" of traffic supports access, safety, and mobility for pedestrians, bicyclists, and transit users, in addition to motorists.

Driveway spacing - Appropriate driveway spacing also affects pacing and access. Large numbers of driveways can increase the potential conflicts on the street, both in the vehicle lanes (for motorists and bicyclists) and across the sidewalk (for pedestrians). Fewer driveways spaced further apart present fewer challenges to drivers, but also tend to limit access to businesses and residences, which might be less desirable in some contexts than others. Therefore, avenues will have fewer limitations on driveways than will boulevards, and parkways will have the greatest limitation on driveways.

Exclusive turning lanes - Exclusive turning lanes for vehicles remove slowing or stopped vehicles from through traffic. Left-turn lanes at intersections substantially reduce rear-end crashes and help to increase the capacity of many streets. Right-turn lanes have a less substantial impact on crashes, other than rear-end crashes, because there are fewer motorist conflicts on right turns (although there may be significant conflicts between motor vehicles, bicyclists, and pedestrians at right turns). At intersections with substantial right-turn movements, a dedicated right-turn lane segregates turning vehicles from the through traffic and increases the capacity of the street. Right-turn lanes also have effects on pedestrians and bicyclists. Adding exclusive turn lanes into driveways, for example, can increase crossing distances and traffic speeds. At intersections, there may be more opportunities to mitigate for these effects (see the sections "Pedestrian QOS at Intersections" and "Bicyclist QOS at Intersections"). Generally, parkways and boulevards are most likely to have exclusive right-turn lanes, avenues will rarely have them (and only at intersections), and main streets will never have them.

Medians - Medians (either raised or grassed) represent one of the most effective means to regulate access along streets. They can also limit direct access to land uses and are, therefore, more appropriate

for some street types than others. Treatments for median access range from a continuous median with defined median breaks, to intermittent islands in a center two-way left-turn lane (TWLTL), to continuous access with or without a center TWLTL. Intermittant islands are allowed on streets with center turn lanes.

In comparison to a center TWLTL, medians:

- Separate opposing traffic and significantly reduce a wide range of common crashes, including rear-end, right angle, head-on and left-turn;
- Reduce property damage, injuries, and fatalities related to these crashes;
- Reduce driver confusion by concentrating vehicular maneuvers to intersections where they are more expected and are typically controlled with traffic control devices;
- Limit direct access to land uses along the street;
- Increase the likelihood of u-turns; and
- May result in higher speeds, as motorists feel comfortable traveling at higher speeds and expect fewer impedances.

In comparison with medians, continuous TWLTLs:

- Remove left-turning vehicles from the through traffic;
- Provide for direct access into all land uses and all cross-streets;
- Can create driver confusion, particularly if used for long distances;
- Can be associated with higher frequency and severity of crashes (compared to median-divided);
- Provide little to no opportunity for pedestrian refuge; and
- At higher AADTs, motorists desiring to turn left from a five-lane section might have difficulty finding a safe gap in oncoming traffic.

Boulevards and parkways will always have medians (with more median breaks available on boulevards).

Main streets will almost never have medians and avenues will not typically include continuous medians. On avenues, continuous medians and long distances between intersections and full movement crossings interfere with logical route options and create a need for additional capacity at intersections. However, the TWLTL (particularly when used in a five lane cross-section) has safety implications for motorists, pedestrians, and bicyclists (as described above). **For avenues, the use of intermittent landscaped islands in a center turn lane can support access management strategies for complete streets by:**

- Maintaining access to properties;
- Separating turning movements from through lanes;
- Reducing driver confusion created by longer, continuous center turn lanes
- Allowing for landscaping on intermittent islands;
- Allowing for pedestrian refuge for multi-lane crossings and
- Generally, enabling better organization of the TWLTL space.

In closing, access management objectives are to enable access to land uses while maintaining street safety and mobility through controlling access location, design, spacing and operation. Specific objectives for each street type have been described above, and should be scaled to the relative importance of through traffic, local traffic, and direct access to land uses, as defined collaboratively by NCDOT and local representatives.

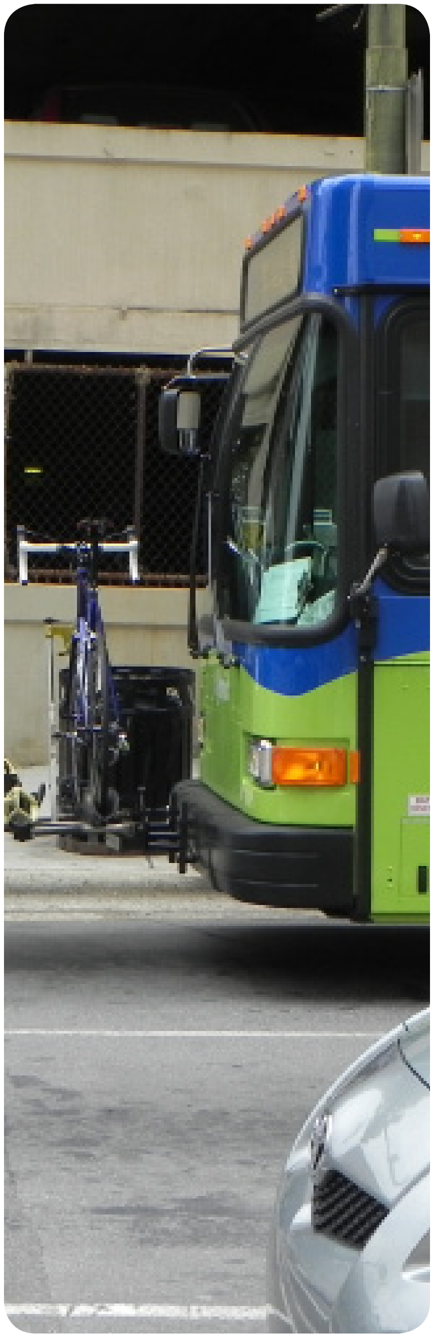
The information provided in this chapter is intended to provide guidance for NCDOT and communities to collaboratively evaluate the many tradeoffs associated with intersection design and to support the objective of providing safe, convenient and comfortable travel for all users. Planners and designers should keep in mind that, although this guidance focuses on pedestrians and bicyclists, designing complete intersections is all-inclusive and considers the context as well as the needs of all users, including bicyclists, pedestrians, transit users/operators, motorists and individuals of all ages and abilities.

6: Designing for Transit in Complete Streets

Transit services, both bus and rail, are an important part of the transportation network. Complete streets can provide opportunities to increase transit usage by ensuring good access and connections for pedestrians and bicyclists on either end of the transit trip, by providing adequate amenities at a transit stop, and by designing streets that accommodate transit vehicles and transit users safely. Nearly every transit trip begins and ends as a walking trip, and facilities to support bicycle and pedestrian access are important in creating a comprehensive transportation network.

Complete street concepts and initiatives ensure safe and convenient access to public transit for all users. As described in Chapter 3, many characteristics of a transit system improve the quality of service for transit users. For example:

- A transit system with a reliable schedule can attract additional riders and increase demand for more frequent service.
- Likewise, the frequency of transit service greatly affects the quality of service.
- Signal priority for transit vehicles improves reliability in many areas (cities that have initiated priority signal systems for transit have seen significant travel time decreases and large ridership increases in the past several years).
- Bus shelters provide a place protected from the elements for transit users to wait for a transit vehicle.
- Lighting enhances the visibility and safety of a bus shelter and/or transit stop.
- Transit schedules provide information to transit users on bus routes, transfers, and timetables.
- Seating can improve the experience of waiting for a bus in places where there is not enough usage or demand to justify a complete bus shelter.
- A bus stop post and sign can identify the route serving a stop and provide additional information on the route and schedule.



Throughout the complete streets planning and design process, transit agencies should be included as collaborative participants in the discussion and decision making process. Current transit services and future transit plans of the transit agencies are important considerations in planning complete street projects. Involvement of the local transit service provider is important in decisions regarding the design of the street, particularly in decisions regarding transit stop access and locations, stop spacing, and transit stop elements. The following sections describe and further discuss transit and quality of service.

Elements of Designing Complete Streets for Transit

As with other elements of complete streets, there is a lot to consider in designing for transit and transit stops.   Traffic operations and passenger accessibility, passenger safety and security, traffic and pedestrian conflicts are just some of the issues that need to be considered in planning for and locating transit stops within the complete street design.

In addition to access and location of transit stations, spacing distance between stations, and the level of personal comfort and safety of the transit stop, the context should be considered when designing streets to include transit. In all environments, the goal should be to make the transit stop as safe and accessible as possible for the transit passenger and for the transit driver without compromising safety for other vehicles and activities within and around the transit stop or station.

Access to Transit

Connections to transit stops are an essential component in the success of transit networks and for the complete street network. Transit quality of service depends in part upon pedestrian quality of service. Circulation of pedestrians and bicyclists adjacent to transit stations and stops is important in ensuring safe and convenient access.   Many of the same elements in pedestrian and bicycle quality of service are also important for transit quality of service:

- Sidewalks and pedestrian crossings should connect the stop with the surrounding area;
- Utility poles, fire hydrants, signage and other potential conflicts should be avoided in the direct access way to the transit stop;
- Pedestrian crossings should be located in close proximity to transit stops;

- Sidewalks should be kept clear of debris and other obstructions;
- Wayfinding and signage should be considered;
- Bicycle storage should be provided at stops (particularly for those transit systems that are not equipped with bicycle racks on buses); and
- A flat, stable landing pad should be provided at the stop for ease boarding by passengers of all abilities.

Transit Stop Spacing

Bus stop spacing is another important element to consider in the design of complete streets. While closely spaced stops are more convenient for pedestrian access, stops farther apart mean less frequent stops and potentially faster service. These tradeoffs for transit users should be considered by the design team in the planning process. Transit stop spacing also depends on the street type, for example:

- Main streets and avenues should have more frequent stop spacing and should be located in-street, typically at intersections but in some cases, mid-block stops are appropriate;
- Boulevards will likely have fewer stops than main streets and avenues, but usually more than parkways; and
- Parkways are more likely to have infrequent/distant spacing, and off-street stops are typical.

While some local jurisdictions may have their own standards for bus stop spacing, the Transportation Research Board, Transit Cooperative Research Program Report 10 (TCRP Report 10) provides guidance for bus stop spacing in different land use contexts (Table 3).

Table 3: Recommended Bus Stop Spacing (Source: TCRP Report 10)

Environment	Spacing Range	Typical Spacing
Central Core Areas of CBDs	300 – 1,000 feet	600 feet
Urban Areas	500 – 1,200 feet	750 feet
Suburban Areas	600 – 2,500 feet	1,000 feet
Rural Areas	650 – 2,640 feet	1,250 feet

Transit Stop Placement

Pedestrians typically want to take the shortest path to their destination; the challenge for the design input team is to designate and design the pedestrian trip to the transit stop to be as safe (and as short) as possible. Transit facilities should be placed in areas with good pedestrian access and as close to area trip generators as possible. When street projects are undertaken, the current stop placements, if any, should be assessed and provided at (or moved to) optimal locations. Elements the design input team should consider in the placement of transit stops include:

- The location of major trip generators;
- Traffic volume, through and turning vehicle and bicycle movements;
- Potential impacts on intersection operations;
- Potential conflicts between buses, other vehicles, bicyclists and pedestrians;
- Intersecting transit routes;
- Physical roadside constraints like utility poles, trees and driveways;

- Ability to restrict parking and/or truck delivery zones if needed;
- Traffic control devices;
- Available space for signage, shelters, benches, if applicable; and
- Accessibility for users of all capabilities.

Transit Stop Locations

Bus stops are placed in one of three locations (Figure 14: Typical Transit Stop Locations): near-side (located immediately before an intersection); far-side (located immediately after an intersection); and mid-block (located between intersections). Each of these locations offers advantages and disadvantages to vehicle drivers and pedestrians. Regardless of the location, the transit stop can affect the function of the street for motorists and transit users. However, the final decision on specific bus stop locations is dependent on ease of operation, transfer situations, space availability and amount of traffic.

The preferred location of a transit stop at a signalized intersection is the far side of the intersection. Locating the stop on the far-side minimizes the conflicts between turning vehicles, weaving of vehicles behind the transit vehicle, and improves sight distance and visibility for the transit driver, motor vehicles, bicyclists and pedestrians.

In circumstances in which a far side transit stop would be unsafe, or at busy transit stops with multiple bus arrivals at a time, a near-side transit stop may be appropriate. Near-side transit stops at signalized intersections will likely conflict with transit signal prioritization in urban contexts.

There may also be cases where a mid-block transit stop is the preferred location, such as when an activity generator is located in the middle of a longer block. For these types of mid-block stops, walking desire lines should be noted to identify likely pedestrian paths and appropriate mid-block crossings should be provided.

In determining where to locate transit stops, the design team should also consider the following:

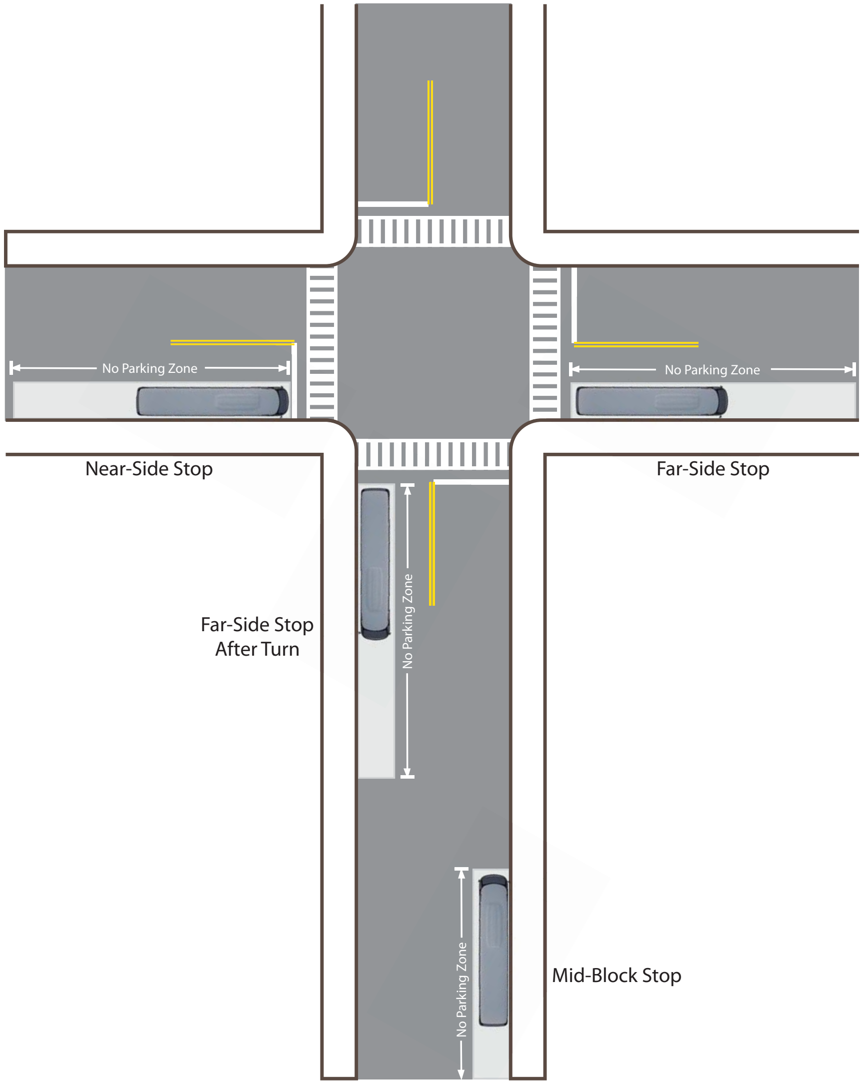
- Far-side of signalized intersections are the preferred locations for transit stops on main streets, avenues and boulevards;
- Near-side stops at unsignalized intersections under certain circumstances may be appropriate;
- Mid-block stop locations may be considered for avenues and boulevards, particularly if there are longer blocks or greater distances between signalized intersections. Include mid-block crossings appropriate to the context at these locations; and
- Off-street stops, or in some cases bus pull outs, are typical for parkways due to the speeds and context. Pullouts may be considered on boulevards, but are typically not preferred on avenues and main streets unless the stop is a staging point.

In all cases, priority should be given to the location that is most convenient and safe for transit passengers. Additionally, for stops at or near intersections (or located mid-block) along main streets and some avenues, curb extensions should be considered.

Marked crossings, curb ramps, pedestrian refuges, lighting, signage and other quality of service elements for transit users, pedestrians and bicyclists should also be considered.

Curb extensions, also known as bus bulbs or nubs, solve the problem of locating transit patron elements in dense urban environments with considerable pedestrian traffic. A curb extension essentially extends the sidewalk through the parking lane. Curb extensions create additional space at a bus stop for shelters, benches, and other transit patron improvements and provide enough space for patrons to comfortably board and depart from the bus away from nearby general pedestrian traffic. Curb extensions also shorten the pedestrian walking distance across a street, which reduces pedestrian exposure to on-street vehicles. Special consideration should be made for bicycle lanes where curb extensions are present to ensure bicyclists are not forced to merge into traffic without warning.

Figure 14: Transit Stop Locations



Transit Stop Elements

A well-designed transit stop is clearly defined, does not interfere with sidewalk travel, and provides a visual cue about where to wait for a transit vehicle. Transit stops can include a number of elements: shelters, benches, lighting, trash receptacles, and route or schedule information. Because transit stops should reflect the context, the necessary and optional elements of transit stops will vary according to the surrounding land use context, connections with other transportation networks, and frequency of transit service.

Frequently spaced street-side stops are typical in urban and suburban areas. In addition, transit stops in these areas can include hub stations (locations with bus-to-bus transfers), retail centers (a bus stop in a parking lot or access road to serve a major activity center), entrances to residential and commercial developments, and/or at park & ride lots (a bus stop in a parking lot to facilitate car-to-bus transfers). In urban/suburban areas well marked stations with transit signage and comfortable and safe waiting areas are important for the riders. Therefore, the following guidance should be applied when designing stops:

- Provide adequate space for appropriate transit stop types, intermodal transfer centers (a bus stop at a train station, for example), and hub stations (a transit stop that can accommodate bus-to-bus transfers).
- Clearly mark all bus stops.
- Site bus stops to provide passenger protection from passing traffic and facilitate safe parking lot and street pedestrian crossings.
- Provide shelters, benches, trash cans, and lighting where possible.
- Consider/provide bicycle storage at transit stops, particularly for those transit systems that are not equipped with bicycle racks on buses.
- Provide for a flat, stable landing pad that allows riders of all abilities to safely access the transit vehicle.

- Consider how to provide route schedules, transit maps, and possibly fare kiosks.
- Electronic transit arrival displays may be appropriate for stations and hubs.
- In hub stations, electronic bus arrival displays may be appropriate to facilitate bus-to-bus transfers.
- Where intermodal transfers occur, provide way finding signage to connecting bus routes and other modes of transit.

Rural transit stops include those in park & ride lots and those on roadways. Rural transit stops typically have less frequent transit service, so facilities should comfortably accommodate passengers who may face longer wait times than passengers at suburban and urban transit stops. Therefore:

- Stops should always include transit signage, and shelters and lighting are preferable.
- Stops should have clear information, including route schedules and transit maps, and should provide passenger protection from passing traffic.
- Rural bus stops should be sited close to pedestrian facilities such as crosswalks and sidewalks, with safe connections to trip generators.
- A rural transit stop might consist only of a waiting area (typically a pad) and clearly marked transit station sign.
- Bicycle storage at transit stops is also an important element, particularly for those transit systems that are not equipped with bicycle racks on buses.

In summary, the elements of transit service listed in this chapter are meant to provide guidance on transit considerations when designing complete streets. North Carolina includes both urban areas with bus and rail transit and rural areas with very limited bus transit service, but safely accommodating transit is an important element of complete streets no matter what the context. Safe and comfortable transfers, be it from walking to a bus stop, or taking transit to a personal vehicle, are a vital element in a complete streets network. North Carolina's streets should not only aim to accommodate transit vehicles, but to encourage transit ridership through highly functional and attractive street-side transit stops and easy connections to the rest of the complete streets network.

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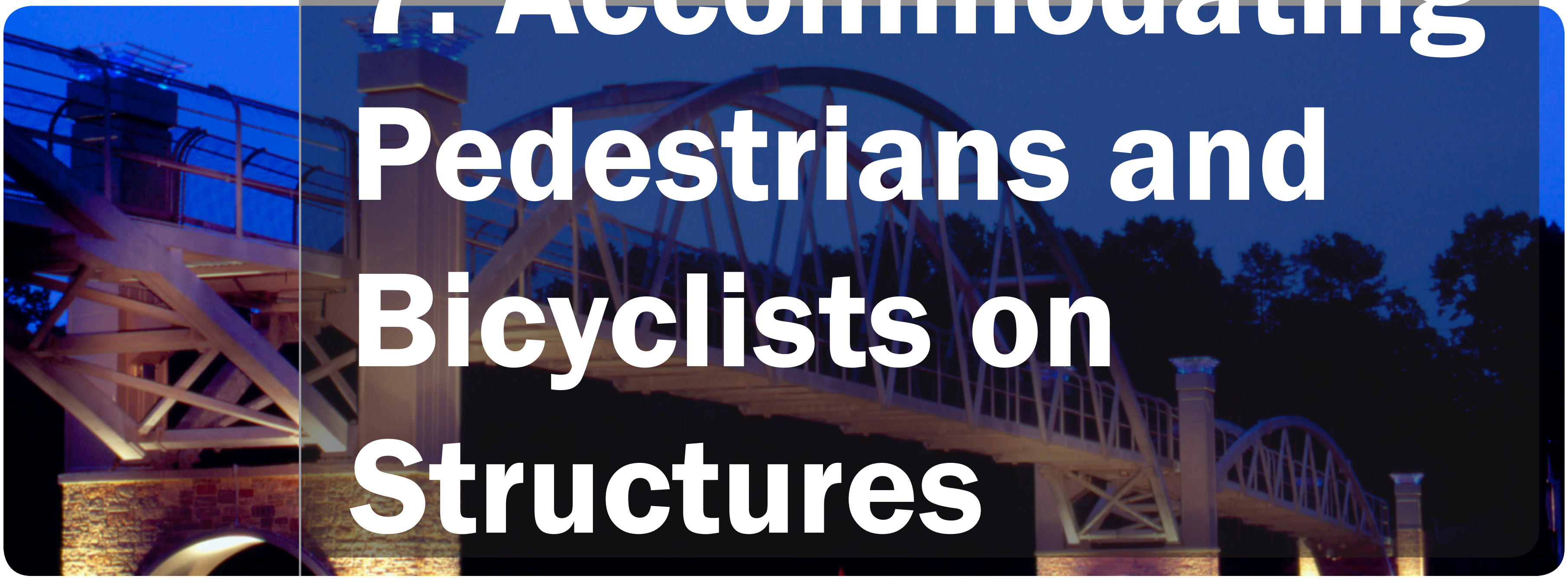
7: Accommodating Pedestrians and Bicyclists on Structures



Sidewalks and Bicycle Lanes for Highway Bridges and Underpasses

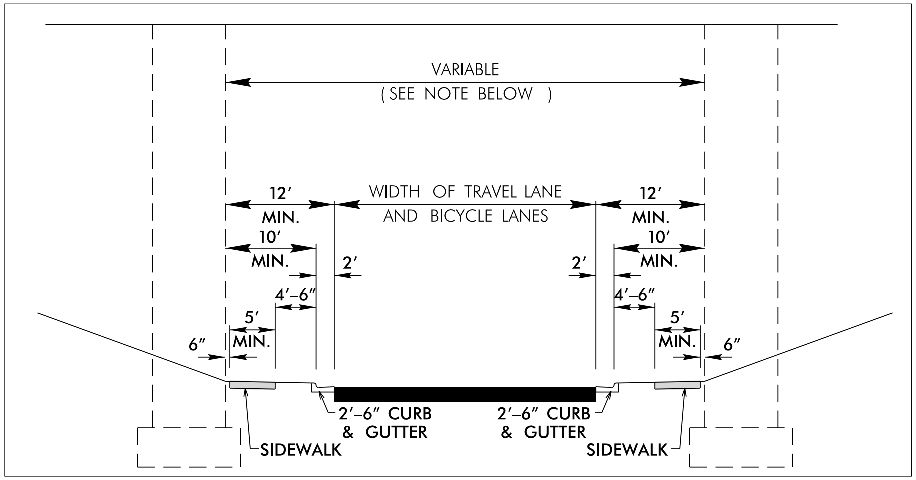
Structures like bridges and tunnels can provide key links in any type of walking facility or bicycle transportation system. Because they are unlikely to be replaced very often and because they are often the only network connections, it is critical to design bridges, tunnels and underpasses to support bicycle and pedestrian travel, particularly in urban and suburban areas. The determination of how to provide these accommodations should be made early in the planning and design process to minimize re-design and potential delay in the project schedule. Local governments and the public should be involved early in project development so appropriate decisions can be made and included in the overall planning and design.

Sidewalks, bicycle lanes, and shared vehicle zones, along and under bridges are more difficult to design than sidewalks and bicycle lanes along streets because the overall space is at a premium, and the edges of the bicycle lanes and sidewalk can be limited by travelway width, abutment wall or railing. However, they are often the only connection for pedestrians and bicyclists, so they should be designed to support each user.

On newly constructed bridges, the minimum clear street width (vehicle zone/shared vehicle zone, bicycle lane) and sidewalk width should be the same as the approach street cross-section and sidewalk width. For a street cross-section with 5 feet of sidewalk approaching the bridge the sidewalk on the bridge will be 5 feet, 6 inches with a bridge rail height of 42 inches.

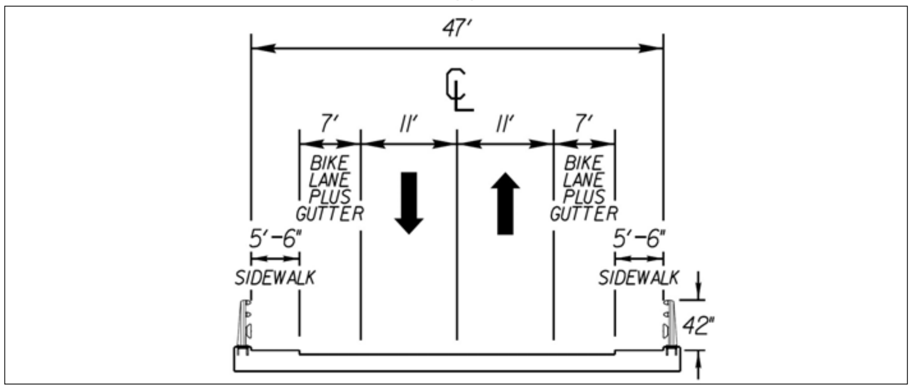
In urban and suburban contexts, where approach streets include curb and gutter, sample bridge typicals shown in Figures 17, 18, 19 and 20 can be used. Figure 17 demonstrates the requirements for a street with bike lanes, curb and gutter and sidewalks going under a bridge. The sidewalk under the bridge on Figure 20 can be increased to 9 foot 6 inches to minimize the maintenance of the 4 foot 6 inch vegetated strip behind the curb. In urban and suburban contexts, where curb and gutter is not present on the approach street, bridge shoulders are typically widened to 12 foot 6 inches or 9 foot 6 inches for the accommodation of either future bicycle lanes or wide outside lanes and sidewalks. A bridge rail height of 54 inches is used on bridges that are set up for future accommodations of pedestrians and bicyclists.

Figure 17: Sample Street Cross-Section Under an Overhead Bridge



Note: Any bridge with special design requirements such as long span lengths, locations with special significance, such as proximity to historic sites or public parks, bridge lengths greater than 200 feet or other special features, will be designed on an individual basis.

Figure 18: Sample Bridge Typical, 2-Lane Street Cross-section with Bicycle Lanes, Sidewalks and Curb and Gutter Approaches



In rural areas, other options are used for accommodating pedestrians and bicyclists on bridges. For rural roads with existing or planned bicycle routes or areas with high pedestrian and bicycle activity, a minimum 4 foot wide shoulder and 54 inch high bridge rail are provided in addition to the width of the vehicle zone. The pedestrians and bicyclists will use the edge of the vehicle zone (or bicyclists may choose to use any part of the vehicle zone/travel way) and/or the shoulder for travel. For rural roads where all users share the same space, traditional bridge widths, shoulder widths (as listed in the current edition of the NCDOT Bridge Policy) and bridge rail heights of 32 – 42 inches are used.

Guardrail on Streets Approaching Bridges

Guardrails on bridge approaches should be designed with the needs of pedestrians and bicyclists in mind. Where sidewalk is provided, the placement of guardrail should be behind the sidewalk and connected to the face of the bridge rail. As a general rule, the guardrail should be placed as far away from the vehicle zone as conditions permit. For streets with shoulders, the minimum offset from the edge of the vehicle zone to the face of the guardrail is 4 feet.

Bridge Decks

On all bridge decks, care should be taken to ensure that smooth bicycle safe expansion joints are used. In cases where expansion joints are uneven, covers should be considered. For lift span bridges (or other bridge types) with grate type decking, accommodations for providing smooth surfaces for bicyclist and pedestrians should be considered, particularly when context suggests this is a significant connection.

Greenways and Multi-Use Path Structures

When a multi-use path meets a barrier – such as a railroad, river or an interstate highway – some type of grade-separated crossing should be considered to provide connectivity. This crossing may take the form of a bridge, an underpass or a facility on a highway bridge. For a multi-use path constructed as part of a street bridge, the minimum clear width should be the same as the approach paved path width (usually 10 feet). The minimum width of a separate greenway or multi-use path bridge should be the same width as the approach path (usually 10 feet) plus an additional 2 foot wide clear area to provide an offset to the railing or barrier. For example, a 10 foot wide path requires a 14 foot wide bridge. The end of railings should be flared away from the adjacent path to minimize the danger of bicyclists running into them. On all bridge decks, special care should be taken to ensure that bicycle safe expansion joints are used. Railing, fences or barriers on both sides of a greenway or multi-use path bridge should be a minimum of 42 inches high. For railings higher than this, smooth rub rails should be attached to the barrier at the handlebar height of 42 inches.

In some cases, an underpass will be the suggested as a means to carry a greenway or multi-use path under a street corridor. The minimal underpass cross-section has a 14 feet (horizontal) by 10 feet (vertical) opening. However, the length of the underpass, lighting, grades, approaching curve design, visibility and maintenance should be carefully considered when using this type of treatment. This treatment may require drainage if the bottom of the underpass is lower than the surrounding land (terrain). Open designs that allow daylight or lighting from the outside to shine into the walking and riding area create a more comfortable and functional underpass.

Access by emergency, patrol and maintenance vehicles should be considered in establishing the design clearances of structures for multi-use paths. Also, service vehicles using the path may dictate the vertical clearance required. Typically, a vertical clearance of 10 feet is sufficient.

Figure 19: Sample Bridge Typical, 4-Lane Cross-section - Median Divided, Bicycle Lanes and Sidewalks

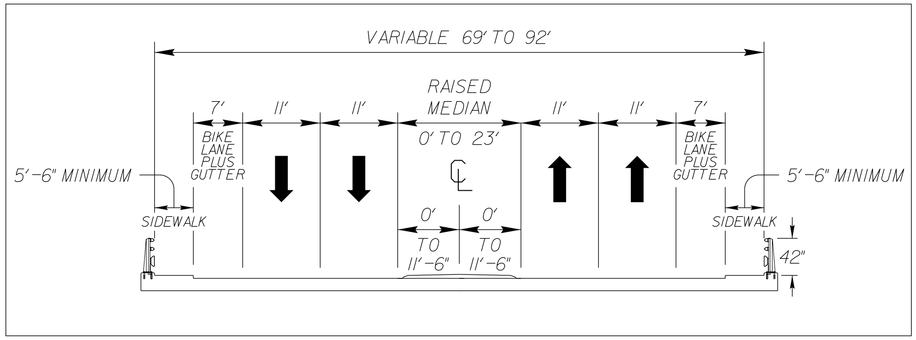
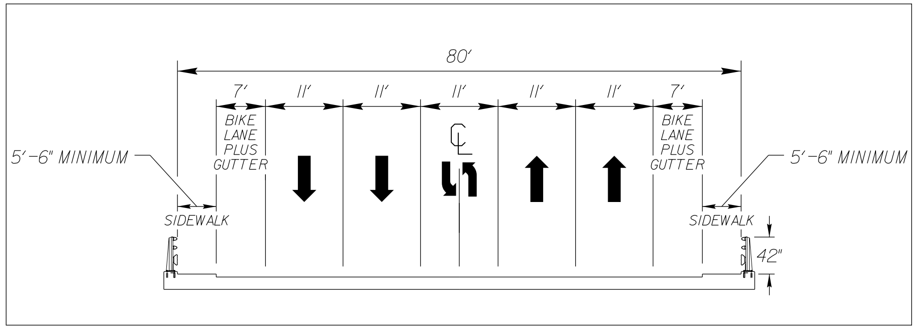


Figure 20: Sample Bridge Typical, 5-Lane Street Cross-section with Center Turn Lane, Bicycle Lanes, Sidewalks and Curb and Gutter



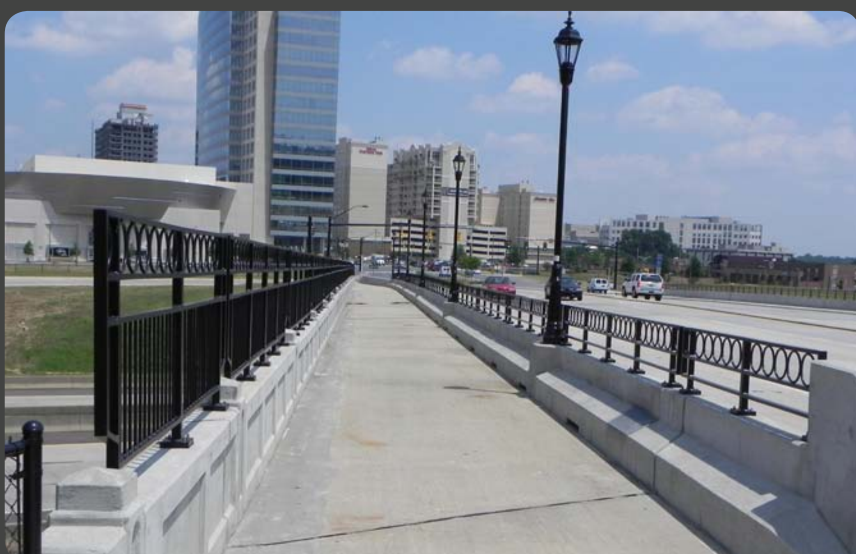
Multi-Use Path Under Street

Special Considerations

While it is not the intent of these guidelines to address requests for aesthetic bridge treatments, such as decorative lighting or bridge rails, such accommodations can be considered. Street type lights installed on bridges are intended to light the street and provide adequate lighting to vehicles and pedestrians. However in some cases, decorative post-top lighting or pedestrian lighting can be installed for either aesthetic purposes or to provide additional functionality. Post-top lights and street lights are mounted on pedestals on top of the bridge rail or on outriggers behind the bridge rail. For shorter bridges, where there is intent to light the street and sidewalk on the bridge, street lights can be installed on each end of the bridge, therefore not requiring any modifications to the bridge.

These considerations should be discussed early in the planning stages of project development to minimize re-design and potential delays to the project schedule. All lighting applications shall meet the latest version of the AASHTO Roadway Lighting Design Guide.

Multi-Use Path on Bridge

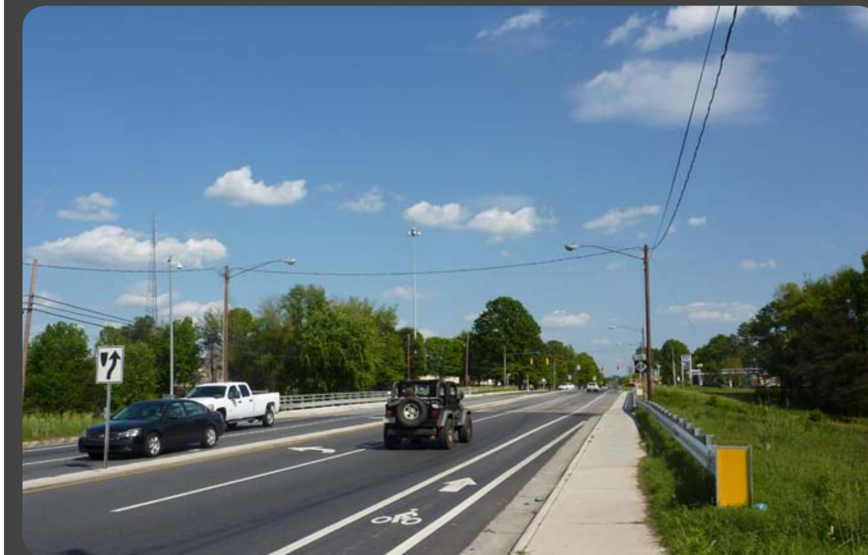


Multi-Use Path Under Street

Conclusions

There are many issues to consider as part of bridge, tunnel and underpass designs in regard to complete streets. Since it is important to create pedestrian and bicyclist connectivity and networks in urban and suburban areas, NCDOT will consider the needs of pedestrians and bicyclists on or under bridges as they are constructed, replaced or modified by maintenance. The determination of how to provide these accommodations should be made early in the planning and design processes. Local governments and the public should be involved early in the project development, so appropriate decisions can be made and included in the overall planning and design. Each bridge or underpass should safely accommodate the expected users and these considerations should incorporate future needs.

Bridge with Bike Lanes and Sidewalk



Multi-Use Path on Bridge

Crossing Underneath Overhead Bridges

8: Implementing Complete Streets in Maintenance & Operations

The State Transportation Improvement Plan (STIP) is the primary method for implementing complete street projects in North Carolina. However, the total dollars spent of the STIP is just a portion of NCDOT's overall budget. STIP projects cover only a small percentage of the 80,000-plus mile network of streets throughout North Carolina for which NCDOT is responsible for providing maintenance. As a result, maintenance and operations projects provide substantial opportunity to integrate complete streets. This Chapter describes keys to successful maintenance and operation projects and considerations for different project types.

Maintenance and operations projects typically have a defined scope and purpose; maintenance projects focus on items of work such as resurfacing and restriping, and operations projects focus on spot improvements and safety enhancements in specific geographic areas. However, there are ample opportunities for NCDOT and local governments to implement complete streets within both maintenance and operations projects. These changes may be on a more incremental basis, but can help meet larger complete streets goals.

Complete streets should not be considered as "additional" elements in maintenance and operations projects. Instead, they should be considered part of the project development process and incorporated early-on through close coordination between NCDOT (District and/or Maintenance staff), local municipalities, the MPO/RPO and private development community. The key is to view maintenance and operations projects as opportunities to integrate complete streets elements rather than to simply reconstruct the same roadway configuration.

Complete Streets in Maintenance Projects

Maintenance projects are a key component of the NCDOT transportation program. Hundreds of miles of roadway are resurfaced and restriped as part of maintenance projects each year. As such, they offer the opportunity to integrate complete streets throughout the state. Because maintenance projects are often restricted in terms of budget, right-of-way constraints, and the need to meet the schedule for annual repairs, coordination between agencies and municipalities should occur early in the project development process.

Design Elements & Features of Maintenance Projects

In general, most standard maintenance projects are resurfacing projects. These projects include the repair and preservation of the roadway pavement structure as well as upgrading pavement markings and signing to meet safety requirements. Opportunities to implement complete streets elements within standard maintenance or resurfacing projects include:

- Pavement restriping:
    - Reducing lane widths to provide a full bike lane;
    - Striping for shoulder/edge lines on streets with curb and gutter (may be in conjunction with a lane conversion or as a standalone maintenance project);
    - Striping for wide outside lanes;
    - Providing shared lane markings; and
    - Reallocating space on two-lane streets with inconsistent cross-sections to accommodate bicycle facilities (these reallocations do not necessarily take away vehicular travel lanes, and may add turn lanes).
- Street conversions or road diets by restriping and reassigning lanes;
- Widen or pave shoulder to provide striped bike lane, wider outside lane, or paved shoulder (note that shoulder widening can reduce future maintenance costs by protecting the roadway edge and provide safety benefits for bicyclists and motorists); and
- In addition, when completing these types of projects, curb ramp upgrades/additions should be provided as part of ADA compliance.

Process for Implementing Complete Streets Components in Maintenance Projects

A key component of implementing complete streets into maintenance projects is timely communication and coordination with local jurisdictions. Typically, each year a resurfacing schedule is developed down to the county level within each NCDOT division. Some counties even develop a tentative 3-year resurfacing list. Once these projects are identified, NCDOT and local agencies should meet to discuss the upcoming annual maintenance schedule and identify complete streets opportunities. It is important to meet early in the planning process to identify complete streets opportunities, find creative strategies and partnerships to implement the full improvements and assign roles and responsibilities. Open communication and subsequent follow-up are critical to successful implementation. The following is a potential process to review resurfacing projects for complete street improvements:

- NCDOT shares resurfacing list with local government as soon as possible;
- Local government reviews resurfacing list for potential revisions to striping, lane assignments, shoulder widening, etc;
- Local government or MPO/RPO as appropriate provides recommendations to NCDOT with supporting data, signal and pavement marking plans (if necessary);
- NCDOT reviews recommendations; then
- NCDOT and local government collaboratively develops a plan for implementation.

Since resurfacing schedules are developed annually and project priorities shift due to current roadway conditions, the project development process is often compressed. This highlights the need for earlier and more intensive coordination between NCDOT and the local government to ensure that maintenance projects realize complete streets opportunities.

Complete Streets in Operations Projects

Operations projects provide localized spot improvements and safety enhancements on specific segments of the existing roadway network, and provide a key opportunity to integrate complete streets elements incrementally. Operations projects are implemented throughout the state by NCDOT as well as local municipalities and agencies.

Design Elements & Features of Operations Projects

Operation projects can offer opportunities to include complete street elements as part of intersection improvements, traffic signal installation/upgrades, pavement restriping, and thoroughfare widening.

Specific opportunities to provide complete street elements for these types of projects include:

- Intersection projects that consist of providing an additional turn lane:
  - Restripe or slightly widen shoulder for bike lanes through intersections;
  - Install sidewalks for pedestrians (both at intersections and to connect different approaches);

- Provide crosswalks;
- Add pedestrian refuges or islands;
- Install curb ramp upgrades/additions to comply with ADA; and/or
- Incorporate other complete street amenities or technologies.

- Traffic signal installation/upgrades:
  - Install pedestrian signal heads and countdown equipment;
  - Retime signals to allow for pedestrian phases and/or improve pedestrian QOS;
  - Incorporate accessible pedestrian crossing signals;
  - Install curb ramp upgrades/additions to comply with ADA requirements; and/or
  - Incorporate other complete street amenities or technologies.
- Pavement restriping (similar to maintenance projects):
  - Convert streets or use road diets to provide a full bike lane;
  - Reduce lane widths to provide a full bike lane;
  - Stripe pavement for a shoulder/edge lines on streets with curb and gutter (may be in conjunction with a street conversion or as a standalone maintenance project);
  - Stripe pavement for wide outside lanes; and/or
  - Provide shared-lane markings.
- Thoroughfare widening:
  - Widen street for striped bike lane;
  - Widen/pave shoulders to provide wider outside lane, paved shoulder, or striped bike lane;
  - Construct sidewalks; and/or
  - Incorporate other complete street amenities or technologies.

Process for Implementing Complete Streets Components in Operations Projects

As with maintenance projects, a key component of implementing complete streets into operations projects is timely communication and coordination between all agencies involved. When an operations project is being defined, NCDOT and other agencies should meet to discuss the project requirements, timing, and investigate opportunities for implementing complete streets elements.

Given the typical smaller focus of many operational projects (as opposed to more expensive corridor widening or STIP projects), timing of the review and coordination between NCDOT and the local government can often be compressed. Open communication and subsequent follow-up are critical to successful implementation, especially with short schedules.

In terms of implementation, it is important to consider that NCDOT spot improvement and safety projects must match the requirements of the specific program (such as directly improving safety at an intersection). Safety is a multi-modal concept and can offer significant opportunities to incrementally improve the complete street network. These project types can be implemented independently or in combination with standard maintenance projects. The benefit to spot improvement and spot safety projects is the flexibility to include additional features beyond resurfacing and restriping. The same applies for municipal projects, which provide the opportunity for additional features beyond pavement overlays and marking revisions. In some cases, they can involve the implementation of full complete streets type sections with separated sidewalks and amenities.

Privately funded street improvement projects can encompass both new roadways and improvements to existing roadways. In many cases, private developers may have incentives for integrating complete streets into their development. In any case, developers need a set of complete street standards and minimum requirements. The NCDOT and local municipality need to communicate these as part of the planning and development review process. Continuous coordination between entities is needed over the life of a project to ensure that the shared goals for the roadway are met.

Lessons Learned and Technical Recommendations

As shown in many projects throughout North Carolina, the implementation of complete streets on existing streets can be successfully implemented as part of maintenance and operations projects. Several technical lessons have been learned based on project experience. The following recommendations have been developed for NCDOT maintenance and operations staff:

- Even the "easy" street conversions require appropriate analysis. Allow plenty of time for:
    - Traffic volume forecasting, traffic analysis, evaluation and design;
    - Public involvement and/or notification (especially if repaving and marking will impact parking for existing businesses); and
    - Pavement marking plan preparation.
- Street conversion for high volume facilities will require more time for each phase.
- Complete pavement marking plans well in advance of resurfacing:
    - Striping plans should be required since in very few projects does a simple typical section apply in all locations;
    - Pavement marking contractor needs to order pre-made legends and prepare for the new pavement marking plan. Conversions, especially those with an odd number of travel lanes, may be more difficult to lay out in the field and may require more experienced staff; and
    - Coordinate conversions with signal design. Signal timers, designers, and field crews (ground and aerial) need sufficient notice to prepare the plans, adjust detection and signal heads, and alert signal timing staff to observe and modify timing if necessary.
- Establish traffic control for conversions:
    - Provide for or consider additional traffic control during the pavement marking process to "transition" motorists into the new cross-section; and
    - Identify whether restriping would require revisions to the existing signal system.
- Specify lane widths:
    - Lane width and striping need to be coordinated with the NCDOT contract administration staff so that the pavement joint will line up with the proposed lane lines; and
    - Street cross-section widths can vary along the length of the conversion; therefore, instructions such as, "stripe a 4' wide bike lane," frequently do not produce the intended final cross-section. Consider which lanes should be held to a consistent width and where additional width of pavement should be absorbed to maintain the most consistent looking cross-section possible. For example:
        - 4 lanes to 3 lanes with bike lanes:
            - Small width variations may best be absorbed in the bike lane/shoulder, provided the bike lane maintains a minimum width, otherwise vary the width of the two-way left turn lane (TWLTL); and
            - Large variations of width should be absorbed in the TWLTL, so that the bike lane is not mistaken for a parking bay or travel lane.
        - 4 lanes to 2 lanes with bike lanes:
            - Measure from the center and define the travel lane width. Extra space may be absorbed in the bike lanes.
        - 4 lanes to 2 lanes with on-street parking on one side;
            - Absorb additional space in parking and bike lane adjacent to curb.

- Avoid paving over gutter pans to retrofit complete streets features, as any perceived benefit will likely be offset by future maintenance costs and difficulties, as well as impeded drainage.
- Take care (and follow up throughout process) that upgraded or added accessible ramps are placed in the correct location, especially where one ramp is being replaced with two, and ensure that the new ramps are oriented to the crosswalk. This is not always a "template"-type design item due to variable curb return radii, intersection configuration, angles, etc.
- In some cases, it may not be possible to maintain a constant typical section throughout the length of the project due to constraints related to right of way, topography, or physical features of the road. In these situations, some allowances should be discussed and considered as part of the planning process.

Project Examples

The following illustrates several examples of North Carolina projects that successfully applied complete streets strategies as part of maintenance projects. Additional examples of projects in various contexts are included in the Appendix.

Bicycle Lanes and Road Diet

Project Location: Wrightsville Avenue, Wilmington

Project Type: Resurfacing

Description:

As part of a resurfacing project on Wrightsville Avenue between Military Cutoff Road and Eastwood Road, the pavement marking was revised to include bicycle lanes. In coordination with the local NCDOT Division office, the City of Wilmington provided a revised pavement marking plan for these improvements. This coordinated effort allowed the installation of bicycle lanes to be incorporated into the final design. Note that due to right-of-way and construction constraints, there are some areas along the project where bike lanes were not installed. In these areas, "Share the Road" signing was used.

Street Conversion with New Bicycle Lanes

Project Location: Morganton

Project Type: Resurfacing and restriping

Description:

Series of three-lane one-way pairs (two through and exclusive right turn) were converted to two lanes (through, shared through-right) and a bike lane. Restriping was done as part of the resurfacing project and was accomplished within the existing curb and gutter.

Bicycle Lane

Project Location: Erwin Road, Durham

Project Type: Resurfacing

Description:

The City of Durham and NCDOT worked together to reduce the existing five-lane roadway section to three-lanes with bicycle lanes completed as part of a resurfacing project.

Reduce Lane Width to Add Bicycle Lanes

Project Location: Spring Forest Road, Raleigh
Project Type: Resurfacing

Description:

As part of a resurfacing project, lane widths were reduced to accommodate striped bicycle lanes. The existing five-lane section was maintained.

Spot Improvement

Project Location: Morganton

Project Type: Spot improvement

Description:

Island channelization was added at the intersection to provide pedestrian crossing and refuge area while reducing pedestrian exposure. A center median and pedestrian crosswalk were added.

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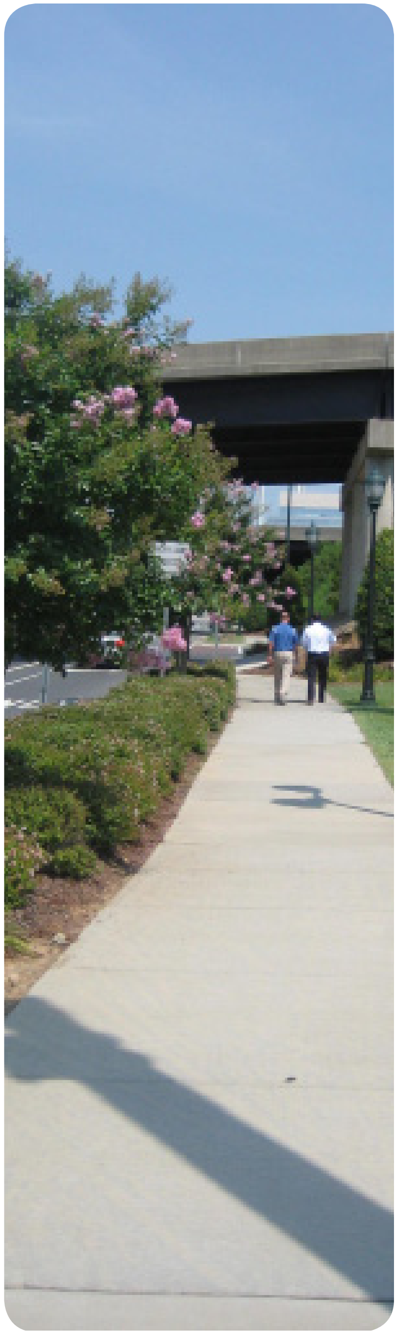
9: Street Elements: Design Considerations for Context-Based Solutions



When designing a street, the design input team designs for all users as well as the differing contexts that must be addressed. In doing so, there are various elements both street-side and within the street travel way (above and below grade) that should be considered in conjunction with the previous chapters related to the design of streets, structures and intersections. Some of these elements are related to safe mobility and accessibility with the complete street intent of expanding these concepts to all users. Other elements are focused on improving the quality of life, connectivity within and between communities and the integration of sustainable practices.

As described throughout this document, designing streets in the urban context will be different than in a rural context. The team should consider the context – area and street type – and competing demands within potentially limited right of way when addressing the broad range of elements included in this chapter.

This chapter includes principles and guidance on specific elements within a complete street. Street-side elements include: landscaping and street trees, stormwater facilities, slopes and retaining walls, curb and gutter, curb ramps, utilities, sight distance and accessibility. Street travel way elements include: drainage grates and utility covers, shoulder rumble strips, clear zone, and superelevation. The discussion of each element has been developed from the perspective of all users of the street, including motorists, pedestrians, bicyclists and transit users. Street side elements are equally important as the travel way elements in creating highly functional complete streets.

Street-Side Elements

The street-side is the part of a complete street that accommodates non-vehicular activity of the street and extends from the face of the buildings or edge of the development zone/private property zone to the face of the curb.   It is the place where people walk, interact and access transit and buildings, and engage in activities along the street. The design of elements within the street-side is no less important for creating complete streets than those elements comprising the travel way.   A broad range of technical engineering elements and design principles need to be considered in the design of the street-side including sidewalks, street trees, utilities and the needs of the pedestrians and transit users.

Landscaping and Street Trees

Landscaping and street trees are important elements of complete streets because they serve both aesthetic and functional purposes. Street trees and landscaping provide increased comfort, shade and aesthetics, making walking a viable transportation choice. Landscaping can aid in the comfort and safety of those who use or live adjacent to the street by providing a buffer between pedestrians and motor vehicles, and an element of traffic calming, which serves to enhance the pedestrian experience.   Street trees add to the aesthetics of an area, adding texture and color to a normally dull asphalt or concrete surface and contributing positively to the environment by providing shade and reduced stormwater run-off. In developing the plan and design of a new street, or the potential retrofit or rehabilitation of an existing street, the design input team should consider the benefits of landscaping such as street trees, shrubs, lawns, decorative rock, and other materials in providing a pleasing setting for drivers, pedestrians, bicyclists, and abutting land owners. Ultimately the landscaping plan should consider the street trees and plantings as a system, not individual plantings. This adds to the sense of connectivity within the area and also adds to the perception of a continual buffer between motor vehicle and pedestrian activities.

Street trees and landscaping provide a level of comfort from the separation of vehicular traffic and pedestrian activity, and are appropriate along local/subdivision streets, main streets, avenues and some boulevards. Depending upon the context, street trees and other landscaping should be placed in either a planting strip or an amenity zone. A planting strip is an unpaved area between the sidewalk and the curb. Planting strips can increase pedestrian safety and comfort by serving as a buffer between vehicles and pedestrians.   They can also absorb run off, enhancing storm water drainage and providing a natural way to water the plantings.

Similar to planting strips, an amenity zone is the area between the curb and sidewalk, but is hardscaped or inter-mixed with a planting strip. It is reserved for street furniture, utility poles, parking meters, signs, and street trees and landscaping. Appropriate planting techniques (tree grates, planters) and vegetation should be considered in the design of the amenity zone. Amenity zones are typically used in higher density or mixed-use areas with significant pedestrian activity, such as main streets.

The width of the planting strip and/or amenity zone should reflect and enhance the context. The recommended planting strip or amenity zone width for most street types is 6 to 8 feet, with 8 feet being the preferred width to provide for street trees. A wider planting strip of 10 to 12 feet is preferred for rural avenues if street trees are provided.

The considerations in the design of landscaping and street trees in the amenity zone or planting strip by the design input team should include:

- A tree canopy of large maturing street trees is desired on most street types. Medium maturing street trees are used when required by the context or constraints (for example underground utility lines, less planting space, high-speed streets).
- Ensure the street trees and plantings allow for visibility for drivers, pedestrians and bicyclists at driveways and intersections.
- Avoid placing street trees or landscaping rocks at driver or pedestrian decision points (for example island noses). Lower shrubs, landscaping or other vertical elements may be appropriate at some decision points.
- If full-time curbside parking is present, the landscaping should allow access to parked vehicles. Amenity zones may be designed to allow for hardscaped materials at parked vehicle access points or fencing around the tree bed to prevent stepping out into soft or grassy areas (although planting strips are allowed next to parking, depending on context).
- Off-set street trees to avoid locating them under utilities.
- Use medium maturing trees to avoid conflicts with utilities or other service wires. This avoids the potential of damage or "downing" during wind or ice events, and "tree topping" by the utility company which results in unattractive trees and can be detrimental to tree survival.
- Attempt to offset street trees and landscaping from underground utility lines, street lights, light standards, fire hydrants, water meters, or utility vaults to assure the growing root systems do not conflict with these utilities. Underground barriers known as "root barriers" should be considered to enclose roots when there is a potential for damage.

The complete streets planning and design process should recognize the benefits of street trees and landscaping as fully as the importance of other design requirements. Landscaping decisions should be a collaborative, incorporating the full design input team into the discussion, and should recognize that urban streets and their designs are different from rural roads.

Stormwater Facilities

As stated in Chapter 1, the NCDOT is committed to caring for the built and natural environment by promoting sustainable development practices. Toward that end, complete street projects should include sustainable drainage practices of which the goal is to preserve the existing hydrologic condition to the extent practicable and improve runoff characteristics and quality of the project site. Site drainage and stormwater management concepts need to be developed early during the project planning phase and remain consistent through design.

The NCDOT National Pollutant Discharge Elimination System (NPDES) permit requires the Department to have a post-construction stormwater program and policy to implement runoff treatment and control as well as retrofitting existing drainage systems in the areas where no stormwater management was provided. In the urban environment, stormwater management seeks to collect as much rain water as possible in the green zone of a complete street to store it, infiltrate it and/or use it as a resource. Stormwater management measures can be incorporated within other street features and traffic calming features such as vegetated/landscaped median and median islands, planting strips, urban street planters or tree boxes, curb extensions and bulb-outs.

Various types of treatment Best Management Practices (BMPs) for stormwater are continuing to be evaluated by NCDOT, including sand filters, bioretention, dry detention, filter strips, infiltration basins, wetlands, swales, catch basin inserts and Low Impact Development (LID) systems. The most economical and effective method for stormwater quality mitigation is to apply the BMPs at the greatest control of the pollutant. In most cases, for stormwater the point of greatest control is at the source of the pollutant, not at the end of the stormwater pipe. Stormwater treatment is often most cost-effective when integrated early in the planning and design process for the street.

Sustainable stormwater management practices should consider using green infrastructure as the preferred and priority treatment. It should also aim to capture water from a rain event as a resource and allow it to nourish street trees, roadside vegetation and soils. Sustainable street post-construction management practices include:

- Dry, Wet and Bio-Swales
- Infiltration trenches or devices
- Filtering (sand filters, organic filter, bioretention),
- Filter strips
- Porous pavement
- Stormwater Detention

The application and performance efficiency of these BMPs are documented in both the North Carolina Department of Transportation's "Stormwater Best Management Practices Toolbox" (NCDOT, March 2008) and North Carolina Department of Environment and Natural Resources (NCDENR)'s "Stormwater Best Management Practices Manual" (NCDENR, 2009).

Provision of Sidewalks: Slopes and Retaining Walls

In urban and suburban areas, the ability to provide sidewalks can be challenging when the terrain or limited right-of-way width restricts the lateral space available to build them. These locations are often where sidewalks are most needed, since walking on uneven terrain next to traffic is difficult at best. The design input team should consider the inclusion of slopes and retaining walls in the project as a means to provide the space for the sidewalks needed to accommodate all users. Providing retaining walls can make the difference between being able to construct a sidewalk or leaving a section of street "incomplete". Even with the advantage of providing retaining walls, there are design considerations to ensure that the sidewalk is functional for all users.

Designers should use the following general guidelines for projects that will incorporate retaining walls:

- For sidewalks constructed at the base of the retaining wall (between the wall and the street), be sure to include additional sidewalk width (space to remove the discomfort of having to walk immediately next to the wall or curb). The additional sidewalk width required might need to vary by the height of the wall, with higher walls requiring more space and very low walls requiring less. However, this distance should typically be at least one foot from the wall and, if the sidewalk must be back-of-curb due to space constraints, the design should include an additional foot on the street side. Generally, this means that a sidewalk next to a retaining wall should be at least 8 feet wide on avenues, boulevards, and parkways, not including the curb measurement.

- For sidewalks constructed near the top of retaining walls, provide the same additional sidewalk width as described above, and (depending on the height of the wall) include a handrail at the top of the retaining wall.

The determination of the material used in the retaining wall should fit within the context of the street, adding to the overall functionality of the pedestrian environment.

Curb and Gutter

Curb and gutter functions to intercept and convey water from the street to drainage structures. It can also allow for a narrower right-of-way and dress the edge of the traveled way – making it neat, uniform, and well-defined. Use of curb and gutter with a six inch or greater near-vertical face is effective in managing access by defining driveway locations. The six inch high curb is primarily a perceived barrier – it strongly discourages, but does not prevent, vehicles from leaving the traveled way. Curbs provide a clear demarcation between vehicle and pedestrian use areas, which in turn, provides a more pedestrian-friendly environment.

Curb and gutter is appropriate in urban areas and is neither common nor recommended on rural roadways with design or target speeds in excess of 45 mph. Most commonly, the width of the gutter pan is two feet, but some areas use a 1.5 feet gutter pan. This can affect the drainage characteristics of the street. To keep the water spread for a 1.5 feet gutter to the same width as that of a 2 feet gutter (with comparable cross-slope and longitudinal grade) would require that inlets be more closely spaced.

Curb Ramps

A curb ramp serves as the connection from the sidewalk to street level and allows a pedestrian or wheelchair user to move onto or off a sidewalk without difficulty. Curb ramps should be part of the initial construction of curbs, or whenever curbs are reconstructed including but not limited to, reconstruction for maintenance procedures/traffic operations, repair and/or utility changes. Curb ramps are also to be installed when streets with curb and gutter and sidewalk are resurfaced. Directional ramps are preferred over dual radial ramps.

The construction of curbs and ramps on each side of any street, where curbs and sidewalks are provided or planned and at other major points of pedestrian flow, shall meet the detailed design requirements for curb ramp standards, directional ramps, parallel ramps, shared landings and ramps in median and turn lane islands listed in Appendix D.

In general, the design input team should consider the following:

- Curb ramp placement and pedestrian crosswalk markings will vary, but must conform to traffic design standards and plans,
- Directional ramps are preferred over single radial ramps,
- A minimum of two curb ramps should typically be provided at each corner of an intersection,

- The walking surface should be stable, firm and a slip resistant surface, with detectable warning domes and appropriate landing dimensions and slopes,
- Curb ramps should be located and constructed relative to the crosswalk, and generally should align with the crossing. The ramps should allow for the crossing to occur in the safest, most visible portion of the corner.
- Place all pedestrian push button actuators and crossing signals as shown in the plans or as shown in the current edition of the MUTCD.

Utilities

When planning, designing and constructing sidewalks, planting strips, medians and other street features provided on complete streets, the design input team must allow for service access to underground and overhead utilities. Placement of utilities in the design of the street side should consider the following guidance:

- Longitudinal underground utility lines should be placed in a uniform alignment as close to the right of way line as practical, or within a planting strip or amenity zone.
- Consolidate utility poles and signage poles where possible. Remove redundant poles in retrofit situations.
- Whenever possible, utilities should be placed underground to preserve sidewalk capacity for pedestrians and allow for street trees and aesthetic treatments.
- When underground placement is not possible, consider alternative locations for utility poles including the back of the right of way or in the planting strip.

The land use context should always be considered in utility placement. In certain highly constrained locations it may be preferable to place utility poles in the planting strip rather than close to buildings. In no circumstance should poles be placed in the sidewalk and every attempt should be made to avoid or minimize conflicts with street trees. When placement of underground utilities is not practical, the following general considerations are applicable for establishing the location for above ground utilities:

- Utility poles and lines should be located as far as possible from the edge of the through lane, preferably near the right of way line.
- Longitudinal installations should be located on a uniform alignment, preferably near the right of way lines to preserve adequate space for planned street improvements. Longitudinal installations under the travelway are not desirable and should be avoided.
- To the extent feasible and practical, utility lines should cross the street perpendicular to the street alignment.
- The horizontal and vertical location of the utility lines within the street right of way limits should conform to the type of street and specific conditions for the street section involved. The location of the above ground utility facilities should be consistent with the clear zone guidance provided below, as well as the objective to minimize interference with street trees.

The following technical guidance should be considered by the design input team regarding the project's proposed right of way (ROW), Permanent Utility Easement (PUE), and utility pole placement along streets.

Main Streets, Avenues and Boulevards with Curb and Gutter:

Curb and Gutter Facilities: The proposed ROW should be set at a dimension that encompasses the green zone (planting strip) and sidewalk. For a curb and gutter facility posted at 25 mph, 35mph and 45 mph, the clear zone is defined as 8, 10 and 12 feet (see Figures 22 and 23), respectively. All new or relocated utility poles shall be placed at a clear zone offset or just outside the right of way and consequently beyond the clear zone values shown above. A PUE may be necessary beyond the proposed ROW to encompass the utility poles. A PUE is preferable along only one side of the street.

Figure 22: Recommended Green Zone and Sidewalk Zone for Streets with posted speeds of 25 and 35 mph (dimensions may vary based on context and available right of way and/or easements).

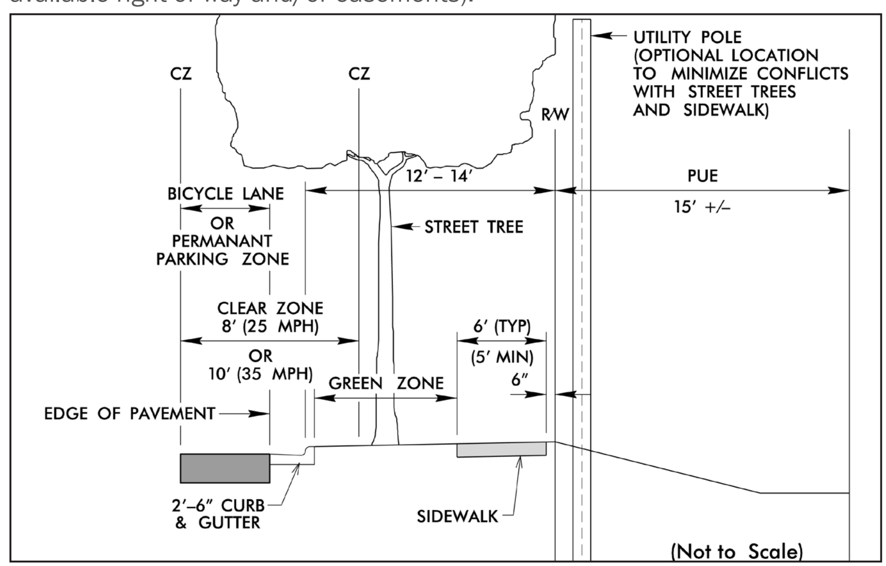
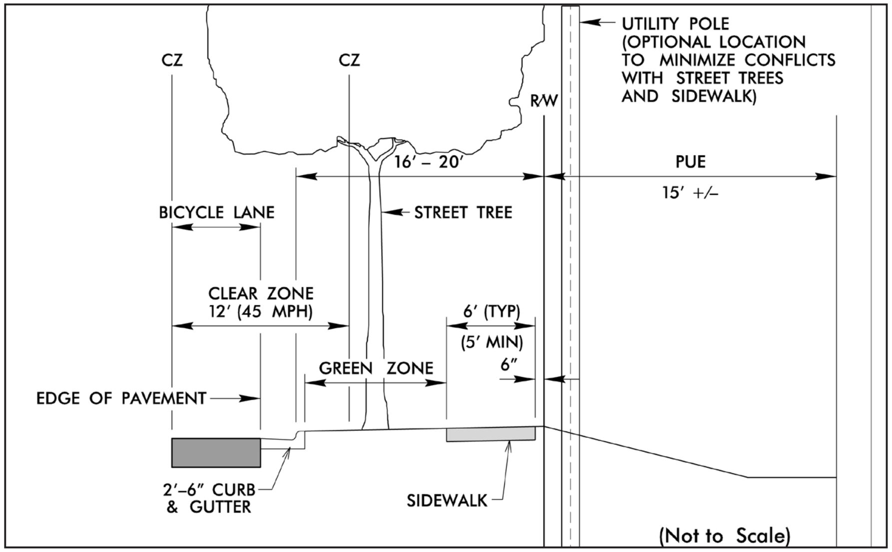


Figure 23: Recommended Green Zone and Sidewalk Zone for Streets with posted speeds of 45 mph (dimensions may vary based on context and available right of way and/or easements).



Parkways:

Shoulder Facilities with Limited or Full Control of Access (C/A): The proposed ROW with C/A should be set at a dimension that includes the project footprint and encompasses the clear zone as discussed later in this chapter and defined by the American Association of State Highway and Transportation Officials (AASHTO) Roadside Design Guide (current edition), (see Figure 24).

Parkways and Rural Roads:

Shoulder Facilities with No or Partial Control of Access (C/A): The proposed ROW should be set at a dimension that encompasses the project footprint and the clear zone as discussed later in this Chapter and defined by the AASHTO Roadside Design Guide. All new or relocated utility poles shall be placed outside the clear zone, but not necessarily beyond the ROW (see Figure 25). A PUE may be provided beyond the proposed ROW to encompass the utility poles and preferably along only one side of the street.

Site specific constraints such as insufficient ROW availability, prohibitive slopes and other factors may make implementation of the full clear zone infeasible. Furthermore, while complete streets such as main streets, avenues and boulevards should strive for utility poles located away from the street side, the application of clear zones for other objects is less consistent with the overall objectives for urban street designs. In such cases good engineering judgment should be used. Relocated and new utility poles should be placed as far as practical from the street to avoid conflicts with street trees and other street design elements that might be provided within the planting strip/amenity zone.

Figure 24: Recommended Utility Pole Placement for Full and Limited Control of Access Facilities with Shoulders.

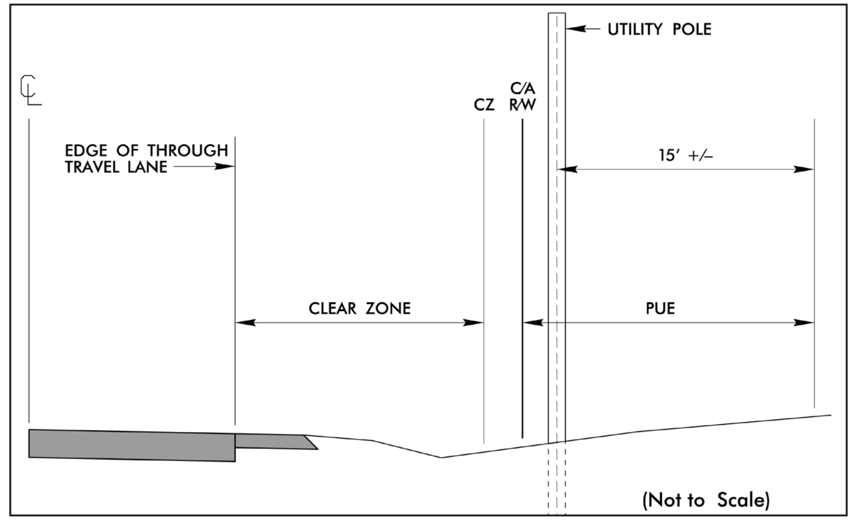
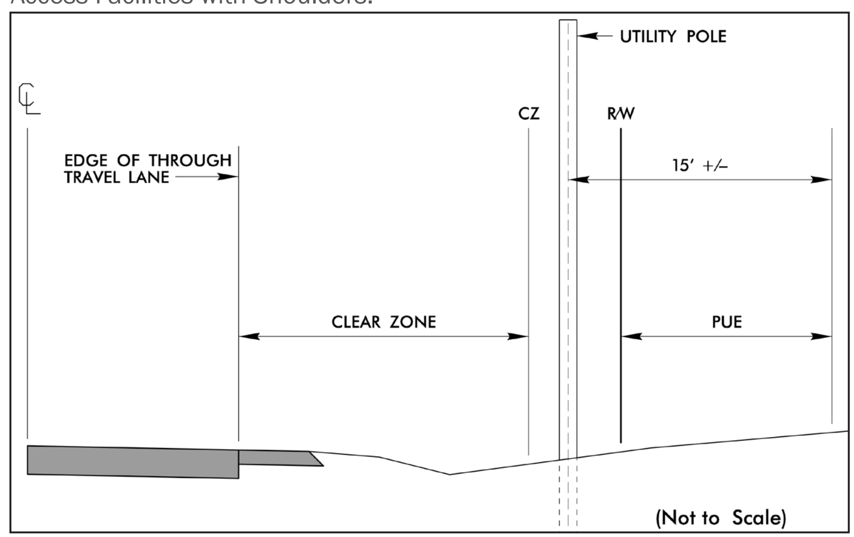
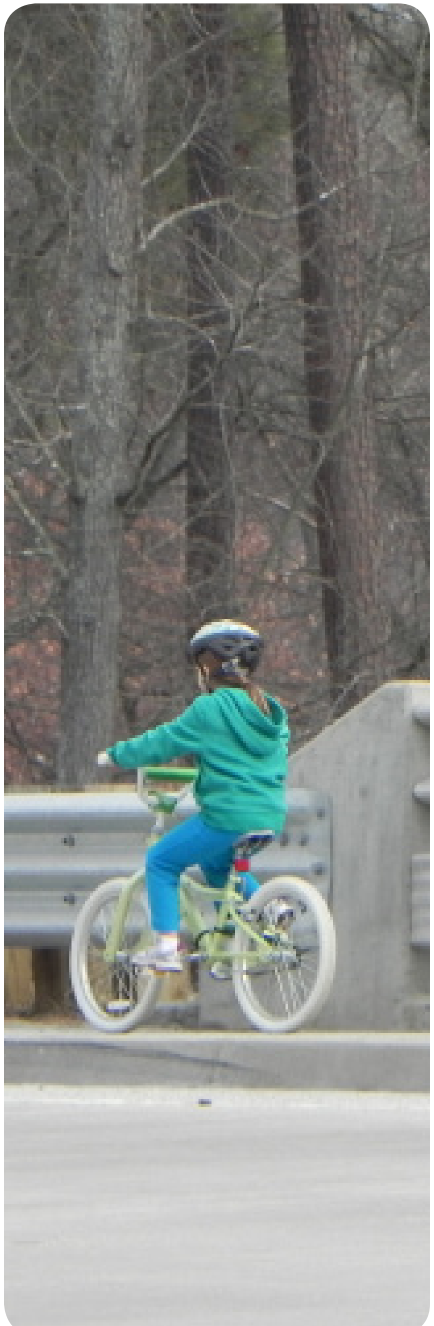


Figure 25: Recommended Utility Pole Placement for No or Partial Control of Access Facilities with Shoulders.





Sight Distance

Sight distance is the area that establishes a clear line of sight for a waiting vehicle, pedestrian or bicyclist to see oncoming traffic and make movements into, out of, or across a street or driveway connection. It is also for traffic to see entering vehicles or waiting vehicles, pedestrians and bicyclists.

For signalized intersections, sight distance should be developed based on AASHTO's A Policy on Geometric Design of Highways and Streets (Current Editon) "Case D – Intersections with Traffic Signal Control." "At signalized intersections, the first vehicle stopped on one approach should be visible to the driver of the first vehicle stopped on each of the other approaches. Left turning vehicles should have sufficient sight distance to select gaps in oncoming traffic and complete the left turns." Corner sight triangles are necessary for signal pole placement, guy wires, signal cabinets, unobstructed 5 to 6 foot wide sidewalks and wheelchair ramps with 4 foot by 4 foot landings when right of way lines are placed directly behind the planting strip and sidewalk. Corner sight triangles will not be symmetrical at skewed intersections.

For main streets and avenues with wider sidewalks and amenity zones, meeting the requirements of a strictly applied sight triangle may not be possible. "Likewise, the requirement for departure sight triangles along streets (when pulling out of streets or driveways), if applied strictly, may conflict with the desire to provide bus shelters, street furnishings, or enough street trees of significant size to create a canopy." (Charlotte, North Carolina, Urban Street Design Guidelines, p. 138). In cases where these design elements compete with departure sight distance, a more thorough evaluation of the sight distance may be appropriate. In order to achieve adequate departure sight distance, a minimum of 50% of an approaching vehicle must be visible to the entering vehicle at all times within the limits of the departure sight triangle. If this condition is met, the departure sight distance is considered adequate. Where trees are the subject of the evaluation, the caliper at full tree maturity should be considered. Typically, adequate sight distance is achieved with a tree spacing of 20 feet for small-maturing trees, 30 feet for medium-maturing trees, and 40 feet for large-maturing trees. Vertical and horizontal alignments can affect the results and should be considered when applying these spacing guidelines.

On streets such as boulevards and parkways, where higher speeds and land uses with deeper setbacks are found, a stricter application of sight distance will be applied. Providing "room for error" by motorists is necessary for maintaining safety along the higher speed street types and rural roads.

Accessibility

In planning and designing for complete streets, whether in a new street or a retrofit/rehabilitation project, each must be designed and implemented so that they are accessible and usable by individuals of all ages and abilities, to the maximum extent feasible. Integrating accessible features in new projects and planned alterations requires an understanding of both regulatory and usability concepts.

The Americans with Disabilities Act (ADA) of 1990 is a civil rights statute that prohibits discrimination against people with disabilities. The accessibility objective of a new or reconstructed project is to design and build a facility that is readily accessible and usable by people with disabilities.

Title II – ADA implementing regulation for title II. Title II – Public Entities (and public transportation) "prohibits disability discrimination by all public entities at the local (i.e. school district, municipal, city, county) and state level. Public entities must comply with Title II regulations by the U.S. Department of Justice. These regulations cover access to all programs and services offered by the entity. Access includes physical access described in the ADA Standards for Accessible Design and programmatic access that might be obstructed by discriminatory policies or procedures of the entity (ADA, 1990)."

"Title II also applies to public transportation provided by public entities through regulations by the U.S Department of Transportation. It includes the National Railroad Passenger Corporation, along with all other commuter authorities (ADA, 1990)."

As with any NCDOT project, complete streets projects must abide by these regulations and in fact seek to exceed the minimum in providing accessibility to all individuals of all ages and abilities. The design input team should address accessibility in their discussions, plans and designs, using current NCDOT guidance on accessibility.

Travel Way Considerations

The previous sections highlighted considerations with street-side elements. The following sections highlight considerations within the travel way of a street or roadway. These include drainage grates and covers, shoulder rumble strips, clear zone, and superelevation.

Drainage Grates and Utility Covers

Drainage grates and utility covers can be serious hazards to bicyclists. Drainage grates with openings running parallel to the curb can trap the front wheel of a bicycle causing loss of steering control, or allow narrow bicycle wheels to drop into the grate, resulting in damage to the wheel and frame and injury to the bicyclist. Care must be taken to ensure drainage grates are bicycle safe. Unsafe grates covers should be replaced with either Type E, F, or G, NCDOT standard grate covers as shown in the Appendix (or other bicycle-compatible drainage grate covers). When a street is designed, constructed or modified, all grates and covers should be bicycle safe.

Utility covers also create problems for bicyclists, and should typically not be located in the bicycle lane. Because they are particularly problematic (for bicyclists and motorists) if left projecting above the surface or become sunken below the pavement surface, utility covers should be installed flush with the adjacent street surface and/or adjusted when streets are reconstructed or resurfaced.

Shoulder Rumble Strips

A shoulder rumble strip is a safety feature for motorists installed on a paved shoulder near the outside edge of the travel lane. It is made of a series of milled or raised elements intended to alert inattentive drivers (through vibration and sound) that their vehicles have left the travel lane. Rumble strips are placed as a countermeasure for driver error, rather than street deficiencies, and are typically used on high speed facilities in rural areas. They are less applicable on urban and suburban street types. Where they are used, rumble strips on shoulders should be designed to lessen impacts on other users (specifically bicyclists). Shoulder rumble strips with a narrow offset of 9 inches or less from the edge of the pavement marking (travel lane) have been shown to be the most effective, because the driver is alerted sooner and it provides a slightly larger recovery area after being alerted.

Characteristics of and concerns about rumble strips that limit their usefulness or application include low traffic speeds, noise for adjacent residences, limited pavement width, presence of curb and gutter, significant turning movements, and other conflicts for motorists, pedestrians and bicyclists.

Bicyclists are affected by rumble strips. As legal street and road users, bicyclists may be in the travel lane, but where paved shoulders are available and clear, bicyclists will often use them to avoid conflicts with faster moving vehicles in the travel lane. As described in Chapters 3 and 4, paved shoulders, if wide enough, can be an appropriate facility type for bicyclists on some higher speed roadways, such as parkways or rural roads. There are a number of measures that should be considered to accommodate bicyclists when installing rumble strips:

- Wide outside paved shoulders improve safety for all highway and road users. Where existing cross-section exists or is available, allow at least four feet beyond the rumble strips to the edge of the paved shoulder. Where guardrail, curb or other continuous obstructions exist, additional width (2 feet extra width) may be needed to provide adequate clearance for bicyclists.
- Bicycle gaps (recurring short gaps) should be designed in the continuous rumble strip pattern to allow for ease of movement of bicyclists from one side of the rumble to the other. A typical pattern is gaps of 10 to 12 feet between groups of the milled-in elements at 60 feet intervals.
- Decreased width of rumble strip and/or decreased offset width to the edge line (travel lane) may provide additional space usable to bicyclists.

Rumble strips have typically been used in rural areas where run-off-road crash problems exist, and their use on urban freeways and possibly urban parkways should be determined on the merit of the street cross-section and context. Rumble strips are generally not necessary on other complete street types. Installation will be considered on rural roads where posted speed limits and/or statutory speeds are at 55 miles per hour and above. Installation will be considered along specific rural roads where significant numbers of run-off-road-crashes that include any form of motorist inattention has been identified.

Clear Zone

For traditional roadway design, the clear zone design concept is an attempt to furnish a “forgiving” roadside for motorists by reducing the effects of striking a fixed object located within a certain distance from the roadway. The particular width of the clear zone – measured from the edge of the through travel lane – is based on statistical analysis of the results of vehicle tests. The recommended widths are typically influenced by vehicle speed, traffic volume, and street alignment, but context and area does play a role in the application of clear zone.

In urban areas (towns as well as cities), on arterials and other non-controlled access facilities, right-of-way is often extremely limited, safety and comfort for all users is the objective, and, in many cases, it is not practical or appropriate to establish a clear zone that eliminates all fixed objects. Therefore, the application of the clear zone concept is of lower priority for urban/suburban main streets, avenues and some boulevards than on other higher speed facilities.

On local/subdivision streets, main streets, avenues and appropriate boulevards, urban environments are characterized by sidewalks beginning at the face of the curb or by sidewalks positioned behind planting strips with street trees, enclosed drainage, numerous fixed objects (signs, utility poles, luminaire (lighting) supports, fire hydrants, sidewalk furniture, etc.) and frequent traffic stops. These environments typically have lower operating speeds and, in many instances, on-street parking is provided. A lateral offset to vertical obstructions (signs, utility poles, luminaire (lighting) supports, fire hydrants, etc., including breakaway devices) is provided in lieu of keeping the clear zone free of all fixed objects.

Where the clear zone values cannot be achieved or are not applicable due to the context and expected speeds (e.g. main streets and avenues), the street should provide sufficient lateral offset to roadside fixed objects. Historically a lateral distance value, referred to as an operational offset, of 1.5 ft. has been considered a minimum lateral distance for placing the edge of objects from the curb face for urban streets. This minimum lateral offset, though sometimes misinterpreted as such, was never intended to represent an acceptable safety design criterion. In a constrained urban environment, there is still a need to position rigid objects as far away from the active travel way as possible.

For curb and gutter facilities posted at 25 mph, 35 mph and 45 mph, NCDOT has defined its urban clear zone as 8-ft., 10-ft. and 12-ft., respectively. This distance is measured from the edge of the through travel lane. In extremely constrained environments, deviations from the urban clear zone dimensions will be discussed by NCDOT and the local agency on a case-by-case basis.

Generally, the principles and guidelines for the AASHTO Roadside Design Guide discuss roadside safety considerations for rural highways, interstates, and freeways where speeds are generally higher, approaching or exceeding 50 mph, and vehicles are operating under free-flow conditions. In rural environments, where speeds are higher and there are fewer constraints, a clear zone appropriate for the traffic volumes, design speed and facility type should be provided in accordance the current edition of the AASHTO Roadside Design Guide. These values are also appropriate for freeways, urban parkways and rural roads. Typical clear zones for freeways and rural roads for speeds of 35 mph, 45 mph, and 55 mph are 14-ft., 20-ft. and 30-ft., respectively.

Decisions regarding the design of forgiving street sides must be made on an individual basis, while considering the value of the street to the community, the benefits of street trees to the environment, anticipated vehicle speeds, the effects of visual friction on reducing speeds, and crash history. Regardless of the decision made about the project’s specific street-side design, the decision should be made using a collaborative process.

Superelevation

Superelevation is the cross slope of a street between the two edges of pavement. Cross slope helps rainwater to drain off the road. In curves, the outside edge of pavement is raised to increase driving comfort through the curve. Superelevation has its place in roadway design – especially on high speed facilities and interchanges with large size trucks. Superelevation can be beneficial for traffic operations, because it generally allows for higher speeds. However, and particularly when related to complete street objectives, various factors often combine to make the use unnecessary in low-speed urban areas. These factors include wide pavement areas, the desire to maintain low speed streets, break-over angles at side streets, reduced visibility of crosswalks, lane alignments, impacts to adjacent property and the higher frequency of intersecting streets and driveways. A full discussion of the application of superelevation to low-speed streets is presented in the current edition of AASHTO's A Policy on Geometric Design of Highways and Streets. Table 3 provides general recommendations for superelevation on various street types.

In keeping with NCDOT's streets objectives, horizontal curves on low-speed urban streets can be designed without superelevation. The minimum radii and corresponding superelevation rates for urban streets and rural roads are shown in Table 3, with flexibility based on discussion with the project input team.

The purpose of this chapter was to identify and describe the intent for various design elements for complete streets, organized by street-side elements and elements within the travel way. The key with each of these elements is to maintain flexibility in the design, and to specifically emphasize that streets in urban, suburban, and town environments will be designed differently than higher speed roadways in rural contexts.

Table 3: Minimum Superelevation and Curve Radii

Context (Street Type)	Design Speed (mph)	Superelevation (e)	Minimum Radii (feet)	Superelevation and Friction Distribution*
Urban and Suburban				
	20	-2% (NC)	107	Method 2
	25	-2% (NC)	198	Method 2
	30	-2% (NC)	333	Method 2
	35	-2% (NC)	510	Method 2
	40	-2% (NC)	762	Method 2
	45	-2% (NC)	1039	Method 2
(Parkway)	>45	+4%	N/A	Method 1
Rural				
(Road)	35	+4%	371	Method 1
(Road)	40	+4%	533	Method 1
(Road)	45	+4%	711	Method 1
(Boulevard)	50	+4%	926	Method 1
(Parkway)	50	+6%	833	Method 1
(Parkway)	60	+6%	1330	Method 1

*Source: AASHTO

NOTES: Method 1 – Superelevation and Friction Distribution uses superelevation and side friction to establish driver comfort through a curve. This allows curves to be sharper and contain more camber/cross slope to establish driver comfort at respective speeds.

Method 2 – Superelevation and Friction Distribution uses side friction alone to establish driver comfort through a curve. Because this method is completely dependent on available side friction, its use is generally limited to low-speed streets. This method is particularly advantageous on low-speed urban streets where, because of various constraints, superelevation frequently cannot be provided.

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Key Definitions

AASHTO: American Association of State Highway and Transportation Officials

Access Management: Access management is a set of techniques that state and local governments can use to control direct access to streets.

Americans with Disabilities Act (ADA): This act prohibits discrimination against people with disabilities. Transportation facilities that support accessibility for people with disabilities include curb ramps, detectable warning pads and level landings, among other features.

Area Type: Categories used in these guidelines to describe a variety of areas or geographies. The nine different types include three urban area types (Central Business District, Urban Center, and Urban Residential), three suburban area types (Suburban Center, Suburban Residential and Suburban Core) and three rural area types (Rural Village, Rural Developed and Countryside).

Complete Streets: Complete streets are streets designed to be safe and comfortable for all users, including pedestrian, bicyclists, transit riders, motorists and individuals of all ages and capabilities. These streets generally include sidewalks, appropriate bicycle facilities, transit stops, right-sized street widths, context-based traffic speeds, and are well-integrated with surrounding land uses.

Comprehensive Transportation Plan (CTP): A transportation system plan to meet the future needs of a planning area for a minimum twenty (20) year period. This include a mutually adopted (by MPO's, RPO's, and NCDOT) multi-modal set of maps that serve that show the long range vision for serving present and anticipated future travel demand for all users. This plan includes all potential project types.

Growth Area: An area where growth is likely to occur and that is categorized as, or transitioning to, urban and/or suburban. It also may include a town or community and areas around or near parks, lakes and schools.

Level of Service (LOS): A measure used to describe the effectiveness of transportation infrastructure for motor vehicles; traditionally used to describe traffic flow.

Long Range Transportation Plan (LRTP): A federally mandated, long-term planning document detailing the transportation improvements and polices to be implemented in an MPO's planning area. It is developed by MPO's and represented municipalities, in partnership with NCDOT, and includes projects that are scheduled for funding over the next twenty (20) years.

Metropolitan Planning Organization (MPO): A regional policy body, required in urbanized populations over 50,000, that is responsible for carrying out the metropolitan planning requirements for federal highway and transit legislation in cooperation with the state and other transportation providers. The MPO develops transportation plans and programs for the metropolitan area.

NACTO: National Association of City Transportation Officials.

NEPA: National Environmental Policy Act of 1969, as amended. NEPA requires all federal agencies to consider environmental factors through a systematic interdisciplinary approach before committing to a course of action. The NEPA process is an overall framework for the environmental evaluation of federal actions, including transportation projects.

North Carolina Complete Streets Policy: Adopted in July 2009; represents North Carolina's approach to interdependent, multi-modal transportation networks that safely accommodate access and travel for all users. The policy states that "working in partnership with local government agencies, interest groups, and the public, NCDOT will plan, fund, design, construct and manage complete street networks that sustain mobility while safely accommodating walking, biking, and riding transit."

North Carolina Transportation Plan: A 30-year document that defines the mission and goals of the Department and sets out key objectives and strategies to achieve them. These elements guide decision making, including investment decisions.

Quality of Service (QOS): A qualitative assessment of the level to which a street provides for all modes of travel, with a particular focus on bicyclists, pedestrians and transit users. Quality of Service is based on the physical and operational designs of the street and emphasizes that these affect the functionality of the street for all users, particularly non-motorists.

Rural Planning Organization (RPO): A regional planning body of local elected officials or their designees and a representative of local transportation systems formed by a memorandum of understanding with NCDOT to work cooperatively with the Department to plan rural transportation systems and to advise the Department on rural transportation policy.

State Transportation Improvement Program (STIP): The State Transportation Improvement Plan represents a 7 year subset of the Project List included in NCDOT's Program and Resource Plan. NCDOT reviews the draft STIP annually and updates the STIP every two years.

Target Speed: Target speed refers to the preferred travel speed on the street.

Traffic Calming: One or a combination of mainly physical measures installed within the street right of way to control traffic speeds and improve the safety and livability of local streets. Traffic calming measures are intended to reduce the negative effect of motor vehicle use, alter driver behavior and improve conditions for non-motorized street users.

Traffic volume: Traffic volume refers to the amount of of motor vehicles that travel on a street.