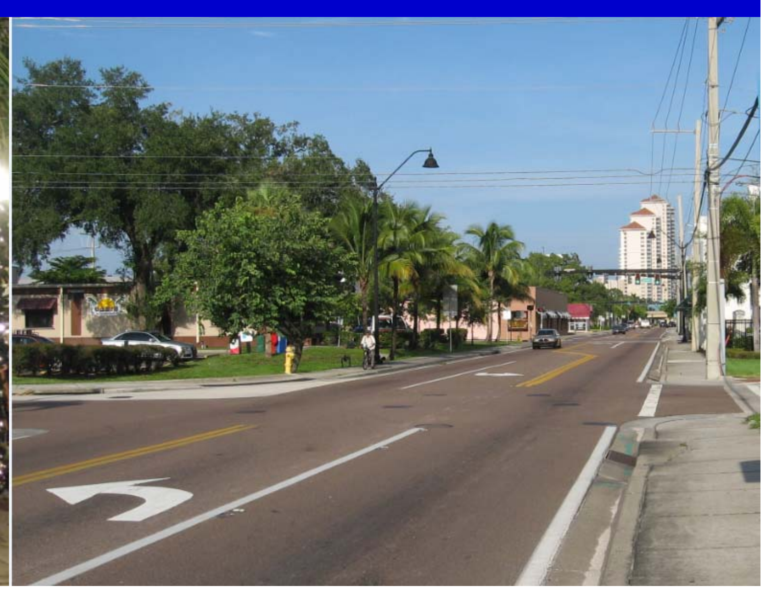
City of Fort Myers

COMPLETE STREETS Guidelines

July 2016



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1. INTRODUCTION

CONTEXT

A growing number of communities are discovering the value of their streets as important public spaces for many aspects of daily life. People want streets that accommodate all modes of transportation, are safe to cross or walk along, offer places to meet people, link healthy neighborhoods, and have a vibrant mix of retail. More people are enjoying the value of farmers' markets, street festivals, and gathering places, and more people want to be able to walk and ride bicycles in their neighborhoods.

People from a wide variety of backgrounds are forming partnerships with schools, health agencies, neighborhood associations, environmental organizations, and other stakeholders in asking their local governments to create streets and neighborhoods that fit this vision.

Complete Streets accommodate all users
(Credit: City of Fort Myers)

As a result, an increasing number of local governments are looking to modify the way they plan and design their streets. The guidelines presented herein provide the City of Fort Myers (City) with an opportunity to make their community healthier and safer by implementing new livable and sustainable practices. This manual presents the City of Fort Myers' guidelines for implementing Complete Streets.

CHARACTERISTICS OF COMPLETE STREETS

Complete Streets are planned and designed to function for all users regardless of age, ability or desired mode of transportation. Utilization of the entire right-of-way is for everyone;

pedestrians, bicyclists, transit riders, and motorists of all ages and abilities, in a manner that allows everyone to safely move along and across a Complete Street. Complete Streets make it easy to cross streets, walk to shops, catch buses, and bike to work.

Comfortable public transportation stop
(Credit: City of Fort Myers)

As defined by the National Complete Streets Coalition (NCSC), "*There is no particular design prescription for Complete Streets; each one uniquely responds to the context of its individual site and/or community*." *Complete Streets FAQ*, National Complete Streets Coalition, www.completestreets.org

Features that comprise a Complete Street may include:

- Sidewalks,
- Bicycle lanes,
- Other innovative bicycle facilities,
- Special bus lanes,
- Accessible public transportation stops,
- Frequent and safe crossing opportunities,
- Median refuges,
- Accessible pedestrian signals,
- Landscaped curb extensions,
- Bioswales,
- Roundabouts,
- On-street parking,
- Secure bicycle parking.

A Complete Street in a suburban area may look differently than a Complete Street in the urban core; however, both are designed with the same principles in mind; a balance of safety and convenience for everyone using the road.

Need for Complete Streets

Streets that are designed with only motor vehicles in mind serve a very limited function because mobility options are minimized. Therefore, transportation options such as walking, bicycling, and taking public transportation are inconvenient, unattractive, and unsafe. These conditions result in, a number of unintended consequences, including:

- Rising obesity rates from inactive lifestyles - Currently, one-third of our nation's children are overweight or obese according to *The Centers for Disease Control.*
- Alarming numbers of Americans being diagnosed with devastating diseases such as diabetes, heart disease, and cancer as a result of sedentary lifestyles.
- Senior citizens feeling trapped in their neighborhoods, because when they cannot safely cross streets.
- Higher levels of air pollution surrounding schools from children being transported rather than walking or bicycling.
- People using cars for short trips rather than getting exercise through walking or bicycling.
- Overconsumption of nonrenewable fuel resulting in global disasters.
- Emission of carbon-based toxins contributing to global warming.
- Neighborhoods lacking social connection causing hardships on retail markets.

Benefits of Complete Streets:

The following benefits are realized through the implementation of a Complete Streets program:

- **Safety.** When alternative traveling becomes more convenient, the public becomes involved in choosing safer modes of commuting. Aging populations are able to move at their own pace to and from destinations.
  Florida Leads Nation in Number of Senior Citizens Killed in Traffic Accidents, February 23, 2012, The Sun Sentinel

- **Equity.** Complete Streets function for people of all ages, abilities, and incomes, therefore, everyone is able to choose which mode of transportation works best for them. Whether traveling to work, school, the grocery store, or to parks simply for healthy recreation, people who choose walking, bicycling, and taking public transportation are selecting less expensive, greener forms of transportation than relying on automobiles.

- **Public Health.** Complete Streets promote "human-powered" transportation, which reduces the risk of disease due to more sedentary lifestyles. The Centers for Disease Control (CDC) identified a strong correlation between the lack of smart planning and investing in usable infrastructure and serious health concerns facing the United States.

- **Capacity.** Complete Streets can improve the efficiency and capacity of existing roads by expediently moving more people in the same amount of space by promoting other mobility options. Complete Streets that promote multi-modal transportation options maintain capacity while reducing congestion.

- **Sustainability.** The City of Fort Myers City Council adopted a resolution (No. 2011-36) in October, 2011 initiating the process of developing guidelines, processes, and procedures for establishing a Complete Streets program adhering to the principle that persons of all ages and abilities who walk, travel by automobile, motorcycle, public transit, or bicycle, are equally legitimate users of public roadways, and shall be provided safe access to all City of Fort Myers public rights-of-way.

Today, many interests are aligning for safer, healthier streets. The American Association of Retired Persons (AARP) is a strong supporter of Complete Streets. In addition, a broad collection of interests such as Smart Growth America, schools, city planners, realtors, insurance companies, health professionals, and civil engineers, such as the Institute of Transportation Engineers [ITE] and the American Society of Civil Engineers, all support Complete Streets initiatives. More than 100 cities across the United States, and at least three Florida Metropolitan Planning Organizations have adopted Complete Streets policies. Many local governments in Lee County and surrounding cities have initiated the redesign of their streets to accommodate various modes of transportation.

Image of a Complete Street image within a main street corridor context
(Credit: AARP)

LEGAL STANDING OF STREET MANUALS

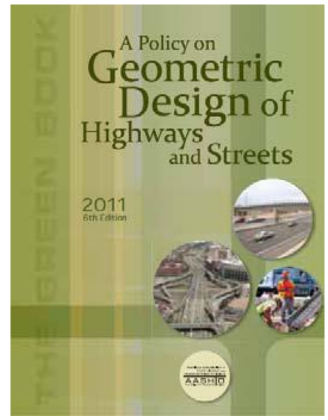
Today's designers now embrace a new design philosophy that encourages "Complete Streets" principles, which have recently been adopted by federal, state, and local agencies. The most important of these design standards originate from the following established entities:

- The American Association of State Highway and Transportation Officials' (AASHTO) *A Policy on Geometric Design of Highways and Streets* (the "Green Book")
- The Manual of Uniform Minimum Standards for Design, Construction, and Maintenance for Streets and Highways (the "Florida Green Book")
- City of Fort Myers Public Works Guidelines
- The Florida Department of Transportation's (FDOT) Plans Preparation Manual (PPM)
- The Federal Highway Administration's (FHWA) *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD)
- The City of Fort Myers Plans and Standards:
    - *2003 City-Wide Traffic Calming Comprehensive Plan*
    - *2007 Bicycle and Pedestrian Plan*
    - *Parks and Open Space System Master Plan*
    - *Code of Ordinances*
    - *Standard Details*
    - *Community Redevelopment Agency*
    - *Comprehensive Plan*
    - *Land Development Code*

The Federal Functional Classification (FFC) System/Urbanized Areas defines the requirements of each of these documents. Urban areas have been established in each metropolitan area under federal transportation requirements; Title 23, Section 103, United States Code. The FHWA's Surface Transportation Assistance Program (STP) requires a small portion of the STP funds be spent outside the federal-aid urbanized areas and federal-aid urban area. Local governments that wish to use certain federal funds must use a street classification system based on arterial roads, collector roads, and local roads. Only arterial roads and certain collector streets are on this federal-aid system. In Chapter 3, *Street Networks and Classifications*, this manual recommends an alternative system. To maintain access to these federal funds, local jurisdictions can use both systems. The federal aid system encourages cities to designate more of these larger streets, and to concentrate modifications along these larger streets.

The following sections provide a brief explanation of the traditional design standards and guidelines relating to federal funding:

AASHTO Green Book



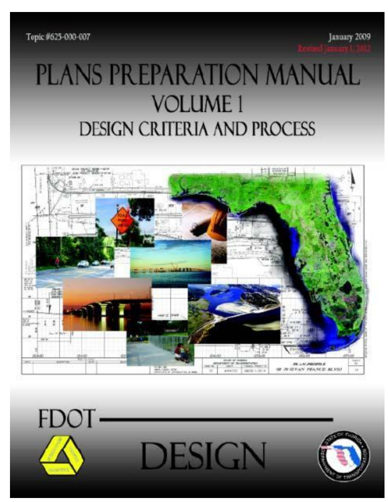
A Policy on the Geometric Design of Highways and Streets, the AASHTO Green Book, 6th Edition, 2011, provides guidance for designing geometric alignment, street width, lane width, shoulder width, medians, and other street features. Design guidelines are given for freeways, arterials, collectors, and local roads. Although the Green Book's application is primary to the National Highway System, local jurisdictions typically apply those guidelines uniformly to all streets.

Further, the Green Book provides guidance that local jurisdictions often unnecessarily regard as *Standards*. The Green Book encourages flexibility in design within certain parameters, as evidenced by the AASHTO publication *A Guide to Achieving Flexibility in Highway Design*. For example, ten-foot lanes, which is an option for local jurisdictions, are well within AASHTO guidelines. This lane width reduction option provides an opportunity to promote traffic calming.

Florida Green Book

The Florida Green Book is intended to provide minimum standards for use on all public streets in Florida that are not part of the State Highway System. Users are encouraged to reference the latest version which may found on the FDOT Roadway Design website:
http://www.dot.state.fl.us/rddesign/FloridaGreenbook/FGB.shtm

FDOT Plans Preparation Manual



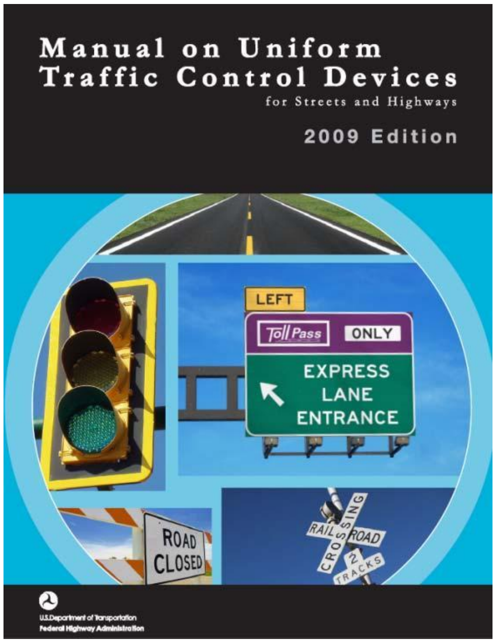
The FDOT Plans Preparation Manual (PPM), Volume I, outlines the design criteria and procedures for use on the State Highway System (SHS) and on FDOT projects. The criteria in the PPM represent requirements for the State Highway System, which must be adhered to for the design of FDOT projects and all improvements within state-owned right-of-way unless approved exceptions or variations are obtained in accordance with procedures outlined in the PPM.

The Plans Preparation Manual, Volume I, contains several chapters of interest to implementing Complete Streets on the SHS including Chapter 2 (Design Geometrics and Criteria), Chapter 8 (Pedestrian, Bicycle, and Public Transit Facilities), Chapter 21 (Transportation Design for Livable Communities), and Chapter 25 (Design Criteria for Resurfacing, Restoration, and Rehabilitation [RRR] projects).

The Plans Preparation Manual, Volume II, sets forth requirements for the preparation and assembly of contract plans for FDOT projects.

MUTCD

The Federal Highway Administration's (FHWA) Manual on Uniform Traffic Control Devices (MUTCD) provides standards, oversight, and guidance for the application of traffic control devices including roadway markings, traffic signs, traffic signals, and traffic striping.



The State of Florida chooses to adopt the Federal MUTCD as its authority for signs, pavement markings, and traffic control devices; however, the rules and requirements for the use of traffic control devices may differ for local street design criteria.

The State of Florida and the FHWA have procedures called "Request for Experimentation" (RFE) that allow local agencies to experiment with new traffic control devices that are not included in the current MUTCD. Such demonstrations are easy to obtain from the FHWA for testing of new devices, especially as they relate to pedestrian and bicycle facilities. However, the requesting agency must agree to conduct adequate before-and-after studies, submit frequent reports on the performance of the experimental device, and remove the device if early results are not promising. Upon receiving FHWA approval for the experiment, the local jurisdiction is then granted limited legal immunity from liability suits.

Over the years, the MUTCD's amendments through experimentation have proven to be quite beneficial. The new devices often are adopted into the manual. A recent example of a successful amendment to the MUTCD includes Shared Lane Bicycle Markings, or "sharrows."

Although the MUTCD provides flexibility to local agencies for the application of standard traffic control devices, custom signs for unique sign situations, and sign placement specifics, local agencies do not generally have the flexibility to develop signs that are similar in purpose to signs within the MUTCD; for example, using different colors, shapes, or legends. Local agencies are also not authorized to establish traffic regulations that are not specifically allowed or are in conflict with state law. The provisions of the MUTCD and related state laws thus make it difficult to deploy new traffic control devices which can result in complications, especially in the areas of speed management, pedestrian movements, and bikeway treatments.

The MUTCD establishes specific traffic warrants regarding the use of traffic control devices. Stop signs, traffic signals, and flashing beacons are expected to meet minimum thresholds before application. These thresholds include such warrant criteria as number of vehicles, number of pedestrians, distance to other devices, and crash history. These MUTCD warrants sometimes present challenges to local engineers, when in their opinion, applying certain traffic control devices may in fact improve safety. For example, pedestrians crossing busy, high-speed arterial roadways may need signals for the safety of users, but they may not meet the MUTCD warrant criteria. However, in such situations, the MUTCD does grant a professional engineer to exercise practical judgement in making a decision to implement a traffic control device based on their expert opinion.

As with street design guidelines, cities may establish their own warrants based upon professional engineering judgement, or modify those suggested by the MUTCD to suit their context in order to use some traffic control devices. In special circumstances that deviate from their own warrants, cities need to document their reasons for the exception. For example, they may stipulate that a trail crossing or school crossing qualifies for a certain traffic control device; however they must provide sufficient reasoning to do so.

Local Street Manuals

Local jurisdictions often do not have the resources to develop their own standards and practices manual. For this reason, and because of liability concerns, they follow the AASHTO Green Book, the Florida Green Book, or design guidance from organizations such as the Institute of Transportation Engineers (ITE). Neither federal nor state law mandates adoption or adherence to these guides unless funding dictates otherwise.

Many of the traditional manuals used today by local jurisdictions embody principles based primarily on moving motor vehicle traffic. From this ideology, wider streets emerge that are built for high speed while compromising other important community goals. This works against present-day community needs. Common outcomes stemming from this traditional approach within urbanized areas often include the following outcomes:

- Streets that are not pedestrian friendly and, therefore, uncomfortable for pedestrians to

traverse.
- Streets that are not safe for bicycling.
- Streets that encourage higher vehicular speeds.
- Streets that are not safe for motorists to drive on.
- Sidewalks that are too narrow, uncomfortable, and not safe for walking.
- Street crossings that are inconvenient and/or hazardous for wheel-chair bound citizens.
- Streets that are uninviting to the public.
- Streets that are land developed based on auto-oriented travel and therefore, uninviting to walkers, bikers, and those who use mass transit.
- Stormwater runoff systems that convey flows directly into storm drains and into waterways, bypassing conveyance filters such as swales that aid in remediating contaminants.
- Street that trees are poorly selected, or not compatible with the local environment.
- Poorly designed hardscapes that are conducive to excessive heat during the summer months, which leads to fewer pedestrians and bicyclists using the facility.

A question often posed by plaintiffs' attorneys in traffic-related crashes is, *"Did the jurisdiction follow established or prevailing designs, standards, and guidance?"* If the attorneys can prove that the local jurisdiction deviated from these, they enhance their chances of winning a judgment against the jurisdiction. Therefore, protection from liability is paramount. Working within previously established urban guidelines generally should result in a design that is protected from liability provided you are working within similar contexts. The AASHTO Green Book or the Florida Green Book are silent on non-safety driven design features, and, therefore, do not consider the needs within other unique contexts. In these cases, local jurisdictions may develop their own guidelines or standards based upon international practices or successful practices from other jurisdictions. Local governments may adopt the guidance in these Complete Streets Guidelines which compiles best practices in initiating the concept of Complete Streets.

Local jurisdictions may utilize designs that fall outside the ranges specified by nationally accepted guidelines and standards, but these practices can potentially increase liability unless done with great care and implemented by a professional engineer. When agencies elect to utilize designs that fall outside the guidelines of nationally recognized documents, they need to use additional care to ensure they do not expose themselves to liability. Other documents provide valuable procedure and reference data, but they do not set standards. They can be referred to and defined as standards by local agencies, but the local authority often has the flexibility to selectively endorse, modify, or define how these informational documents can be used or incorporated into its engineering and planning processes. Also, newer versions of these documents have additional information that can conflict with the local historical approach.

However, most design changes to streets discussed in this publication fall within the range of the guidelines or recommended practices such as AASHTO, ITE, etc.

When a local agency wished to implement a design change to minimize liability, they either need to adopt their own standards, which should be based on rationale or evidence of reasonableness, or they can conduct an experimental project know as a Request for Experimentation, as discussed earlier in the MUTCD sub-section. When conducting an experimental project, agencies need to show that they are using the best information that is reasonably available to them at the time, document why they are doing what they are doing, use a logical process, and monitor the results and modify accordingly. This is because the agency may be required in the future to show that its design is reasonable, and the agency may not be able to cite a nationally published guideline or recommendation to support its local action. Often, these experimental projects are conducted because the design engineer has reason to believe that the new or evolved design will be safer or otherwise more effective for some purpose than if the project had used prevailing standards and guides. These reasons or rationales are based on engineering judgment and should be documented to further minimize exposure to liability.

Unsafe pedestrian crossing on a six-lane arterial
(Credit: City of Fort Myers)

AASHTO design guidelines may not provide information on innovative or experimental treatments that have shown great promise in early experiments and applications. Since AASHTO is a design guide, agencies have some flexibility to use designs that fall outside the boundaries of the AASHTO guide. Deviation from the range of designs provided in the AASHTO guide requires agencies to use greater care and diligence to document their justification, precautions, and determination to deviate from the guidelines. In Florida, the precautions to establish “sovereign immunity” should be followed based on *Florida State Statute* 768.

Local agencies may currently use many other reports and documents to guide their roadway design and transportation planning. Other documents provide valuable procedure and reference data, but they do not set standards. They can be referred to and defined as standards by local agencies, but the local authority often has the flexibility to selectively endorse, modify, or define how these informational documents can be used or incorporated into its engineering and planning processes. Also, newer versions of these documents have additional information that can conflict with the local historical approach.

Unless otherwise noted, most information contained in this publication can readily be adopted and incorporated into the City’s Comprehensive Plan. In addition, these guidelines carry the credibility of the many transportation professionals who helped produce it. The expected results of the design approaches presented in this document are generally intended to improve safety and/or livability. As a result, implementation of these features should generally reduce liability and lawsuits. There is no way to prevent all collisions or lawsuits, but adopting policies, guidelines, and standards, while performing experimental projects with reasonable precautions, is a defensible approach.

PURPOSE OF THE COMPLETE STREETS GUIDELINES

Local governments depend on street guidelines manuals for direction in designing their streets, to retrofit and to modify existing streets with new development, and to develop new subdivisions. Along with land-use planning, street manuals play a large role in determining urban form. Street manuals, in effect, serve as the “DNA” of streets. As such, they help to determine how walkable and bicycle-friendly neighborhoods function within a community, how conducive cities are to transit use, and how livable communities develop. As such, these Complete Streets Guidelines will help meet the requirements of *Florida State Statute* 335.065, which requires transportation projects to consider bicycle and pedestrian improvements.

Jackson Street bike lane and streetscaping
(Credit: City of Fort Myers)

Roundabouts are a complete street strategy
(Credit: City of Fort Myers)

The *City of Fort Myers Complete Streets Guidelines* are based on Complete Streets principles that aim to design streets for people of all ages and physical abilities while accommodating all travel modes. The result will be more livable neighborhoods with healthier residents due to opportunities for varying, active modes of active travel.

2. VISION, GOALS, POLICIES, AND BENCHMARKS

**Chapter 2
Vision, Goals, Policies, and Benchmarks**

INTRODUCTION

Southwest Florida comprises a diverse group of communities that includes cities, villages, and rural jurisdictions. As a prominent city in this region, Fort Myers embraces this diversity of year-round residents and seasonal visitors. The populous all share in the magnificent landscape that shapes the city. Embracing Complete Streets Guidelines ensures that all will benefit from a safer, healthier, and more mobility-friendly community, whose streets best serve all users.

Ninth Avenue Complete Street in New York
(Credit: Bikes Belong Foundation)

Complete Streets Guidelines are necessary to support, in a healthier and commuter friendly manner, the numerous local, county, and state regulations that govern the streets.

This chapter establishes the Vision, Goals, Policies, Performance Measures, and Benchmarks for implementing Complete Streets principles in Fort Myers.

VISION

This manual provides guidance regarding the planning and designing of streets that adhere to a collective vision of Complete Streets in Fort Myers. It begins with the premise*:*

Changes or improvements to streets will add value to the adjacent land and neighborhoods.

The following statements present The City of Fort Myers' vision of Complete Streets.

Complete Streets:

- Are designed for all ages/abilities whether they walk, bicycle, ride transit, or drive cars;
- Integrate income, and social equity into future planning and budgetary functions;
- Combine connectivity with traffic-calming and pedestrian-friendly site/building design features that create safe and inviting places;
- Connect people through everyday interaction;
- Engage the community in designing streets "from the bottom up;"

- Create inviting spaces with engaging architecture, landscaping, and public art that reflect the diversity and cultures of the community;
- Foster healthy and safe commerce;
- Strengthen and enhance neighborhoods as envisioned by community members without displacing residents;
- Encourage active and healthy lifestyles;
- Integrate environmental stewardship, water management, energy conservation, and preservation of plant life;
- Vary in character by neighborhood, density, and function.

Multimodal Palm Beach Boulevard
Walkable communities are livable communities.
(Downtown Fort Myers)

GOALS

By establishing guidelines that promote safer, healthier streets as part of the *City of Fort Myers Complete Streets Guidelines,* the following goals are achievable:

- Provide transportation options for people of all ages, abilities, and income levels;
- Support land uses and public mobility means that service the street;
- Encourage multimodal transportation options including walking, bicycling, and mass transit;
- Enhance the safety and function of streets, from both traffic and pedestrian perspectives;
- Provide sufficient landscaping along streets and sidewalks that will shade pedestrians and bicyclists from the sun thereby diminishing the "heat-island effect;"
- Maximize infiltration and reuse of stormwater and reduce unfiltered stormwater runoff

into watersheds;
- Reduce greenhouse gas emissions and other air pollution contaminants;
- Reduce energy consumption;
- Promote the economic well-being of businesses and residents;
- Increase civic space and encourage human interaction;
- Efficiently utilize paved areas to accomplish healthier living opportunities;
- Provide increased opportunities for physical activity; and,
- Create livable neighborhoods that connect communities.

POLICIES

Policies help to implement the vision and goals. Table 2.1 below presents Complete Streets policies in support of the ten elements for Complete Streets established by the National Complete Streets Coalition. By following these established policies, the City of Fort Myers will carry out the vision of Complete Streets. It is intended that these policies become enacted through a Complete Streets ordinance or resolution.

Table 2.1 Fort Myers Complete Streets Coalition Elements and Policies

Complete Streets Elements	Complete Streets Policies
Vision	The City of Fort Myers will develop policies and practices that promote the design of their streets according to the Vision expressed in this chapter.
All Users and All Modes	The City of Fort Myers will incorporate the full range of appropriate Complete Streets elements when planning and designing its transportation networks. The City of Fort Myers will enhance the safety, access, convenience, and comfort for users of all ages and abilities. The City of Fort Myers designers understand that children, seniors, and handicapped citizens require special accommodations. The City of Fort Myers will plan, design, and build high-quality mobility access for pedestrians, bicyclists, and transit users.
Connectivity	The City of Fort Myers will design, operate, and maintain a transportation system that provides a highly connected network of streets that accommodate travel for all stakeholders. The City of Fort Myers will provide non-vehicular connectivity to services and amenities, and

3. STREET NETWORKS AND CLASSIFICATIONS

INTRODUCTION

This chapter describes the inter-relationship between the broader network of streets, how streets are classified, and how this affects the experience of the network user. It presents how the principles of Complete Streets can be used in the planning for urban street networks. The consideration of Complete Streets principles in the network and corridor planning processes will contribute to the consideration of key issues and community objectives.

The United States has a long and distinguished history of creating memorable and enduring cities, such as Savannah, Charleston, Washington, D.C., Boston, Santa Monica, and San Francisco. These cities are memorable and enduring partly because of their street networks. Well-planned street networks help create sustainable cities that support the environmental, social, and economic needs of their residents.

The street network configuration affects three fundamental aspects of urban transportation; Safety, Mode Choice, and Emergency Response.

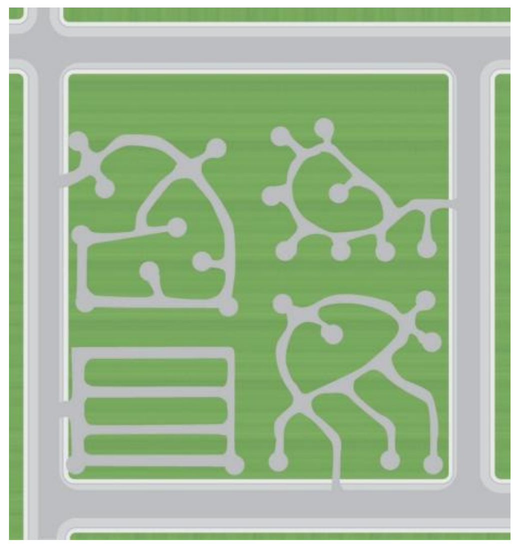
The Link to Safety

- **Sustainable street networks improve traffic safety**.
  Over 30,000 people perish each year in traffic crashes. 4,092 pedestrians died in traffic crashes in 2009, which represented 12.1 percent of all traffic fatalities, accounting for a significantly higher percentage than their typical mode share would indicate. Bicyclists, termed *pedalcyclists* in the analysis, are also overrepresented; 630 bicyclists died in traffic crashes in 2009, which represented 1.9 percent of all traffic fatalities (National Highway Traffic Safety Administration, Fatality Analysis Reporting System [FARS], 2009 data).

  A well-designed street network is a powerful tool for reducing traffic crashes and fatalities while creating beautiful landscapes and choices of mobility. The definition of **street hierarchy,** in an urban planning context, is a technique for laying out road networks that exclude automobile through-traffic from developed areas. It is conceived as a hierarchy of roads that embeds the link importance of each road type in the network topology (the connectivity of the nodes to each other). Street hierarchy restricts or eliminates direct connections between certain types of links, for example residential streets and arterial roads, and allows connections between similar order streets (e.g. arterial to arterial) or between street types that are separated by one level in the hierarchy (e.g. arterial to highway and collector to arterial.) By contrast, in many regular, traditional grid plans, as laid out, higher order roads (e.g. arterials) are connected by through streets of both lower order levels (e.g. local and collector.) An ordering of roads and their classification can include several levels and finer distinctions as, for example, major and minor arterials or collectors.

Hierarchical street patterns, such as arterial-collector-local street networks, with cul-de-sac subdivisions, do not perform as well as sustainable street networks and cause more traffic crashes because they divert traffic to high-speed arterials with large intersections. Even local travelers on short trips must use arterials when there is no supporting network of connected collector streets designed to provide access to residential properties, and the speed at which motor vehicles move on these arterial streets increases the severity of crashes.

A 2011 study of 24 California cities found a 30 percent higher rate of severe injury and a 50 percent higher chance of dying in cities dominated by sparsely connected cul-de-sacs compared with cities having densely connected street networks[1]. A 2009 study from Texas found that each mile of arterial roadway is associated with a 10 percent increase in multiple-vehicle crashes, a 9.2 percent increase in pedestrian crashes, and a 6.6 percent increase in bicyclist crashes.[2]

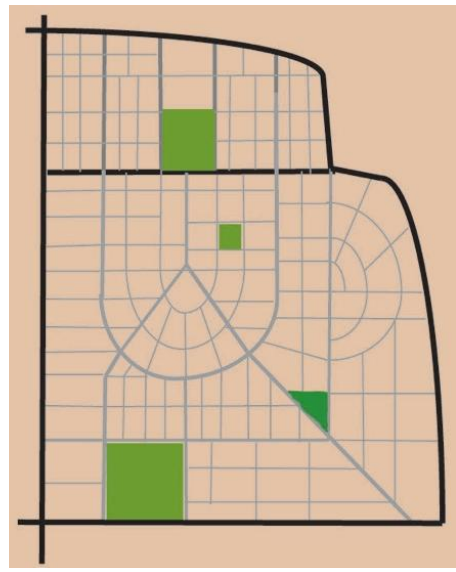


[1] Marshall, W. and Garrick, N., "Does the Street Network Design Affect Traffic Safety?" *Accident Analysis and Prevention* 43[3]: 769-781

[2] Dumbaugh, E. and Rae, R., "Safe Urban Form: Revisiting the Relationship between Community Design and Traffic Safety," *Journal of the American Planning Association* 75[3]:309-329

THE LINK TO MODE CHOICE

Sustainable street networks increase the Number of people walking and bicycling and also reduce vehicle miles traveled.



Connectivity between arterial streets and local s enables people to take shorter travel routes. It also enables them to travel on quieter streets. These shorter routes on quiet streets are more conducive to bicycling and walking. The California study cited above found that places with a densely connected street network had three to four times more people walking, bicycling, or using transit to get to work. This in turn led to a 50 percent reduction in vehicle miles traveled per capita in these cities (Marshall, W. and Garrick, N., "*The Spatial Distribution of VMT Based upon Street Network Characteristics*," 90th Meeting of the Transportation Research Board, Washington, D.C., January 2011).

THE LINK TO EMERGENCY RESPONSE

- **Sustainable street networks allow effective emergency response.**
  Two primary reasons why sustainable grid street networks work better for emergency response are:
  1. Maximizing the number of addresses served from each station, and
  2. Providing a redundancy of routes.

Studies in Charlotte, North Carolina, found that when one connection was added between cul-de-sac subdivisions, the local fire station increased the number of addresses served by 17 percent and increased the number of households served by 12 percent. Moreover, the connection helped avoid future costs by slowing the growth of operating and capital costs; most of the cost to run a fire station is in salaries. Furthermore, Congress for the New Urbanism's (CNU) report on emergency response and street design, found that emergency responders favor well-connected networks with a redundancy of routes to maximize access to emergencies. Emergency responders can get stuck in cul-de-sacs and need options when streets back up ("*Effect on Connectivity on Fire Station Service Area and Capital Facilities*," 2009 presentation by the Charlotte, North Carolina Department of Transportation).

THE LINK TO ECONOMIC ACTIVITY

In addition to transportation benefits, broader community goals such as economic activity and Healthy Communities are supported by sustainable grid street networks.

- **Sustainable and resilient street networks foster economic and social activity.** Sustainable street networks help constrain traffic growth by limiting the number of traffic lanes and increasing other travel modes that collectively promote a framework for safe, livable communities, where the human scale of the individual and the act of walking represent the basic unit of design. An ideal sustainable street network that provides opportunities for all modes of travel enhances social equity in support of high-quality design at all levels - buildings, neighborhoods, and regions. The resulting communities translate into beautiful settings that promote healthy living and high economic value.

  An excellent local example of this principle is the downtown district of Fort Myers. The downtown area originated in the 1920's around a grid street network. Over the many years, local real estate studies have consistently found that the downtown area enjoys the most resilient and sustainable values in Lee County. Downtown commercial lease rates remain at a premium. Although no new office space is likely for downtown in the near future, planned development of multi-family residential could actually spur more activity resulting in even higher demand for office space. This demonstrates the positive impact of mixed-use areas and a sustainable grid street network.

  Affordable housing also benefits from a sustainable grid street network. Affordable and/or subsidized housing developments are often located in older neighborhoods with at least a partial grid street network in place. This allows residents to take advantage of the transportation benefits offered by shorter walks to work or public transportation, and being able to bicycle on connected local streets and collectors, rather than arterial boulevards.

  A recent report from the Center for Real Estate at the Massachusetts Institute of Technology (MIT) debunks the notion that affordable housing developments depress the values of nearby single-family dwellings. Using data from 36,000 property sales between 1982 and 2003, the researchers found that home value changes over time in the areas near affordable housing developments simply "tracked" those in nearby market areas with no affordable housing options (Pollakowski, H., Ritchay, D., and Weinrobe, Z, "*Effects of Mixed-Income, Multi-Family Housing Developments on Single-Family Housing Values*" April 2005).

THE LINK TO HEALTHY COMMUNITIES

- **A sustainable and resilient street network enhances active transportation and community vitality.**

  By enhancing connectivity, traditional grid-street networks give residents the option to walk or bike to desired destinations including shopping areas, parks, restaurants, libraries, cultural centers, transit stations, places of worship, and places of work. Connectivity promotes an efficient path with a selection of route and travel options. Grid street networks attract travelers who may not feel comfortable on arterials and prefer local streets. As a result, community vitality increases because active transportation enhances positive interaction with neighbors, unlike with automobiles where little or no interaction is possible.

  Solutions that have the broadest impact occur at the network level rather than at individual street segment level. Design of the network level establishes the parameters for design of the individual street level.

  The studies such as the ones cited above provide strong evidence that the benefits of a well-designed street network go beyond safety; they include health, environmental, social, and economic gains. Sustainable street networks shape land use markets and support compact development which in turn, decreases the costs of travel and provides utilities.

  Street networks like these are resilient over hundreds of years and accommodate changing lifestyles, technology, and travel patterns. Interconnected street networks can preserve habitat and important ecological areas by condensing development, reducing city edges, and reducing sprawl.

ESSENTIAL PRINCIPLES OF SUSTAINABLE STREET NETWORKS

Sustainable street networks promote the following principles:

- Blend together the natural and built-up environments.
- Encourage trips by walking, bicycling, and mass-transit commuting.
- Promote destinations that are within walkable commutes and pedestrian friendly

environments.

- Protect, respect, and enhance a city's natural, ecological systems.
- Maximize social and economic activity.

APPROACH

Sustainable street networks provide the following outcomes:

- High level of connectivity such as motorists, pedestrians, bicyclists, and transit riders choose the most direct routes to access urban destinations.
- Interspersed arterial thoroughfares with intermediate collector thoroughfares serve local trips in nearby neighborhoods.
- Network capacity is built through densely connected networks of small streets rather than on super-wide arterial facilities with high-capacity travel.
- Expanded definition of collectors recognize their role in connecting local origins with

  local destinations rather than just connecting local streets to arterial boulevards.

- Multimodal street network planning is integrated into long-range comprehensive, transportation, and land use plans.

STREET CHARACTERISTICS AND CLASSIFICATIONS

A sustainable street network provides a multimodal pattern of streets that serve all community land uses and facilitates easy access to local, city, and regional destinations. The pattern gives priority to non-motorized modes which results in distribution of traffic that is consistent with the desired function of the street. One characteristic of this pattern is that it offers many route choices that connect origins with their destinations.

A street network's most prominent feature is the provision of a variety of street types. The variety is enforced by the pattern of the street network itself, but also by the design of individual street segments. Natural and built-up features, including topography and popular community destinations, should be taken into account to create unique designs.

Connectivity Index

A Connectivity Index provides information about how well a street network connects destinations in terms of quantity. Indices are useful in measuring between motorized and non-motorized travel. Several useful methods of measurement are:

- Link to Node Ratio – This is an index of connectivity equal to the number of links divided by the number of nodes within in a study area. Links are defined as roadway or pathway segments between two nodes, or intersections. Ewing (1996) suggests that a link-node ratio of 1.4, about halfway between extremes, is a good target for network planning purposes. At least three cities have adopted the link-node ratio as a standard, with values of 1.2 and 1.4 (Handy et al., 2003)[1] A higher index means that travelers have increased route choices, allowing more direct access connects between two locations.
  [1]*Measuring Network Connectivity for Bicycling and Walking, 2004,* Jennifer Dill, Ph.D.

- Intersection/Dead-end Ratio - The ratio of intersections divided by the sum of intersections and dead-ends, expressed on a scale from zero to one (U.S. Environmental Protection Agency, 2002). The closer the index is to 1.0, the more connected the street network. A Ratio of 0.75 is desirable

- Intersection Density - Determining the number of surface street intersections within a given geographic area, such as a square mile determines intersection density. The greater number of intersections yields the greatest degree of density and connectivity.

- Route Directness Index - An Accessibility Index as the ratio of direct travel distances to actual travel distances. Well-connected streets result in a high index. Less connected streets with large blocks result in a lower index.

Source: Victoria Transport Policy Institute (VTPI) www.vtpi.org

In new subdivisions, integrating a network of shared-use pathways and earthen trails into the street network is worthy of consideration. Under this concept, every fourth or fifth pathway/street provides quiet, comfortable access for all travelers along a linear parkway without motor vehicles. Where these streets intersect, they become intersections with appropriate treatments. This type of network would allow people to circulate in their new communities to schools, parks, stores, and offices while staying primarily on dedicated paths and trails. These networks can also link to paths and trails along waterways, utility corridors, rail rights-of-way, and other more common active transportation corridors. The adjacent diagram illustrates this concept.

Descriptions of the types of streets used in the network design standards follow, (See item # 13, p. 3-10). The types differ in terms of their network continuity, cross-section design, and adjoining land use. The individual streets themselves will change in character depending on their immediate land use context.

CONTEXT: THE TRANSECT

Context is the environment in which the street is built and includes the placement and frontage of buildings, adjacent land use or open space, and historic, cultural characteristics that form the built and natural environments of a given place.

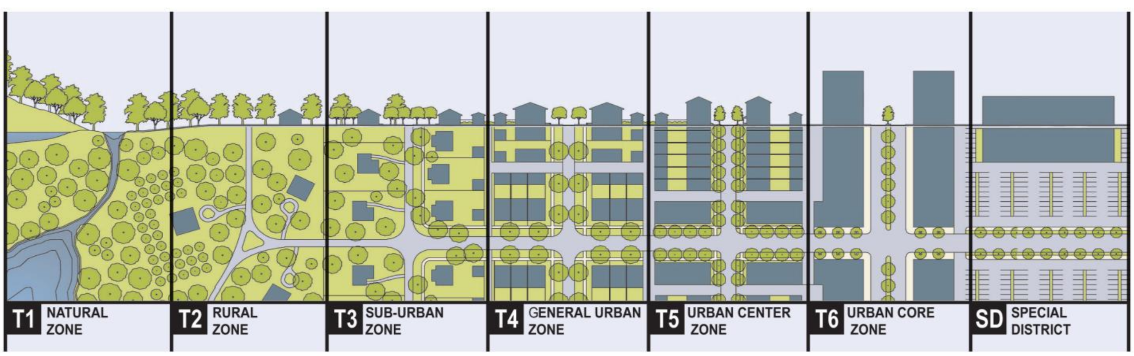
Transect is a recognized tool for defining the context and assists designers in creating an appropriate design for the context. *Duany, Plater- Zyberk & Co., Architects and Town*

Planners, defines Transect as a master planning tool that guides the placement and form of buildings and landscape, allocates uses and densities, and appropriately details civic spaces, including the selection of tree types and lighting poles for thoroughfares.

The cross-section below can be used to identify a set of habitats that vary by their level and intensity of urban character - a continuum that ranges from rural to urban.

The Transect seeks to rectify the inappropriate intermixing of rural and urban elements known as sprawl. No desire for a particular type of development is categorically "wrong;" it is just in the wrong Transect location. The Transect eliminates the "urbanizing of the rural" - office towers in otherwise pristine environments - or equally damaging, the "ruralizing of the urban" - undefined, vacant open space in the urban core. The prescribed urban pattern is therefore based on, theoretically, finding the proper balance between natural and human-made environments along the rural-to-urban Transect.[1] Each T-Zone is highly walkable and assumes the pedestrian mode as a viable and often preferred travel mode, especially for the ¼ mile or five-minute walk.

[1] *Urban Design Derived from Nature, http://www.dpz.com/Initiatives/Transect*



The Transect zones (Credit: Duany, Plater, Zyberk & Co.)[1]

The T3 suburban zone defines the urban to rural edge. Of all the T-Zones, T3 appears most like conventional sprawl. It has single-family dwellings, a limited mix of uses and housing types, and tends to be more automobile-oriented than T4, T5, or T6. The five-minute test of walkable distance (¼ mile radius) limits the overall size of a T3 transect zone. The T3 zone often defines the edge of the more developed urban condition, so it is sometimes called the "neighborhood edge." For example, knowing that a particular area is a T5, Town Center, defines the context for the built environment including the street design criteria and elements, such as the width of sidewalks, the presence of on-street parking, and the use of tree wells instead of planting strips.

Buildings built to the sidewalk with on-street parking, for instance, are appropriate in T5 and T6. Referring to a set of tables and design recommendations correlated to the transect helps the designer determine how a street should function in each T-Zone.

Contexts will not always flow evenly and incrementally from T1 to T6; there may be gaps. For example, T2 jumps to T5 may occur, or a rural community may have only T2 with a community center that is not urban enough to be T5. For example, a church, convenience store, antique store, and gas station are at the one intersection in the entire town.

An important element of the design process is to ensure that the travelled-way design fits the context of the intended design. Through use of a regulating plan, an appropriate street design is designed to fit the context, purpose, and type of street.

DESIGN STANDARDS

1. Establish a perimeter block-size maximum of 1,320 linear feet.
   - Ensure greater accessibility within the block through alleys, service courts, and other access ways.
   - Where block size is greater, retrofit large blocks with new street, alley, pedestrian, and/or bicycle connections.
   - For existing street networks, do not allow street closures that would result in larger blocks.

2. The basic form/shape of the street network system is dependent upon the spacing and alignment of the major thoroughfares or continuous boulevards and avenues. Major continuous thoroughfares should be spaced based on context zone as follows:
   - Dense urban centers (T-5 and T-6)
     - ✓ Thoroughfares @ 1,320 feet
   - General urban centers (T-4)
     - ✓ Thoroughfares @ 2,640 feet
   - Conventional suburban areas
     - ✓ Thoroughfares @ 5,280 feet

3. Require multiple street connections between neighborhoods and districts across the whole region by having boulevards and avenues that extend beyond the local area. Multiple local streets must also connect with the adjacent neighborhoods.

4. Connect streets across urban freeways so that pedestrians and bicyclists have links to neighborhoods without having to use streets with freeway on and off ramps.

5. Maintain network function by accepting growth and/or the natural expansion of the street network, including development, redevelopment, intensification, or revitalization, while avoiding increases in street width or in number of lanes.

6. Provide on-street, curbside parking on most streets. Exceptions can be made for very narrow streets, streets with bus lanes, or where there is a better use of the space.

7. Establish maximum speeds of 25 to 35 mph, depending on the street type.
   - Use design features that support lower-speed environments including tight corner radii, travel lanes of 10 to 11 feet in width, robust landscaping, and frequent, marked pedestrian crosswalks.
   - On local streets, the speed should be 25 to 35 mph, depending on the street type

8. Maintain network quality by discouraging the following poor connectivity features:
   - One-way Streets
   - Turn Prohibitions
   - Full or Partial Closures (except on bike boulevards, or areas taken over for other uses of public space)
   - Removal of On-Street Parking (except when replaced by wider sidewalks, an enhanced streetscape, bus lanes, bike lanes, etc. rather than additional vehicle lanes)
   - Gated Streets
   - Widening of Individual Streets
   - Conversion of City Streets to Limited Access Facilities

9. Include a system of connected bicycle facilities with parallel routes no more than one-half mile apart.

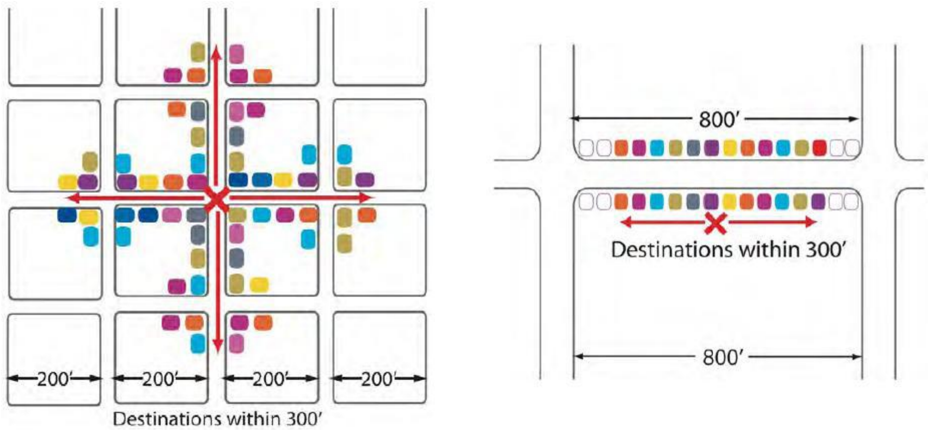
10. Pedestrian facilities should be defined by block lengths and should be located on both sides of streets.

11. Local streets should be configured in a fine-grained, multimodal network that is internal to neighborhoods.

12. Pedestrian shortcuts should be provided in locations where the network is broken.

13. Classify major streets using the common street and context types presented in Table 3.1, Common Street Types. Some streets, however, are unique and deserve a special category that lies outside the common street network types. Table 3.2, Special Street

Types, describes these special streets. Chapter 4, "Traveled Way Design," contains guidance related to cross sections of these street types. New street types should be welcomed, as well.



Many more destinations can be reached walking 300' within a network of short blocks than in one with long blocks (Credit: Marty Bruinsma)

TYPES AND ROLES OF STREETS

The Federal Highway Administration (FHWA) Functional Classification Guidelines contain the conventional classification system commonly accepted to define the function and operational requirements for streets. These classifications are also the primary basis for geometric design criteria.

Traffic volume, trip characteristics, speed, level of service, and other factors in the functional classification system relate to the mobility of motor vehicles, not necessarily to bicyclists or pedestrians. This approach, while appropriate for high speed rural and some suburban roadways, does not provide designers with guidance on how to design for Complete Streets or in a context-sensitive manner.

The street types described herein provide mobility for all modes of transportation with a greater focus on the pedestrian. The functional classification system can be generally applied to the street types in this document. Designers should recognize the need for greater flexibility in applying design criteria, based more heavily on context and the need to create a safe environment for pedestrians, rather than strictly following the conventional application of functional classification in determining geometric criteria.

(It should be noted that many local governments, including the City of Fort Myers, use the terms "Avenue" or "Street" in combination with the street name as a way to differentiate streets running north and south from those running east and west (e.g., 1st Street, 1st Avenue); these uses differ from the definitions used in this manual.)

The following sections describe the street types specifically for Complete Streets:

<u>Boulevard</u>

A boulevard is a street designed for high vehicular capacity and moderate speed, traversing an urbanized area. Boulevards serve as primary transit routes. Boulevards should have bike lanes.

Boulevard example: Hillsboro Boulevard
(Credit: City of Deerfield Beach)

Boulevards are similar to arterials in the conventional street functional classification system. Boulevards may be equipped with bus lanes or side access lanes, buffering sidewalks, and buildings. Many boulevards also have landscaped medians.

Avenue

An avenue is a street of moderate to high vehicular capacity and low to moderate speed

acting as a short distance connector between urban centers and may be equipped with a landscaped median. Avenues are similar to collectors in the conventional street classification system.

Avenue example, (Credit: Kimley-Horn and Associates, Inc.)

Street

A street is a local, multi-movement facility suitable for all urbanized transect zones all frontages, and uses.

A street is urban in character, with raised curbs, except where curb-less treatments are designed, drainage inlets, wide sidewalks, parallel parking, and trees in individual or continuous planters aligned in an alley.

*Commercial Street, Sanford, FL
(Credit: Billy Hattaway)*

Residential Street (Credit: Kimley-Horn and Associates, Inc.)

Character may vary in response to the commercial or residential uses lining the street.

Alley/Lane

An alley or lane is a narrow street, often without sidewalks. Alleys and lanes connect streets and can provide access to the backs of buildings and garages.

Residential Alley, Chapel Hill, NC (Credit: Ryan Snyder)

Commercial Alley, Boca Raton, FL (Credit Kimley-Horn & Asso.)

Table 3.1 provides a list of common street types and defines them according to functionality.

Table 3.1 Common Street Types

Street Type	Description	Comment
Boulevard* (conveniently called arterials)	Traverse and connects districts and cities; primary a longer distance route for all vehicles including transit.	Often has a planted median. Should have bike lanes and sidewalks standard. May have shared-use paths.
Avenue* (conveniently called collectors)	Traverse and connects districts, links streets with boulevards. For all vehicles including transit.	May or may not have a median. Should have bike lanes and sidewalks.
Street* (conveniently called local streets)	Serves neighborhood, connects to adjoining neighborhoods; serves local function for vehicles and transit.	Can be commercial or residential. Bicycles are served by shared space. Commercial streets should always have sidewalks. Residential streets should have sidewalks unless traffic volumes are less than 1,200 per day and speeds are 25 MPH or less.
Alley/Lane	Link between streets; allows access to garages	Narrow and without sidewalks
*May have segments with specialized functions and features such as a Main Street segment.		

The special street typologies listed in Table 3.2 have particular functions within the street network.

Table 3.2 Special Street Types

Street Type	Description	Comment
Main Street	Slower vehicle speeds, favors pedestrians most, contains the highest level of streetscape features, typically dominated by retail and other commercial uses	Functions differently than other streets in that it is a destination
Drive	Located between an urbanized neighborhood and park or waterway	
Transit Mall	The traveled way is for exclusive use by buses or trains, typically dominated by retail and other commercial uses	Excellent pedestrian access to and along the transit mall is critical. Bicycle access may be supported.
Bike Boulevard	A continuous through street for bicycles, but short distance travel for motor vehicles	Usually a local street with low traffic volumes and low speeds
Shared Space	Slow, curbless street where pedestrians, motor vehicles, and bicyclists share space	May support café seating, play areas, and other uses

4. TRAVEL WAY DESIGN

INTRODUCTION

Streets and their geometric design have traditionally focused on the movement of motor vehicles resulting in street environments that neglect other users. This emphasis can be seen in wide travel lanes, large corner radii, and turn lanes that severely impede the safety of pedestrians and the overall connectivity for non-automobile users. The geometric design of the travel way and intersections has usually reflected the need to move traffic as quickly as possible. A renewed approach to the design of public streets now requires the need to consider alternate modes of travel that includes pedestrians and bicyclists, which embodies the principles of Complete Streets.

Wide, uninviting boulevard; a typical existing condition
(Credit: City of Fort Myers)

The travel way is the portion of the roadway pavement, exclusive of shoulders and bicycle lanes, marked to separate opposing traffic or vehicles traveling in the same direction. Traffic lanes include through travel lanes, auxiliary lanes, turn lanes, weaving, passing, and climbing lanes. They provide space for passenger cars, trucks, buses, recreational vehicles and, in some cases, bicycles (Topic #625-000-007 Plans Preparation Manual, Volume 1, January 1, 2016). Design of the travel way is critical to design of the entire right-of-way, because the travel way typically utilizes the largest portion of the right-of-way, and it affects not just the users in the traveled way, but those using the balance of right-of-way, including the areas adjacent to the travel way often used for sidewalks and bicycle lanes.

ESSENTIAL PRINCIPLES OF TRAVEL WAY DESIGN

The following key principles should be considered for a well-designed travel way.

- **Design to accommodate all users.** Street design should accommodate *all* users of the street, including pedestrians, bicyclists, transit users, automobiles, and commercial vehicles. A well-designed travel way provides appropriate space for all street users to coexist.

Design to accommodate all users.
Everyone from schoolchildren to the elderly should feel safe using our streets.
(Credit: City of Fort Myers)

- **Design using the appropriate speed for the surrounding context.** The posted speed **limit** should respect the desired role and responsibility of the street, including the type and intensity of land use, urban form, the desired activities on the sidewalk, such as outdoor dining, and the overall comfort of pedestrians and bicyclists. The speed of vehicles impacts all users of the street and the livability of the surrounding area. Lower speeds reduce crashes and injuries.
- **Design for safety.** The safety of all street users, especially the most vulnerable users, (children, the elderly, and disabled), and modes, (pedestrians and bicyclists), should be paramount in any design of the travel way. The safety of streets can be dramatically improved through proper geometric design and operational considerations.

Building on the momentum of successfully implemented Complete Streets programs in different parts of the nation and around the world, there is a strong need for the City of Fort Myers to retrofit existing streets and create new types of street environments that reflect the values and desires of all users. This chapter discusses different factors affecting travel way design. Individual geometric design elements, such as lane width and sight distance, are examined in greater detail. The benefits and constraints of each element are examined. The appropriate location and correct use of each element is defined to maximize the creation of Complete Streets.

FACTORS AFFECTING STREET DESIGN

USERS

Pedestrians

Walking is the most basic mode of transportation, yet pedestrian mobility at times is significantly restricted in roadway design. These restrictions sometimes occur where limited right-of-way is available, which creates competition for the space needed to accommodate traffic lanes and the level of service (LOS) needs versus the pedestrian mobility needs. Where roadways at intersections are significantly wide, pedestrians crossing from one side of the intersection to the other side are challenged to swiftly cross the roadway within the existing signal timing restrictions that often favor the motorists and LOS needs over the crossing pedestrians. These deficiencies contribute to vehicular – pedestrian accidents. The most common crash type is a conflict between a crossing pedestrian and a turning vehicle at an intersection. Most pedestrian crashes occur when a person crosses the road.

Certain areas, such as downtown, residential, commercial, entertainment, and school districts, generate high pedestrian activity. These areas must consider the safety needs of these high pedestrian activity when designing streets. Many of the vehicular-pedestrian accidents are attributed to speed. As speeds increase, drivers are less attentive to what is happening on the side of the road. A driver's reaction time is increased, and therefore, the pedestrian has a higher probability of getting severely injured in case of a crash.

Designing for pedestrians, however, should not focus primarily on avoiding crashes. The goal of roadway and intersection design should be to create an environment that is conducive to walking; where people can walk along a sidewalk and cross the road, and where the roadside becomes a place that people want to be.

Complete Streets promotes two effective methods to achieve these goals:

1. Minimize the footprint dedicated to motor vehicle traffic, and
2. Reduce the posted speed limit of moving traffic.

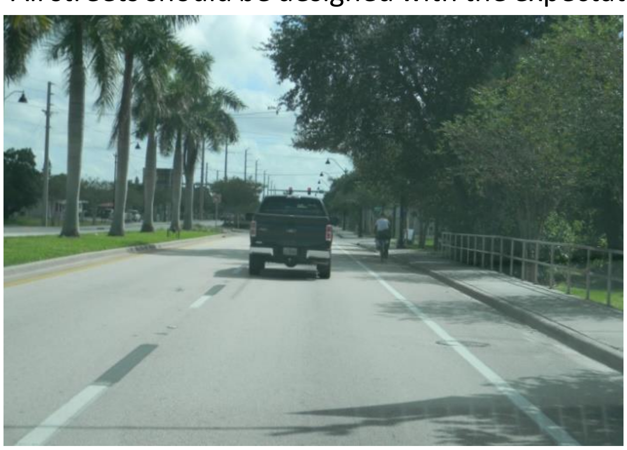
This approach allows the designer to use many features that enhance the walking environment and in turn, slows traffic; a virtuous cycle. Shady trees, curb extensions and street furniture are examples of these features that enrich the experience of pedestrian travel. All streets should have sidewalks except for rural roads.

Pedestrian crossing a super-wide street with very long block spacing
(Credit: City of Fort Myers)

See Chapter 6, Universal Pedestrian Access, for specifics of sidewalk design and Chapter 7, Pedestrian Crossings, for the specifics of pedestrian crossings.

<u>Bicyclists</u>

All streets should be designed with the expectation that bicyclists will use them. This expectation is consistent with *Florida State Statute 316* and the (FDOT) Florida Department of Transportation (PPM) Plans Preparation Manual. This does not mean every street needs a dedicated bicycle facility, nor will every road accommodate all types of bicyclists. Minimizing the footprint dedicated to motor vehicle traffic and slowing down the speed of moving traffic increases the safety factor for bicyclists. Chapter 8, “Bikeway Design,” describes in greater detail the various types of bikeways and their application.



Bicyclist in Commercial Boulevard bike lane
(Credit: City of Fort Myers)

Ideally, all multi-lane streets should have bike lanes. On multi-lane streets, where bike lanes aren't feasible because of space constraints, other bikeway treatments should be applied.

Public Transportation

Designing for public transit vehicles on roadways takes into consideration many factors:

- Buses have operational characteristics that resemble trucks.
- They operate in mixed traffic.
- They stop and start often for passengers.
- They must be accessible to people boarding the bus.

The consequences for roadway design are many. Examples include:

- Lane width (in most cases buses can operate safely in travel lanes designed for passenger cars),
- Intersection design (turning radius or width of channelization lane).
- Signal timing,
- Pedestrian access (crossing the street at bus stops),
- Sidewalk design (making room for bus shelters in the furniture zone
- Bus stop placement and design (far side/nearside at intersections, bus pullouts, or bulb outs).

LeeTran bus station at Rosa Park
(Credit: City of Fort Myers)

Emergency Vehicles

Major urban arterial boulevards and avenues are the primary conduits for emergency response vehicles including police, fire, and ambulance. Emergency vehicle access and operations should always be considered in travel way design. Many factors affect emergency vehicle response time including congestion, width of street and travel lanes, geometric design of intersections, access management features, signal timing, and the presence of signal pre-emption devices.

The following principles should be considered in designing traveled ways to accommodate emergency vehicles:

- High levels of street connectivity improve emergency response time by providing alternate routes. Look for opportunities to improve overall network connectivity.
- When establishing new or reviewing existing access management configurations, care should be taken to permit direct routing capability to emergency vehicles.
- On streets with medians, traffic circles, tight corner radii, or other access management features, emergency response time may be reduced by the implementation of mountable curbs to allow emergency vehicles to cross.

Design Vehicles

The design vehicle influences several geometric design features including lane width, corner radii, median nose design, and other intersection design details. Designing for a larger vehicle than necessary is undesirable, due to the potential negative impacts larger dimensions may have on pedestrian crossing distances and the speed of turning vehicles. On the other hand, designing for a vehicle that is too small can result in operational problems if larger vehicles frequently use the facility. Designers should coordinate with City staff to determine necessary accommodations for safe passage of emergency vehicles.

For design purposes, the WB-40 (40-foot wheel-base) is appropriate unless larger vehicles are more common. On bus routes and truck routes, designing for the bus (CITY-BUS or similar) or large truck (either the WB-50 or WB-62FL design vehicle) may be appropriate, but only at intersections where these vehicles make turns. For example, for intersection geometry design features such as corner radii, different design vehicles should be used for each intersection or even each corner, rather than a “one-size-fits-all” approach, which results in larger radii than needed at most corners. The design vehicle should be accommodated without encroachment into opposing traffic lanes. It is generally acceptable to have encroachment onto multiple same-direction traffic lanes on the receiving roadway.

Furthermore, it may be inappropriate to design a facility by using a larger "control vehicle," which uses the street infrequently, or infrequently makes turns at a specific location. An example of a control vehicle is a vehicle that makes no more than one delivery per day at a business. Depending on the frequency, by under designing for its turning needs, the control vehicle can be allowed to encroach on opposing traffic lanes or make multiple-point turns.

Traffic Volume and Composition

Traffic volume data collection is an integral part of transportation planning and decision-making. Traffic volume data are collected for various periods of the day depending on the purpose for which the data is used. For most analyses, it is necessary to collect peak period and daily traffic volume. Peak period traffic could be further divided into morning (a.m.), mid-day (m.d.), and evening (p.m.) peak periods. Daily traffic data is also called average daily traffic (ADT). Other types of data collected are annual daily traffic, average annual daily traffic, average weekday traffic, hourly traffic (usually at intersections), and short-term counts, as required. There are special types of traffic volume counts collected, such as vehicle classification counts and average vehicle occupancy counts. The traffic volumes collected are also used for a variety of studies, including traffic forecasting. Traffic volume on a segment of a road or at an intersection can be collected either manually or by using tubes.

The ADT volume is the most commonly collected traffic volume data. The ADT provides both the peak period traffic and the total daily traffic for analysis purposes. Typical ADT data for a central business district (CBD) will show an a.m., mid-day, and p.m. peak volume, which clearly indicates the typical usage of the CBD.

Vehicle classification counts are conducted on a daily basis to determine the types of vehicles using the roadway. The vehicle classification devices currently being used accurately record axle impulses, but they do not provide consistent and accurate interpretation of axle impulses into classification of vehicles when vehicles (typically in urban areas) are traveling at speeds below 25 mph. The Federal Highway Administration (FHWA) has classified trucks into several categories based on the number of axles.

Turning movement volumes are collected at intersections to record the various turning movements. The collection of data on turning movements allows determining the level of service and making improvements to the intersection to reduce delay and idling for all vehicles. The data collected on traffic volumes and turning movements helps to determine the number of travel lanes needed.

Currently, City of Fort Myers does not conduct any traffic volume data collection for record keeping. The average daily traffic volume data is collected only for traffic calming studies. Lee County keeps record of the traffic counts.

DESIGN SPEED

The **Design Speed** is a selected speed used to determine the various geometric design features of the roadway. Fambro et al. 1997, (*15*); *MUTCD*,2000 *(16)*;AASHTO *GreenBook*, 2001 (*17*).
The Engineering approach defines **Posted Steed** as a two-step process where a base speed limit is set according to the 85th percentile speed and then modified according to the design speed for the road and other criteria. (Federal Highway Administration, *Methods and Practices for Setting Speed Limits)*

The application of design speed for Complete Streets is philosophically different than for conventional transportation practices. Traditionally, the approach for setting design speed is to use as high a design speed as practical. The intent of this approach when it was developed was to move people and goods in automobiles as efficiently as possible over long distances. In addition, it was thought that achieving similar speeds for all motor vehicles using a roadway would maximize safety by minimizing speed differentials. However, this approach has many negative effects. The risk of injuries and fatalities increases with speed. Speed inherently places efficiency over access even though access is just as fundamental. Because high design speed reduces access to places on foot, it degrades the social and retail life of a street, and devalues the adjacent land. Local economies thrive on attracting people.

In contrast to this approach, the goal for Complete Streets is to establish a design speed that creates a safer and more comfortable environment for motorists, pedestrians, and bicyclists. This approach also increases access to adjacent land, thereby increasing its value, and therefore is appropriate for the surrounding context. For Complete Streets, design speeds of 25 to 35 mph are desirable. Alleys and narrow roadways intended to function as shared spaces may have design speeds as low as 10 mph. Design speed does not determine nor predict exactly at what speed motorists will travel on a roadway segment; rather, design speed determines which design features are allowable (or mandated). Features associated with high-speed designs, such as large curb radii, straight and wide travel lanes, ample clear zones (no on-street parking or street trees), guardrails, etc., degrade the walking experience and make it difficult to design Complete Streets. In the end, the design of the road encourages high speeds. A slower design speed allows the use of features that enhance the walking environment, such as small curb radii, narrower sections, trees, on-street parking, curb extensions, and street furniture, which in turn slows traffic.

The City of Fort Myers only allows on-street parking in downtown, but no other areas except for special conditions. The speed limit is 25 mph on all local streets unless otherwise posted. The speed limits on other local streets are 35 mph, 45 mph on collectors, and 55 mph on arterials within the City.

High automobile level of service, but poor multi-modal level of service
(Credit: City of Fort Myers)

An increase in motorist travel time due to the speed reduction is usually insignificant because communities designed with Complete Streets are generally compact. When the speed reduction cannot be achieved, measures to improve pedestrian safety for those crossing the corridor should be evaluated and installed where appropriate. Posted signs signaling in advance of a speed reduction are sometimes used with success, as well as flashing-light reduced speed signs during times of high traffic.

MULTI-MODAL LEVEL OF SERVICE

Some municipalities use qualitative assessments to describe the perceived service a street provides to the people using the facility. The quality of service has conventionally been obtained using Level of Service (LOS) measurements. LOS assesses delay for motorists along a roadway section or at a signalized intersection. The LOS is defined using letters A to F, where LOS F denotes the greatest delay and LOS A, no delay. The LOS is used to develop solutions to improve the existing system to achieve the desired LOS. This convention considers quality of service for only automobiles and other vehicles, including commercial, using the roadway system. The Highway Capacity Manual (HCM) provides details of the LOS computations for roadways and intersections.

High multi-modal level of service
(Credit: City of Fort Myers)

Since travel ways are used by different modes, the multimodal level of service (MMLOS) was developed under National Cooperative Highway Research Program (NCHRP) project 3-70. The MMLOS was developed for urban streets and it is currently designed for analysis of steady state conditions during a specified analysis period. MMLOS applies to urban streets with all modes of travel (pedestrians, bicycles, cars, and transit) and assesses the impacts of facility design and operation on all users except for commercial vehicles. The MMLOS analysis provides a tool to predict travel perceptions of quality of service.

The MMLOS for the four modal usages is output as numerical ratings, which are converted into the traditional A to F letter grade system. Table 4.1 indicates the MMLOS letter grade equivalents of the numerical values obtained.

Table 4.1 MMLOS Letter Grade Equivalents

MMLOS Modal Output	MMLOS Letter Grade
Model <= 2.0	A
2.0<Model <=2.75	B
2.75<Model <=3.50	C
3.50<Model <=4.25	D
4.25<Model <=5.00	E
Model>5.0	F

Source: NCHRP-Web Only Document 128: Multimodal level of service analysis for urban streets: User Guide, 2009. Notes:

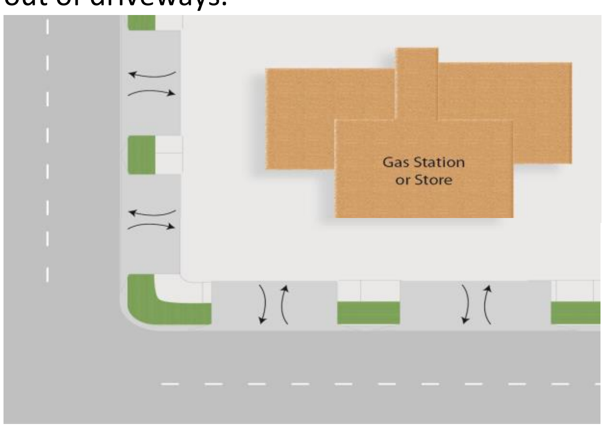
1. If any directional segment hourly volume/capacity ratio (v/c) exceeds 1.0 for any mode, that direction of street is considered to be operating at LOS F for that mode of travel for its entire length (regardless of the computed LOS).
2. If the movement of any mode is legally prohibited for a given direction of travel on the street, then the LOS for that mode is LOS "F" for that direction.

For conducting MMLOS, it is necessary to select a roadway segment that has signalized intersections, pedestrians, bicycle riders, and transit usage. The segment could have 5 to 6 signals in the selected section. The data required for conducting MMLOS includes street geometrics, such as number of through lanes, width of lanes, median width, bike lane, shoulder width, parking lane width, sidewalk width, right turn lanes, transit stops, and signalized and un-signalized intersections. The methodology provides some basic default values for use, which can be found in the reference provided at the end of this chapter.

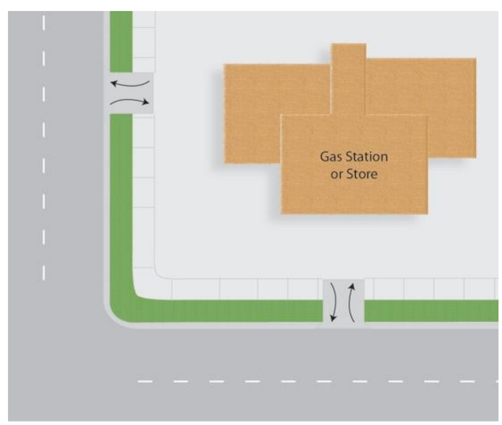
Access Management

Access management refers to properly locating and designing access to adjacent land use (context) to preserve safety and reasonable traffic flow. A major challenge in street design is balancing the number of access points to a street. As discussed in Chapter 3, "Street Networks and Classifications," there are many benefits of well-connected street networks. On the other hand, most conflicts between users occur at intersections and driveways.

The presence of many driveways in addition to the necessary intersections creates many conflicts between vehicles entering or leaving a street and bicyclists and pedestrians riding or walking along the street. When possible, new driveways should be minimized and old driveways should be eliminated or consolidated, and raised medians should be placed to limit left turns into and out of driveways.



Corner with many wide driveways
(Credit: Michele Weisbart)



Reconstructed corner with fewer, narrower driveways
(Credit: Michele Weisbart)

Access management requirements often include public street intersection spacing, especially signalized intersection spacing. FDOT's access management guidelines generally restrict signalized intersection spacing to one every one-quarter mile (1,320 feet) on major thoroughfares. In dense urban centers (Transects T-5 through T-6), continuous thoroughfares (boulevards or avenues) should be spaced every one-quarter mile (1,320 feet), which is consistent with the FDOT policy; however, a grid network of streets should intersect the major thoroughfare between signalized intersections to provide access and locations for crossings.

It has been demonstrated that good access management principles can reduce crashes by 50 percent or more, depending on the condition and the treatment used ("*Access Management Manual*," Transportation Research Board, 2002).

The following principles define good access management practices:

- Classify the street system by both function and context.
- Establish standards for intersection spacing. In urban areas, these standards should include both minimum spacing and maximum spacing. Access management studies should determine not only if minimum spacing standards are being violated, but also if maximum spacing standards are being violated (a.k.a. not enough connectivity within the network).
- Locate driveways away from intersections to minimize crashes and to minimize interference with traffic operations.
- Use curbed medians on boulevards (major thoroughfares) and locate median openings to manage access and minimize conflicts.
- Consolidate driveways in urban areas to reduce conflicts between vehicles, pedestrians, and bicyclists.

Access management through limiting driveways and providing raised medians has many benefits:

- The number of conflict points is reduced, especially by replacing center-turn lanes with raised medians since left turns by motorists account for a high number of crashes with bicyclists and pedestrians.
- Pedestrian crossing opportunities are enhanced with a raised median.
- Universal access for pedestrians is easier, since the sidewalk is less frequently interrupted by driveway slopes.
- Fewer driveways result in more space available for higher and better uses.
- Improved traffic flow may reduce the need for road widening, allowing part of the right-of-way to be recaptured for other users.

Possible Negatives of Access Management

The following possible negative effects of access management should be considered and addressed.

- Streamlining a street may increase motor vehicle speeds and volumes, which can be detrimental to other users.
- Reduced access to businesses may require out-of-direction travel for all users, including walkers and bicyclists.
- Concrete barriers and overly-landscaped medians act as barriers to pedestrian crossings. Medians should be designed with no more than normal curb height and with landscaping that allows pedestrians to see to the other side.
- Adjacent land uses can experience decreased access. This can impact businesses as well as residents. Careful planning of access management considers this.
- An overly protective approach to intersection spacing can lead to negative effects on network connectivity.

CROSS SECTIONAL ELEMENTS

Complete Street design treats streets as part of the public realm. The street portion of the public realm is shaped by the features and cross section elements used in creating the street. Attention to what features are included, where they are placed, and how the cross section elements are assembled is necessary.

CONTEXT

The first design consideration that should be addressed when determining the optimum cross section for a travel way is context. Determine the context zone and identify thoroughfare type based on the transect and classifications presented in Chapter 3. Identifying the context first establishes the general parameters for the cross section.

ON-STREET PARKING

On-street parking can be important in the urban environment (1) for the success of the retail businesses that line the street, (2) to provide a buffer for pedestrians, and (3) to help calm traffic speeds. On-street parking is efficient from a land use perspective because it occupies about half the surface area per car compared to off-street parking, which requires driveways and aisles for access and maneuvering. However, on-street parking cannot meet all of the parking demand in modern urban areas. Local jurisdictions should manage demand for on-street parking by charging market-rate prices. Free or underpriced parking encourages people to drive instead of taking transit, biking, or walking. Parking expert Donald Shoup recommends setting variable parking prices to target a 15 percent vacancy rate for curb parking. In addition to encouraging people to curtail driving, it also creates turnover that benefits retailers by making convenient parking available for short shopping trips.

Reserve-in angled parking
(Credit: City of Fort Myers)

General principles and considerations regarding on-street parking are presented below:

- On-street parking should be located based on the context of the urban roadway and the needs of the adjacent land use.
- On-street parking should be primarily parallel parking on urban boulevards and avenues.
- Orientation of parking should be determined based on design speed and ability of the right-of-way width to accommodate the desired elements.
- Use metered parking to enforce parking time limits that provide reasonable short-term parking for retail customers and visitors while discouraging long-term parking. Automated meter machines should be used for efficiency of parking management and to reduce street clutter and sidewalk obstacles.

Another tool for on-street parking is the park assist lane. Often when on-street parking is provided on busy roads, drivers find it difficult to enter and leave their parked vehicle. Where space is available, consideration should be given to adding a park assist lane between the parking lane and travel way to provide 3 feet of space so car doors can be opened and vehicles can enter or depart with a higher degree of safety and less delay. Bike lanes can serve this function as well. Parking assist lanes also narrow the feel of the travel lane and slow traffic.

Parking assist lane
(Credit: Michael Wallwork)

Curb extensions should be provided in place of on-street parking at mid-block crosswalks and intersection crosswalks. Curb extensions reduce the distance that pedestrians must cross within the travel way, help to calm traffic, and serve as opportunities for rain gardens and other forms of aesthetic enhancement.

Curb extension with rain garden
(Credit: City of Fort Myers)

On-street parking should be prohibited within 20 feet of either side of fire hydrants, at least 20 feet from mid-block crosswalks, and at least 30 feet from the corner radius of intersections (or greater if required to meet engineering sight distance requirements).

Table 4.2 below details recommended parking lane widths for slow and low movement types.

Table 4.2 Parking Lane Widths

Movement Type	Design Speed	Parking Lane Width
Slow, Avenues and Streets (residential)	20-25 mph	Parallel: 8 feet
Slow, Avenues and Streets (commercial)	20-25 mph	Parallel: 8 feet
Low, Boulevard	30-35 mph	Parallel: 8 feet

Bicycle Facilities

Bicycle facilities within the travel way may include conventional bicycle lanes, buffered bicycle lanes, contra-flow bicycle lanes on one-way streets, bicycle boulevards, other types of shared roadways (with or without shared lane markings), and cycle tracks. See Chapter 8, "Bikeway Design," for design recommendations for these facilities.

Travel Lanes

Travel lane widths should be provided based on the context and desired speed for the area in which the street is located. Table 4.3 shows lane widths and the associated speeds that are appropriate. In low speed urban environments, lane widths are typically measured to the curb face instead of the edge of the gutter pan. Consequently, when curb sections with gutter pans are used, the vehicle, bike, and parking lane all include the width of the gutter pan.

General principles and considerations in the selection of lane widths include the following.

- In order for drivers to understand how fast they should drive, lane widths have to create some level of driver discomfort when driving too fast. The presence of on-street parking is important in achieving the speeds shown in Table 4.3. When designated bike lanes or multi-lane configurations are used, there is more room for large vehicles, such as buses, to operate in, but car drivers will feel more comfortable driving faster than is desired.

Wide two-lane street (Credit: Ryan Snyder)

Narrow two-lane street (Credit: Michael Ronkin)

- Reducing travel lane width is one strategy of incorporating Complete Streets elements into the travel way design, as required in the FDOT PPM, Volume I, Chapters 2 and 8.
- Where adjacent lanes in the same direction of travel are unequal in width, the outside lane should be the wider lane to accommodate bicyclists (only where bicycle lanes are not practical).
- Yield streets are typically residential two-way streets with parking on one or both sides. When the street is parked on both sides, the remaining space between parked vehicles (12 feet minimum) is adequate for one vehicle to pass through. Minimum width for a yield street with parking on both sides should be 26 feet curb face to curb face. Minimum width for a yield street with parking on one side should be 20 feet curb face to curb face.

Table 4.3 Travel Lane Widths and Associated Design Speeds

Movement Type	Design Speed	Travel Lane Width
Yield* (shared space)	Less than 20 mph	14 feet
Slow, Avenues and Streets (residential)	20-25 mph	9*-10 feet
Slow, Avenues and Streets (commercial)	20-25 mph	10 feet
Low, Boulevard	30-35 mph	10-11** feet
Low, Boulevard Wide curb lane bicycle facility	30-35 mph	14 feet

- *9' requires a design exception, but could be considered in low volume settings where lane width narrowing would provide desired complete streets elements.
- **Generally, 10-foot lanes are preferred. On bus routes or where truck traffic exceeds 10 percent, 11-foot lanes should be considered for the outside motor vehicle travel lane only.

Alleys can be designed as one-way or two-way. Right-of-way width should be a minimum of 22 feet with no permanent structures located within the right-of-way that would interfere with vehicle access to garages or parking spaces, access for trash collection, and other operational needs. Pavement width should be a minimum of 12 feet. Coordination with local municipalities on operational requirements is essential to ensure that trash collection and fire protection services can be completed.

The lane widths presented in Table 4.3 are consistent with guidance provided by the American Association of State Highway and Transportation Officials (AASHTO), with the exception of the 9-foot lane consideration for slow speed avenues and streets in residential areas. In addition, the lane widths are consistent with FDOT's Transportation Design for Livable Communities (TDLC) in the PPM, Volume I, Chapter 21, also with the exception of the 9-foot lane consideration for slow speed avenues and streets in residential areas. It should be noted that it would be very unlikely that such as street would be an FDOT roadway. In addition, FDOT currently requires a minimum 11 feet for new construction or reconstruction; 10 feet is allowable for lane width narrowing on existing roadways when the purpose is to provide a designated bicycle facility.

<u>Turn Lanes</u>

The need for turn lanes for vehicle mobility should be balanced with the need to manage vehicle speeds, the need to provide continuous bicycle lanes, and the potential impact on the border width such as sidewalk width. Turn lanes tend to allow higher speeds to occur through intersections, since turning vehicles can move over to the turn lane, allowing the through vehicles to maintain their speed.

Left-turn lanes are considered to be acceptable in an urban environment since there are negative impacts to roadway capacity when left turns block the through movement of vehicles. Sometimes just a left-turn pocket is sufficient, just long enough for one or two cars to wait out of traffic. The installation of a left-turn lane can be beneficial when used to perform a road "diet" such as reducing a four lane section to three lanes with the center lane providing for turning movements.

In urban places, normally no more than one left-turn lane should be provided. Dual and triple left-turn lanes are typically the result of poor street connectivity within the network. While right turns from through lanes may delay through movements, they also create a reduction in speed due to the slowing of turning vehicles. The installation of right-turn lanes increases the crossing distance for pedestrians and the speed of vehicles; therefore, exclusive right turn lanes should rarely be used except at "T" intersections. When used, they should be mitigated with raised channelization islands. See Chapter 5, "Intersection Design," for more details.

The desired turn lane width is 10 feet for right-turn lanes and 10 to 11 feet for left-turn lanes.

MEDIANS

Well-designed street medians bring multiple benefits (Credit: Dan Burden)

Medians are the center portion of a street that separates opposing directions of travel. Medians used on urban streets provide access management by limiting left turn movements into and out of abutting development to select locations where a separate left turn lane or pocket can be provided. The reduced number of conflicts and conflict points decreases vehicle crashes, provides pedestrians with a refuge as they cross the road, and provides space for landscaping, lighting, and utilities. These medians are usually raised and curbed. Landscaped medians enhance the street or help to create a gateway entrance into a community.

Medians can be used to create tree canopies over travel lanes, contributing to a sense of enclosure. As shown in Table 4.4, medians vary in width. Recommended widths depend on available right-of-way and function. Because medians require a wider right-of-way, the designer must weigh the benefits of a median with the issues of pedestrian crossing: distance, speed, context, and available roadside width.

In urban areas, it may be desirable to plant trees in raised curbed medians for aesthetic purposes. Small caliper trees can be healthy in medians that are at least 6 feet wide, as long as a critical root area is provided. Larger trees are only possible when the median is at least 10 feet wide. Consult an urban forester for guidance on health requirements for trees in medians. Crash mitigation strategies on trees within the public right-of-way can be found in "*A Guide for Addressing Collisions with Trees in Hazardous Locations*," Transportation Research Board, 2003.

Avoid providing overly wide medians in urban contexts at the expense of bicycle lanes or unreasonable reductions in roadside widths for elements such as sidewalks.

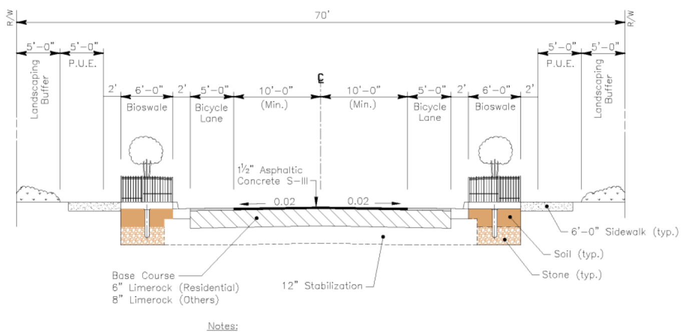
Table 4.4 Median Types and Widths

Movement Type	Minimum Width	Recommended Width
Median for access control	4 feet	6 feet
Median for pedestrian refuge	6 feet	8 feet
Median for trees and lighting	6 feet [1]	10 feet [2]
Median for single left-turn lane	10 feet [3]	10 feet [2]
Median for single left-turn lane and pedestrian refuge	16 feet [4]	16 feet

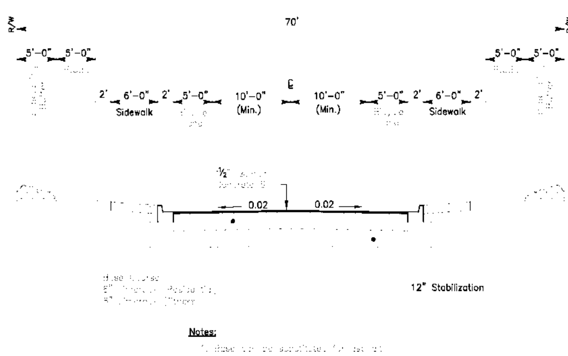
Table Notes
[1] Six feet measured curb face to curb face is generally considered the minimum width for proper growth of small caliper trees (less than 4 inches).
[2] Wider medians provide room for larger caliper trees and more extensive landscaping.
[3] A 10-foot lane provides for a turn lane without a concrete traffic separator.
[4] Includes a 10-foot turn lane and a 6-foot pedestrian refuge.

Sample Cross Sections

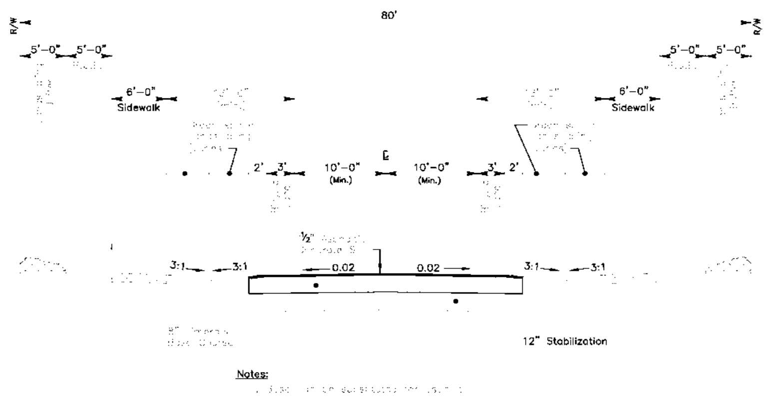
Anyone developing new subdivisions or brand new streets can create new street standards based on the information above. Sample curb-to-curb cross sections for the basic street typologies are shown in the diagrams below. These are only samples; other cross sections using the above guidance are also acceptable. When adopting standards for new streets, City of Fort Myers include the sidewalks as an integral part of the street and use the guidance provided in Chapter 6, "Universal Pedestrian Access." Local governments should reconfigure streets by reassigning space to make streets more closely meet the principles of Complete Streets presented herein. The following diagrams provide examples of how some of these apply:



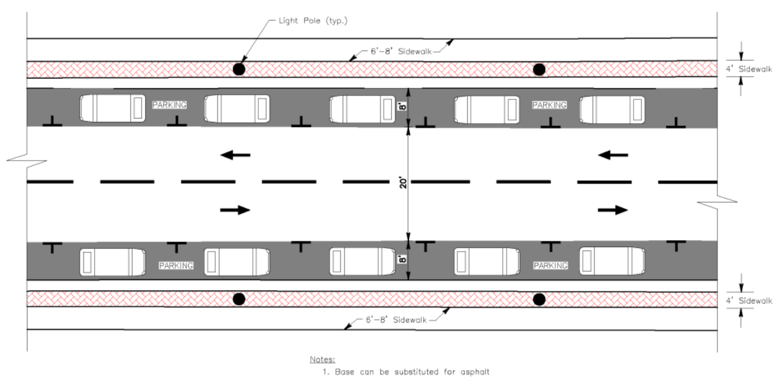
LOCAL STREETS - URBAN SECTION
PROPOSED BIORETENTION



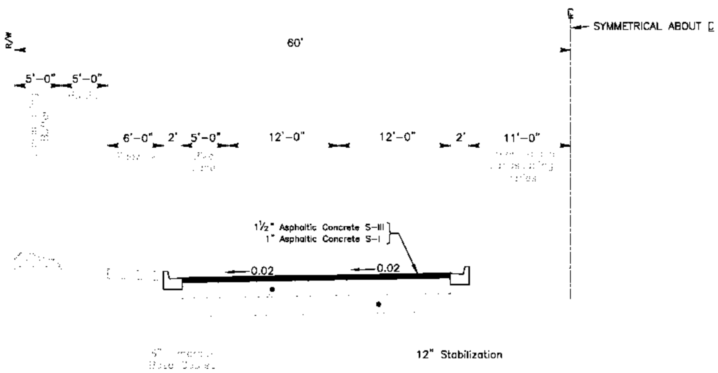
LOCAL STREETS - URBAN SECTION
PROPOSED



LOCAL STREETS - RURAL SECTION
PROPOSED

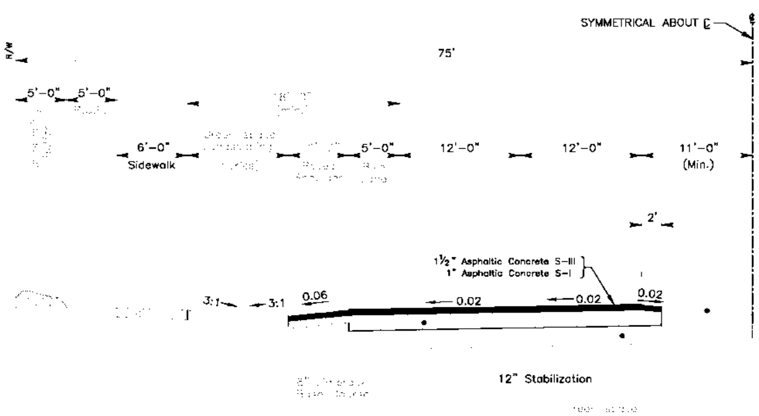


TYPICAL
DOWNTOWN ROADWAY SECTION
WITH INSET PARKING



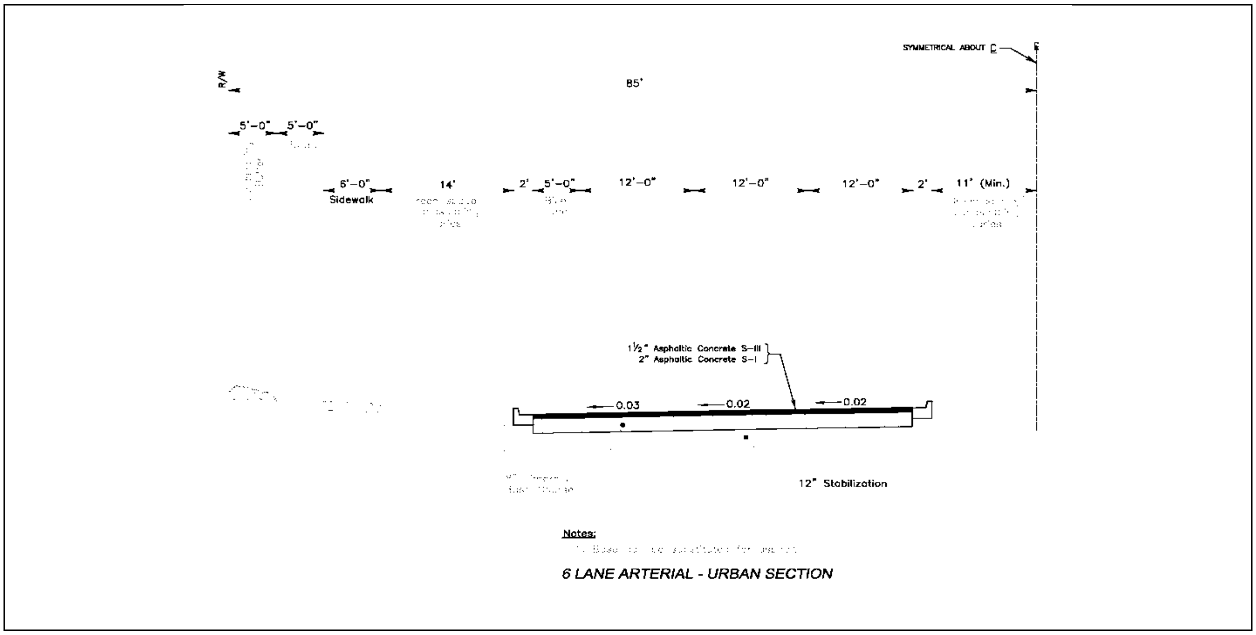
Notes:

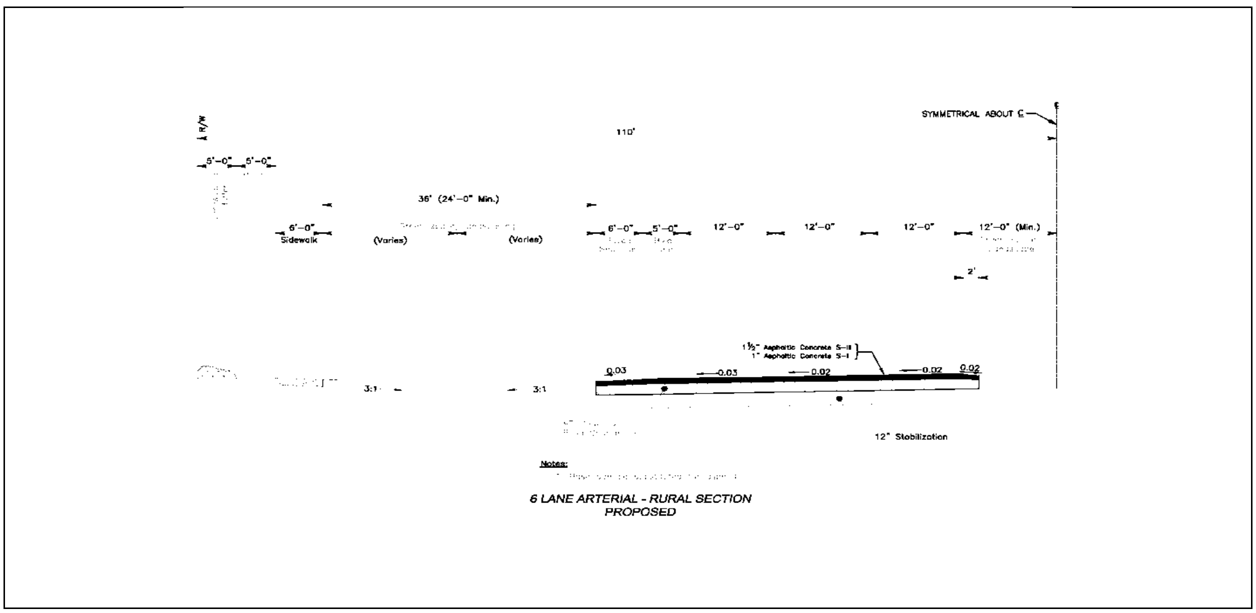
4 LANE COLLECTOR - URBAN SECTION
PROPOSED



Notes:

4 LANE COLLECTOR - RURAL SECTION
PROPOSED





OTHER GEOMETRIC DESIGN ELEMENTS

VERTICAL ALIGNMENT

The American Association of State Highway and Transportation Officials (AASHTO) *Geometric*

Design of Highways and Streets manual (AASHTO Green Book) provides acceptable values for designing vertical curves for complete streets. The values used in design of vertical curve design should be selected based on the design speed appropriate for the context of the street. Using higher values can contribute to increased vehicle speeds and may require increased modification to the natural terrain, increasing negative impacts to the natural environment.

Horizontal Alignment

The AASHTO Green Book provides appropriate values for designing horizontal curves for complete streets. The values used in horizontal curve design should be selected based on the design speed appropriate for the context of the street. Using higher values can contribute to increased vehicle speeds and also impacts the character of the street. Larger horizontal curves also create a more “suburban” or “rural” highway feel.

Transition Design

Transitions refer to a change in context, right-of-way width, number of lanes, neighborhoods, or districts. Multi-modal accommodations should be continuous through transitions. If the purpose of the transition is to change context, neighborhood, or district, then the designer should provide a transition speed zone, visual cues to changes in context or environment, and change the width of the traveled way or travel lanes as appropriate for the context.

Sight Distance

Stopping Sight Distance

The AASHTO Green Book provides appropriate values for designing stopping sight distance for Complete Streets. The 2004 AASHTO *Guide for Achieving Flexibility in Highway Design* is based on the latest research concerning the establishment of stopping sight distance. The document states that the established values for stopping sight distance are very conservative and provide adequate flexibility without creating increased crash risk. Consequently, appropriate design speed selection is critical to avoid overly negative impacts such as unnecessarily limiting on-street parking and tree planting.

Intersection Sight Distance

Intersection sight distance should be calculated in accordance with the AASHTO Green Book using the design speed appropriate for the street being evaluated. When executing a crossing or turning maneuver onto a street after stopping at a stop sign, stop bar, or crosswalk, drivers will move slowly forward to obtain sight distance (without intruding into the crossing travel lane) stopping a second time as necessary. Therefore, when curb extensions are used or on-street parking is in place, the vehicle can be assumed to move forward on the second step movement, stopping just shy of the travel lane, increasing the driver's potential to see further than when stopped at the stop bar. As a result, the increased sight distance provided by the two step movement allows parking to be located closer to the intersection.

Horizontal Clearance/Clear Zone

Horizontal clearance is the lateral distance from a specified point on the roadway, such as the edge of the travel lane or face of the curb, to a roadside feature or object. The clear zone is the relatively flat unobstructed area that is to be provided for safe use by errant vehicles.

In urban areas, horizontal clearance based on clear zone requirements for rural and suburban highways is not practical because urban areas are characterized by more bicyclists and pedestrians, lower speeds, more dense abutting development, closer spaced intersections and accesses to property, higher traffic volumes, and restricted right-of-way. Therefore, streets with curbs and gutters in urban areas do not have sufficiently wide roadsides to provide clear zones.

Consequently, while there are specific horizontal clearance requirements for these streets under normal operation, they do not maintain a clear roadside for errant vehicles. The minimum horizontal clearance is 1.5 feet measured from the face of the curb. This is primarily intended for sign posts and bicycle parking racks, so they aren't hit by large vehicles with overhangs maneuvering close to the curb. The desired horizontal clearance for bicycle parking racks is 4 feet to minimize the likelihood that a bicycle parked at the rack will not be struck by a vehicle overhang maneuvering close to the curb.

Travel Way Lighting

Pedestrians are disproportionately hit when visibility is poor: at dusk, night, and dawn. Many crossings are not well lit. Providing illumination or improving existing lighting increases nighttime safety at intersections and midblock crossings, as motorists can better see pedestrians. Pedestrian scale lighting along sidewalks provides greater security, especially for people walking alone at night.

If bus stops are present between roadway sections, it is necessary to illuminate the roadway and the bus stop. The lighting at the bus stop is essential to provide safety for transit users. Bus stops have high pedestrian activity; therefore, it is necessary to accommodate them with adequate lighting at these facilities.

5. INTERSECTION DESIGN

INTRODUCTION

Lively intersection (Credit: Dan Burden)

Most conflicts between roadway users occur at intersections, where travelers cross each other's path. Good intersection design indicates to those approaching the intersection what they must do and who has to yield. Improved safety prevails at locations where travel speeds are low (typically less than 20 mph) or where a shared space design causes users to approach intersections with caution. Conflicts for pedestrians and bicyclists are exacerbated due to their greater vulnerability, associated with smaller size, corresponding to reduced visibility to other users.

Multimodal intersections operate with pedestrians, bicycles, cars, buses, trucks, and in some cases, light rail transit. The diverse uses of multimodal intersections involve a high level of activity and shared use. These types of intersections have the unique characteristic of accommodating a regular occurrence of conflicts between the various modes. Most collisions on major roadways take place at intersections. This characteristic is the basis for most intersection design standards, particularly relating to safety. Designing multimodal intersections, with the appropriate accommodations for all users, is performed on a case-by-case basis. The designer should begin with an understanding of who the community stakeholders are, their needs and objectives, and their design priorities, especially relating to the design tradeoffs that must be considered.

This chapter describes the design considerations involving intersection geometry and intersection control features, which may include signalization, roundabouts, Stop signs, Yield signs, or other traffic control features. The benefits and constraints of each traffic control feature are examined with the goal of achieving the optimum design in consideration of safety, accessibility, and mobility for all users.

ESSENTIAL PRINCIPLES OF INTERSECTION DESIGN

The following principles apply to good intersection design:

- Provides compact and efficient movements for all users.
- Promotes functional, multi-modal modes of transportation.
- Minimizes conflicts for all users.

- Fulfills satisfactory levels of service for all mobility modes.
- Supports access management practices with respect minimizing intersection conflict points.
- Facilitates signal timings in consideration of safety and convenience for all users.
- Accommodates a fully accessible facility.

Intersections should be designed to serve all types of users comfortably, even on wide arterial boulevards (Credit: Kimley-Horn and Associates, Inc.)

INTERSECTION GEOMETRY

Intersection geometry is a critical element of intersection design, regardless of the type of traffic control device. Geometry sets the basis for how all users traverse intersections and interact with each other. The principles of intersection geometry apply to both street intersections and freeway on-off ramps.

Intersection layout primarily consists of providing safe vertical and horizontal alignments that properly accommodate the various legs comprising the intersection. Geometric features such as the width of traffic lanes, bicycle lanes, and sidewalks serving each approach (number of lanes, median and roadside elements), must be considered with respect to the method for treating turning movements; for example channelization, exclusive turning lanes, two-way center turning lanes, and the type of traffic control device implemented; for example traffic signals, Stop control signs, roundabouts, etc. The design of an intersection's layout requires a balance between the needs of pedestrians, bicyclists, vehicles, freight transport, and mass-transit within the available right-of-way.

Intersection design includes consideration of the functional area, where drivers make decisions and then maneuver into the various turning movement locations that service the intersection. The three parts constituting the functional area include the perception-reaction distance, maneuver distance and storage distance. AASHTO's *Policy on Geometric Design of Highways and Streets,* addresses these issues and provides guidance for the detailed geometric design of the functional area. The basic types of intersections in urban environments include the T-intersection, cross intersection, multi-leg intersection, and modern roundabout intersection.

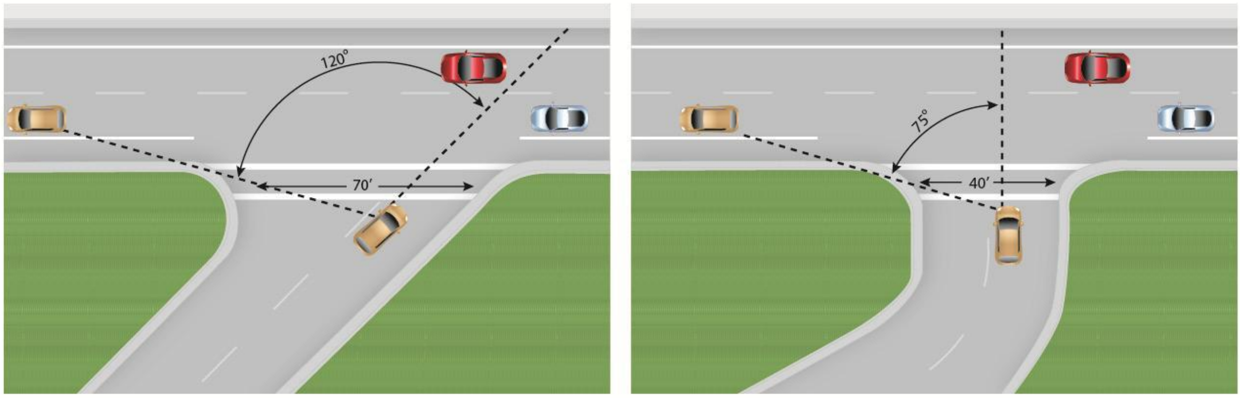
Intersection Skew

Skewed intersections are generally undesirable because they introduce the following complications:

- Greater travel distance across the intersection creating exposure to maneuvering conflicts.
- Increased signal timings for vehicular and pedestrian traffic.
- Poor driver sight distance along the skewed intersection approaches.

Improving skewed intersections include consideration of the following alternatives:

- Reasonable efforts should be made to design or redesign the intersection closer to a right angle. Additional right-of-way may be required to accomplish this. However, the added costs can be offset by no longer needing the larger spread area to accommodate the intersection, which in turn can often result in the excess area being sold back to the adjoining property owners or repurposed for other uses such as a pocket park, rain garden, or other greenery areas.
- Converting stop-controlled and signalized intersections into modern roundabouts, which provide for better operations and levels of service, increased safety, speed reduction, and improved aesthetics.
- Pedestrian refuge areas should be considered where crossing distances exceed approximately 40 feet.
- Travel lanes and bike lanes should be striped with dashed lines and pavement marking to guide motorists and bicyclists through any long or undefined areas.



Realigning the skewed intersection in the graphic on the left to the right-angle connection in the graphic on the right results in less exposure distance and better visibility for all users.
(Credit: Michele Weisbart)

Multi-leg intersections (more than four approaching roadways) are generally undesirable, because in addition to the poor sight triangles that are often created, they also complicate pedestrian crossings. Multi-leg intersections also present the following complications for all users:

- Multiple conflict points that all users must react to, which compromises safety and reduces functional operations.
- At least one leg will be skewed, which reduces driver sight distance.
- Users must cross more lanes of traffic and the total travel distance across the intersection is increased.

Improving multi-leg intersections include consideration of the following alternatives:

- Reasonable efforts should be made to design or redesign the intersection to accommodate no more than four legs. This may be accomplished by removing one or more legs from the major intersection and creating a minor intersection further upstream or downstream of the major intersection.
- Alternatively, consideration may be given to closing one or more of the approach roadways to vehicular traffic, while still allowing access for pedestrians and bicyclists.
- Ideally, a modern roundabouts should be considered, which may provide for better operations and levels of service, increased safety, speed reduction, and improved aesthetics.
- Pedestrian refuge areas should be considered where crossing distances exceed approximately 40 feet.

- Travel lanes and bike lanes should be striped with dashed lines and pavement marking to guide motorists and bicyclists through any long or undefined areas.

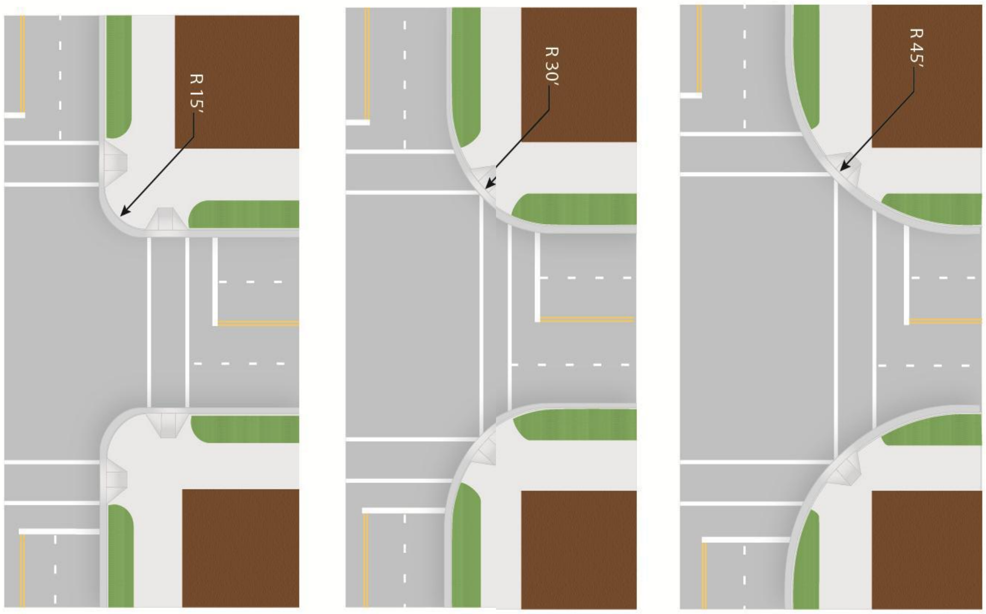
CORNER RADII

Corner radii, also termed curb return radii, are the curved portion of curbs connecting one intersection to another. The geometry of this intersection feature can significantly impact the comfort and safety of non-motorized users. Using the smallest practical corner radii to shorten the length of the crosswalk is usually desirable. However, the functional land use of the surrounding neighborhood must also be considered when designing smaller corner radii, with respect to other transportation modes that may frequently service the community, such as the freight and transport industry.

To accommodate the freight and transport industry, where practical, alternative “truck routes” should be considered, or permitting only smaller trucks to service the neighborhood, can minimize noise and congestion impacts to downtown street environments and allow smaller corner radii to prevail.

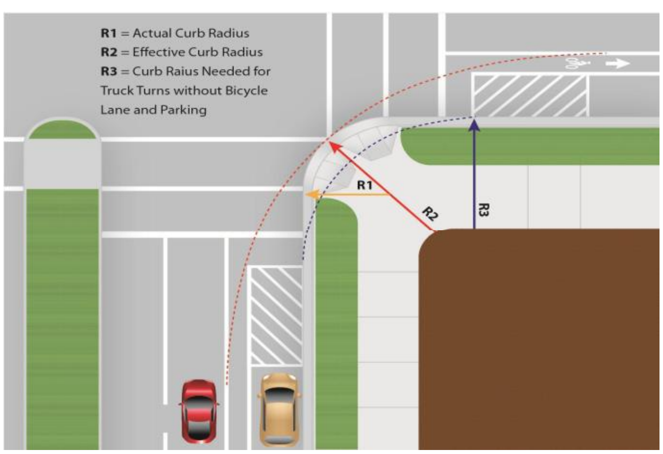
Small corner radii provide the following benefits:

- More pedestrian-friendly intersections with shorter crossing distances.
- Slower vehicular turning speeds.
- Quicker pedestrian crossing times.
- Better geometric curb ramps at intersection crosswalks.
- Better placement of crosswalks, in line with the approaching sidewalks



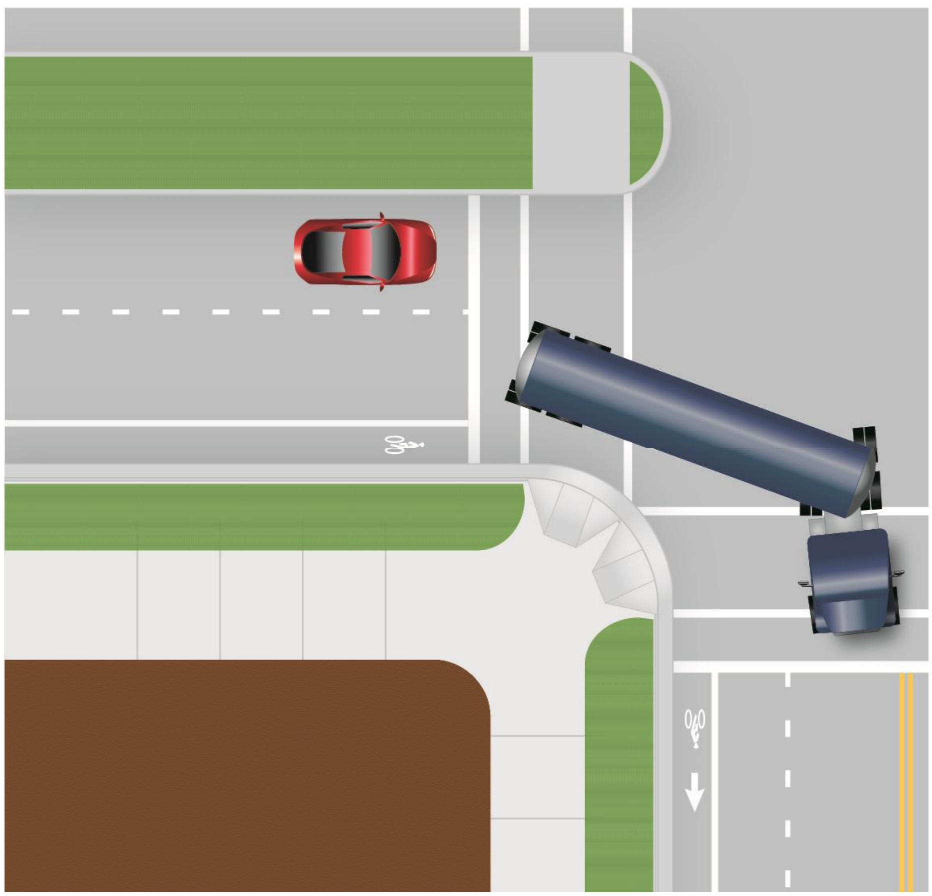
Tighter corner radii reduce crossing distance and slow turning traffic.
(Credit: Michele Weisbart)

- When designing corner radii for Complete Streets, the default design vehicle should be the passenger (P) vehicle. Therefore, the default corner radius is typically 15 feet. Larger design vehicles should be used only where they are known to regularly make turns at a particular intersection. In such instances, the corner radii should be designed based on the larger design vehicle traveling at crawl speed. In addition, designers should consider the effect that bicycle lanes and on-street parking have on the effective radius, increasing the ease with which large vehicles can turn.



The effective corner radius controls turning speeds and the ability of large vehicles to turn.
(Credit: Michele Weisbart)

- Encroachment by large vehicles is acceptable onto multiple receiving lanes. When a design vehicle larger than the passenger (P) vehicle is used, design parameters allow the truck or bus to turn into all available receiving lanes, in consideration of available sight distance and other safety issues. As described in Chapter 4, "Traveled Way Design," larger, infrequent vehicles (the "control vehicle") can be allowed to encroach on multiple departure lanes and partway into opposing traffic lanes.
- Corner radii may need to be larger where occasional encroachment is not acceptable.



Corner radii can be kept smaller by allowing trucks and buses to turn into multiple receiving lanes.
(Credit: Michele Weisbart)

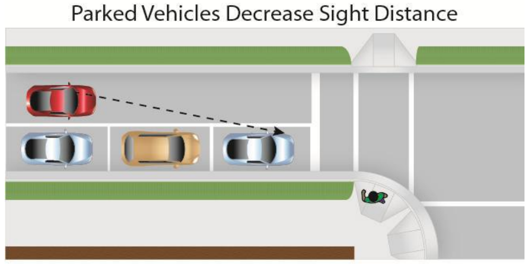
CURB EXTENSIONS

Where on-street parking is allowed, curb extensions, or bulb-outs, should replace the parking lane at crosswalks. Curb extensions should be the same width as the parking lane. The appropriate corner radius should be applied based on the aforementioned criteria. Due to reduced road width, the corner radius on a curb extension may need to be larger than if curb extensions were not installed.

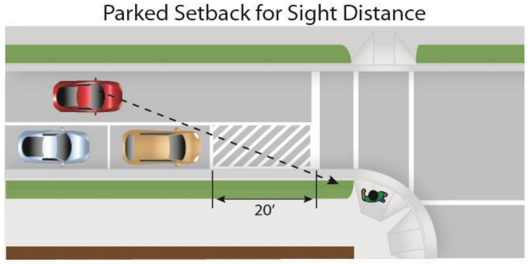
Curb extensions offer many benefits related to livability:

- Reduced pedestrian crossing distance resulting in less exposure to vehicles and shorter pedestrian clearance intervals at signals.
- Improved intersection sight distance, providing better visibility between pedestrians and motorists.
- Narrowed roadways, promoting traffic calming.
- Increased space for street furniture, landscaping, and curb ramps.
- Defined parking spaces, which improves traffic flow and overall operational safety.

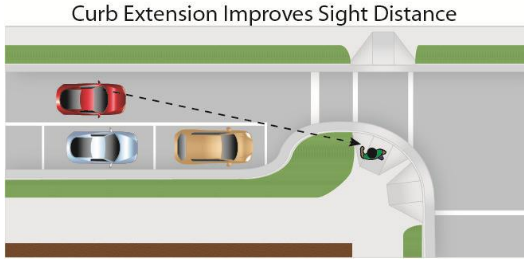
Parked Vehicles Decrease Sight Distance



Parked Setback for Sight Distance

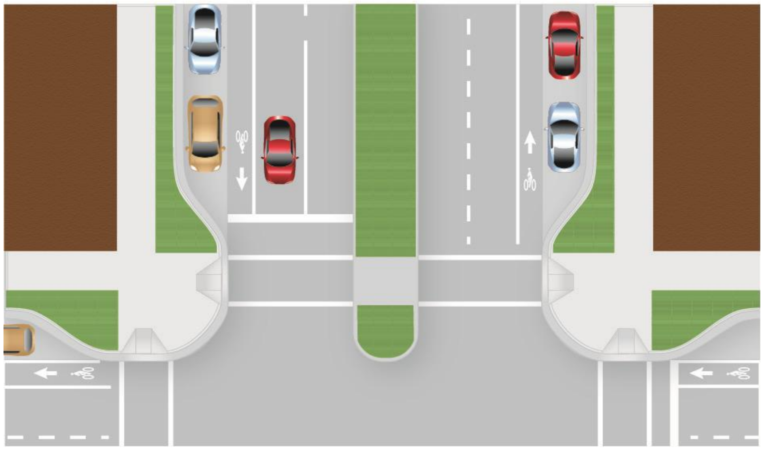


Curb Extension Improves Sight Distance



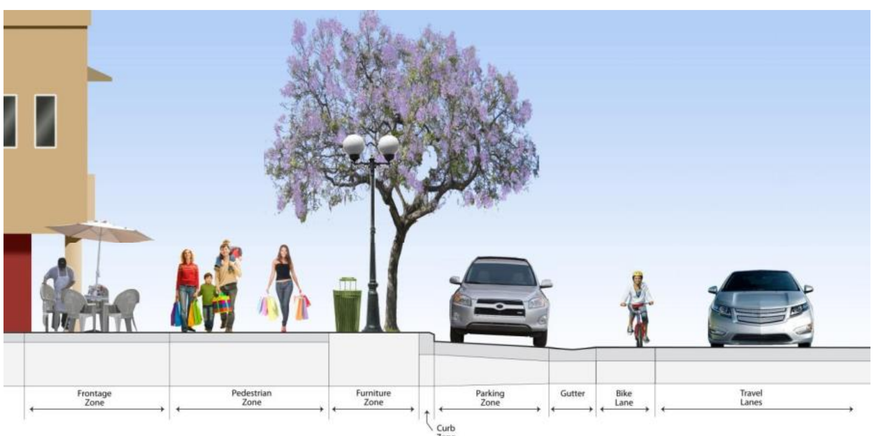
Curb extensions improve sight distance between pedestrians and motorists, possibly allowing additional on-street parking. (Credit: Michele Weisbart)

To achieve livability goals, integrate the curb extensions and parking areas into the furniture zone portion of the sidewalk corridor. This technique involves using similar surface materials for the curb extension, parking area, and sidewalk portion, as shown in the figure below. Instead of the curb extensions appearing to jut out into the street, the parking appears as "parking pockets" in the furniture zone. Curb extensions can be used in any context zone, but they should be standard in T-5 and T-6. Curb extensions must always be outside of the width of the bike lane or the location within the traveled way where bicyclists will ride.



Integrating curb extensions and on-street parking into the sidewalk corridor enhances pedestrian safety and the walking experience.
(Credit: Michele Weisbart)

Place the gutter line and drainage grates between the travel lane and the parking lane/curb extensions where street grades permit. This "valley gutter" creates a stronger visual cue, separating the parking lane from the bicycle lane or travel lane. It can sometimes allow existing drainage infrastructure to remain in place.



An example of integrating curb extensions and parking into the sidewalk corridor by placing a valley gutter between the parking and the traveled way.
(Credit: Michele Weisbart)

Placement of Crosswalks and Ramps

Crosswalks assist pedestrians in crossing the street. *Florida State Statute 316* makes it clear that unmarked crosswalks can exist only at intersections, whereas, marked crosswalks can exist at intersections or mid-block locations. This is consistent with the Manual on Uniform Traffic Control Devices (MUTCD). Place crosswalks and ramps at intersections so they provide convenience and safety for pedestrians. The following recommended practices will help achieve these goals:

- Allow crossings on all legs of an intersection, unless there are no pedestrian accessible destinations on one or more of the corners. Closing a crosswalk usually results in a pedestrian either walking around several legs of the intersection, exposing them to more conflicts, or crossing at the closed location, with no clear path or signal indication as to when to cross.
- Provide marked crosswalks at signalized intersections.
- Provide marked crosswalks at an intersection approach controlled by stop sign.
- Provide 10 feet wide crosswalks in urban zones.
- Provide clearly marked crosswalks with appropriate signage, flashing pedestrian signals, and pedestrian refuge islands at major, unsignalized intersections or on wide, one-way streets.
- Place crosswalks as close as possible to the desired line of pedestrians, which should coincide with the approaching sidewalks.
- Provide the shortest possible crossing distance to reduce pedestrian travel time and exposed to motor vehicles. This is typically accomplished by providing crosswalks as close as possible to right angles with the crossing roadway, except where skewed intersections prevail.
- Ensure that there are adequate sight lines between pedestrians and motorists by keeping the crosswalks positioned near the intersection.
- At raised medians, extend the nose of the median past the crosswalk and provide a cut-through for pedestrians.
- Provide one ramp per crosswalk or two per corner for standard intersections with no closed crosswalks. Ramps must be entirely contained within a flared crosswalk if the ramp relocation is difficult to relocate. Align the ramp run with the crosswalk when possible, as ramps angled away from the crosswalk may lead some users into the intersection.
- At the intersections of skewed roads, or where larger radii are necessary for trucks, the best location for crosswalks and sidewalk ramps can be difficult to determine. In these situations, it is important to balance the recommended practices above. Tighter curb radii make implementing these recommendations easier.
- At signalized crossings, use shared-use path crossing markings, or other high emphasis crosswalk markings (ladder style crosswalk) to increase visibility.
- Curb ramp openings on shared-use paths shall be the same width as the path itself.
- The design for detectable warning surfaces shall follow MUTCD 3B.18 and 49 Code of Federal Regulations Part 37.

Pedestrian warning sign (W11-2) at a high emphasis crosswalk. Note the yield bars (series of isosceles triangles painted on the approach to the crosswalk.
(Credit:)

One curb ramp per crosswalk should be provided at corners. Ramps should align with sidewalks and crosswalks.
(Credit: Michele Weisbart)

On-Street Parking Near Intersections

Position on-street parking far enough away from intersections to allow for good visibility of pedestrians preparing to cross the street. Curb extensions allow parking to be placed closer to the intersection.

Right-Turn Channelization Islands

In urban context sub-urban zone (T-3) through urban core zone (T-6), high speed channelized right-turns are inappropriate because they create conflicts with pedestrians. Avoid right-turn lanes, if not necessary, as they increase the size of the intersection, the pedestrian crossing distance, and the likelihood of right-turns-on-red by inattentive motorists who do not notice pedestrians on their right. However, where there are heavy volumes of right turns (approximately 200 vehicles per hour or more), a right-turn lane may be the best solution to provide additional vehicle capacity without adding additional lanes elsewhere in the intersection. For turns onto roads with only one through lane, and where truck-turning movements are rare, providing a small corner radius at the right-turn lane often provide the best solution for pedestrians' safety and comfort.

At intersections of multi-lane roadways where trucks make frequent right turns, a raised channelization island between the through lanes and the right-turn lane is a good alternative to an overly large corner radius, and it enhances pedestrian safety and access. If designed correctly, a raised island can achieve the following objectives:

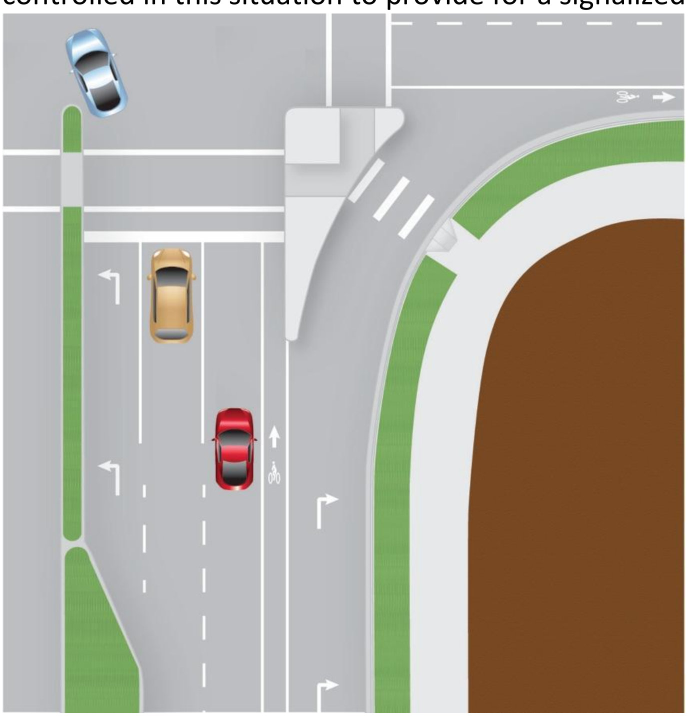
- Allow pedestrians to cross fewer lanes at a time.
- Allow motorists and pedestrians to judge the right turn/pedestrian conflict separately.
- Reduce pedestrian crossing distance, which can improve signal timing for all users.
- Balance vehicle capacity and truck turning needs with pedestrian safety.
- Provide an opportunity for landscape and hardscape enhancement.

The following design practices for right-turn lane channelization islands are useful in providing safety and convenience for pedestrians, bicyclists, and motorists:

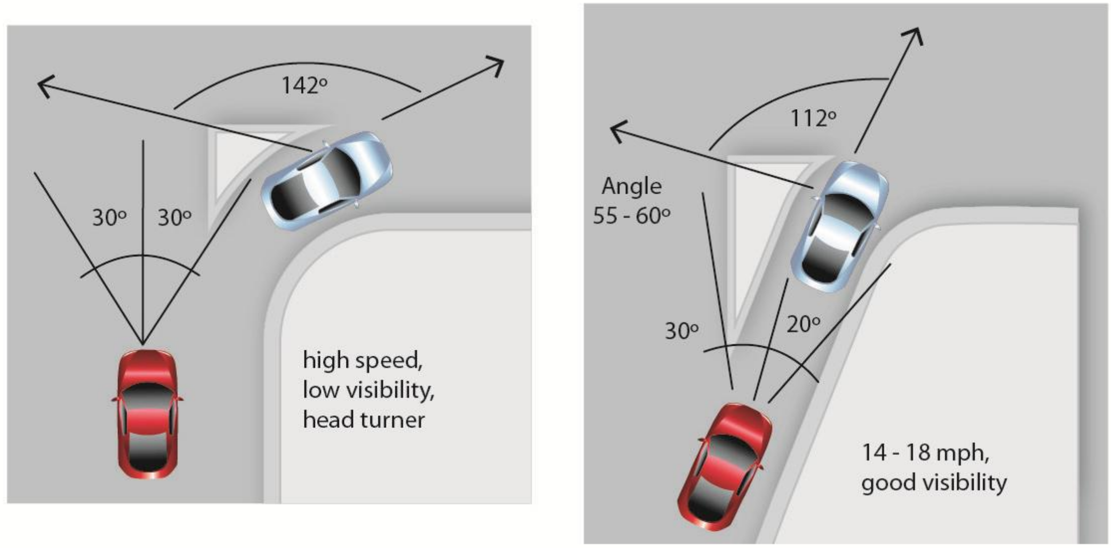
- The provision of a channelized right-turn lane is appropriate only on signalized approaches where right-turning volumes are high or large vehicles frequently turn and conflicting pedestrian volumes are low.
- Provide accessible islands for refuge.
- Provide a yield sign for the channelized right-turn lane.
- Tighter angles are preferred.

- Provide at least a 60-degree angle between vehicle flows which reduces turning speeds and improves the yielding driver's visibility of pedestrians and vehicles.
- Place the crosswalk across the right-turn lane about one car length back from where drivers yield to traffic on the other street, allowing the yielding driver to respond to a potential pedestrian conflict first, independently of the vehicle conflict, and then move forward, with no more pedestrian conflict.
- If vehicle-pedestrian conflicts are a significant problem in the channelized right-turn lane, it might be appropriate to provide signing to remind drivers of their legal obligation to yield to pedestrians crossing in the crosswalk. Consider placing regulatory signs such as the R10-15 sign from the MUTCD or warning signs such as the W11-2 sign in advance of or at the crossing location.
- To assist pedestrians, consider removing channelized right-turn lanes where practical.

Accomplishing these goals is achieved by creating an island that is roughly twice as long as it is wide. The corner radius will typically have a long radius (150 feet to 300 feet) followed by a short radius (20 feet to 50 feet). When creating this design, it is necessary to allow large trucks to turn into multiple receiving lanes. However, this design is often not practical for right-turn lanes merging onto roads with only one through lane. This right-turn channelization design is different from designs that provide free-flow movements (through a slip lane) where right-turning motorists turn into an exclusive receiving lane at high speed. Right turns should be signal-controlled in this situation to provide for a signalized pedestrian walk phase.



Traffic channelization is an effective mitigation strategy when intersection radii reduction is not an option. (Credit: Michele Weisbart)



Sharper angles of slip lanes are important to slow cars and increase visibility
(Credit: Michele Weisbart)

YIELD AND STOP CONTROLLED INTERSECTIONS

Unsignalized intersection control options include the following:

- Yield control, which often is under-utilized and should be considered to reduce unnecessary stops caused by the overuse of STOP signs.
- Uncontrolled intersections are yield controlled by default.
- Two-way stop control; the most common form of intersection control. This is also an overused device. At many intersections, a neighborhood traffic calming circle, or roundabout, is a preferable and more effective operational option.
- All-way stops are often overused, incorrectly, to slow traffic. The use of all-way stops should be consistent with MUTCD criteria. At many intersections, a neighborhood traffic calming circle, or roundabout, is the preferable and a more effective option.
- Crosswalks may be marked, consistent with *Florida State Statute 316*.

SIGNALIZED INTERSECTIONS

Signalized intersections provide unique challenges and opportunities for livable communities and complete streets. On one hand, signals provide control of pedestrians and motor vehicles with numerous benefits. Where signalized intersections are closely spaced, use signals to control vehicle speeds by providing appropriate signal progression on a corridor. Traffic signals allow pedestrians and bicyclists to cross major streets with only minimal conflict with motor vehicle traffic. On the other hand, traffic signals create challenges for non-motorized users. Signalized intersections often have significant turning volumes, which conflict with concurrent pedestrian and bicycle movements. In many cases, roundabouts offer a safer, more convenient intersection treatment than do traffic signals.

To improve livability and pedestrian safety, signalized intersections should meet the following principles:

- Provide signal progression at speeds that support the target speed of a corridor whenever feasible.
- Provide short signal cycle lengths, which allow frequent opportunities to cross major roadways, improving the usability and livability of the surrounding area for all modes.
- Ensure that signals detect bicycles through video detection zones for video monitoring or through loop detectors in the pavement.
- Place pedestrian signal heads in locations where they are visible.
- At locations with many crossing pedestrians, time the pedestrian phase to be on automatic recall, so pedestrians do not have to seek and push a pushbutton.
- Where few pedestrians are expected and automatic recall of walk signals is not desirable, place pedestrian pushbuttons in convenient locations, using separate pedestals if necessary. Use the recommendations regarding pushbutton placement for accessible pedestrian signals found in the Manual on Uniform Traffic Control Devices (MUTCD).
- Include pedestrian signal phasing that increases safety and convenience for pedestrians, as further discussed below.

Operational Design

Pole-mounted signal

Approximately 2 percent of intersections contain traffic signals, and nearly 20 percent of all intersection crashes occur at signalized intersections. Unfortunately, in many locations, signalization is the only option because of right-of-way limitations, high vehicle volumes, and the need to create gaps to provide reasonable operations for all users.

Over the years, the most common signal hardware has transitioned from post-mounted signals to span-wire signals to overhead mast arms. These changes have lifted drivers' eyes upward and created a situation in many east/west streets, where drivers must look toward a rising or setting sun, which can block vision of a signal. In urban areas, the large mast arms are intrusive. As part of the conversion to healthier streets, changing to post-mounted signals in urban areas could lower the cost of installing and maintaining signals, reduce the vision intrusion, and help lower a driver's vision back to pedestrians. There are two primary advantages for pedestrians and bicyclists to pole-mounted signals:

- Drivers have to stop back from the crosswalk to see the indication so they are less likely to encroach into the crosswalk, and more likely to see pedestrians and bicyclists when turning right.
- Mast-arm signals encourage higher speeds since drivers can see several in a row. If they are green, drivers are more likely to accelerate. However, pole-mounted signals are only visible to drivers closer to the intersection, causing them to drive slower on the approach.

Phasing

A signal phase is the cycle length allocated to a traffic movement at an intersection receiving the right-of-way, or to any combination of traffic movements receiving the right of way simultaneously. The combination of all phases is equal to one cycle length.

Basic Signal Timing

The "timing" is the time taken in seconds for various vehicular and pedestrian movements. A traffic control signal transmits information to the users by selective illumination of different color lights at a signalized intersection. The illuminated color indicates the user should take a specific action at the signalized intersection:

- **Green phase:** Green phase is when motorists and bicyclists may proceed through an intersection.
- **Yellow phase:** Yellow phase is the cycle phase before changing to the red interval that prohibits traffic movement. It signifies to users that the light is about to turn red and that they should stop if they can safely do so, or continue proceeding if that is the safer option. A properly timed yellow time interval is important to reduce signal violations by users passing through the intersection.
- **All-red phase:** All-red phase is that portion of a traffic cycle phase where all vehicles are prohibited from any movements at an intersection. The all-red time follows the yellow time interval and precedes the next green interval. The purpose of the all-red time is to allow vehicles that entered the intersection late, during the yellow phase, to clear the intersection before the traffic signal displays green time for conflicting approaches.

Permissive left-turn signal (Credit: Michele Weisbart)

Left-Turn Phasing

Protected-permissive left turn signal (Credit: Michele Weisbart)

The most commonly used “left-turn” phases at an intersection with a left-turn lane are:

- **Permissive:** Under permissive left-turn phasing, through traffic may proceed straight through the intersection with a circular green signal indication, as side traffic is stopped (with a circular red signal indication); the left-turning vehicles are permitted to make the turn when they find a safe and adequate gap from the approaching vehicles. Permissive left-turn phases create conflicts with pedestrians crossing the street, as the timing puts the two users on a collision course.
- **Protected-permissive:** Under protected-permissive, left-turn phasing, left turns are allowed to pass the intersection with a green arrow first, during the protected phase (opposing through traffic is stopped). Usually three to five vehicles may pass through in the cycle before the left turn changes from a left arrow to a circular green indication, and opposing through traffic may pass through the intersection. During the permissive phase, motorists may turn left while others go straight. Protected-permissive left-turn phases create conflicts with pedestrians crossing the street, as the timing puts the two on a collision course, especially with left-turning drivers who arrived after the left-turn phase and are impatient to turn left before the signal reverts to red.
- **Protected only:** Under protected left turns, a driver can only make a left turn on a green arrow. The protected left turns can be either “leading” or “lagging.” A leading protected left turn allows left-turns during the beginning of the cycle. A lagging protected left allows left turns at the end, after opposing through traffic has proceeded. Protected left-turn phases are preferred to both permissive phases because they eliminate the inherent conflict between left turning vehicles and pedestrians. Protected left turns provide the greatest safety for pedestrians. Typically, permissive phases maintain a higher LOS for motorists.

Protected left-turn signal (Credit: Michele Weisbart)

Pedestrian Phasing

Combine basic pedestrian signal timing principles with innovative pedestrian signal timing techniques to enhance pedestrian safety and convenience.

Pedestrian signal heads provide indications exclusively intended for controlling pedestrian traffic. These signal indications consist of the illuminated symbols of a WALKING PERSON (symbolizing WALK) and an UPRAISED HAND (symbolizing DON'T WALK). Pedestrian signal head indications have the following meanings:

- A steady WALKING PERSON (WALK) signal indication means that a pedestrian facing the signal indication may start to cross the roadway in the direction of the signal indication, possibly in conflict with turning vehicles.
- A flashing UPRAISED HAND (DON'T WALK) signal indication means that a pedestrian may not start to cross the roadway in the direction of the signal indication. However, any pedestrian who has started to cross shall proceed to the far side of the traveled way of the street or highway, unless otherwise directed by a traffic control device to proceed only to a median or pedestrian refuge area.
- A steady UPRAISED HAND (DON'T WALK) signal indication means that a pedestrian shall not enter the roadway in the direction of the signal indication.

The text below discusses the timing of each of these indicators.

Walk Interval
The WALK interval (clear WALKING PERSON) must typically be a minimum of 7 seconds. However, to provide more convenience for pedestrians, and possibly more safety due to better pedestrian behavior, maximize the WALK interval using the following techniques:

- Instead of providing the minimum WALK interval, maximize the WALK interval within the available green interval. This is achievable by subtracting the necessary pedestrian clearance interval (discussed below) from the available green time for the concurrent vehicular movements.
- Except at intersections where pedestrians are relatively few, and anywhere that vehicle signals are set on fixed time, provide "recall" WALK intervals during every signal cycle.
- Where a major street intersects a minor side street, the WALK interval for crossing the minor street can be set on recall, concurrent with the green interval for the parallel through vehicle movement, which is typically set to recall as well. This minimizes pedestrian delay along the major street with no impact to motor vehicle capacity.

Pedestrian Clearance Interval

The procedures for calculating the timing of the pedestrian clearance interval (flashing orange hand) are included in the MUTCD, but have recently changed. The pedestrian clearance interval allows a pedestrian who left the curb at the end of the WALK interval, traveling at a walking speed of 3.5 feet per second, to travel the length of the crosswalk. Measurement of the crosswalk length is the distance from the center of one curb ramp to the center of the opposing curb ramp. This speed allows pedestrians, especially seniors, children, and ADA users, to clear the intersection. The MUTCD includes another test that requires the total of the WALK interval plus the pedestrian clearance interval to be sufficient to allow a pedestrian, traveling at a walking speed of 3 feet per second, to travel the length of the crosswalk, measured from the top of one ramp to the bottom of the opposing ramp. Any additional time that is required to satisfy this second requirement adds to the walk interval. In neighborhoods where high numbers of slow pedestrians are present, such as near senior centers, rehabilitation centers, and disabled centers, the interval should be set for even slower speeds.

Pedestrian countdown signals (Credit: Sky Yim)

The MUTCD also requires countdown pedestrian signals for all pedestrian signals where the pedestrians change interval is more than 7 seconds. These signals count down the pedestrian clearance interval and provide more information to pedestrians, allowing them to adjust easily their walking patterns to ensure they are out of the crosswalk before the end of the pedestrian clearance interval. Research on pedestrian countdown signals has determined:

- Pedestrians understand how they work.
- Fewer people start walking in the pedestrian clearance interval.
- The crosswalks have few pedestrians during the steady orange hand.
- Drivers do not accelerate to beat the light.
- Research in San Francisco shows a 25 percent reduction in all crashes.

Other Signal Design Changes for Pedestrians

Where appropriate, use signal timing and operations techniques that minimize conflicts with pedestrians and motor vehicles, including the following:

- Protected only left-turn phases.

- Leading pedestrian intervals (LPI) are necessary where the display of pedestrian WALK interval measures 2 to 5 seconds prior to the concurrent green interval. This enables pedestrians to enter the crosswalk before drivers turn, increasing their chances of being seen by drivers.
- Prohibiting right-turns-on-red where there are restricted sight lines between motorists and pedestrians, where there are an unusual number of pedestrian conflicts with turns on red compared to right-turns-on-green, or where a leading pedestrian interval is used.
- Signs that remind drivers to yield to pedestrians when turning at signals.
- Pedestrian-user-friendly-intelligent (PUFFIN) signals, which detect slower pedestrians in crosswalks and add clearance interval time to the pedestrian signal.
- Exclusive Pedestrian Phase, that stops traffic on all legs of the intersection and allow pedestrians to cross diagonally, are useful where turning vehicles conflict with very high pedestrian volumes. Although pedestrians can cross in any direction during the pedestrian phase, pedestrians typically have to wait for both vehicle phases before they get the walk signal again. Exclusive Pedestrian Phase intersections can incorporate a walk phase concurrent with the green phase for pedestrians continuing along a straight path to eliminate this delay.

ROUNDABOUTS

This section briefly describes roundabout applications and corresponding design information. For more detailed information, refer to the National Cooperative Highway Research Program (NCHRP) Report 672, *Roundabouts: An Informational Guide*, Second Edition.

Roundabout: San Diego, CA (Credit: Michael Wallwork)

Modern roundabouts are becoming more widely accepted in the United States. Modern roundabouts are potentially the cheapest, safest, and most aesthetic form of traffic control for many intersections. A roundabout is an intersection design with the following characteristics and features.

Users approach the intersection, slow down, stop and/or yield to pedestrians in a crosswalk, and then enter a circulating roadway, yielding to drivers already in the roundabout. The circulating roadway encircles a central island around which vehicles travel counterclockwise. Splitter islands force drivers to turn right, and provide a refuge for pedestrians. Deflection encourages slow traffic speeds, but allows movement by trucks. A landscaped visual obstruction in the central island obscures the driver's view of the road ahead, to discourage users from entering the roundabout at high speeds. Pedestrians are not allowed to access the central island, which should not contain attractions. The central island can vary in shape from a circle to a "square-a-bout" in historic areas, ellipses at odd shaped intersections, dumbbell, or even peanut shapes.

Each leg of a roundabout has a triangular splitter island that provides a refuge for pedestrians, prevents drivers from turning left (the "wrong-way"), guides drivers through the roundabout by directing them to the edge of the central island, and helps to slow drivers. Roundabouts can range from quite small to quite large, from a central island diameter of about 12 feet for a traffic-calming device at a neighborhood intersection, to 294 feet to the back of sidewalk on a large multi-lane roundabout.

Operations and Analysis

Roundabouts operate on the principle that drivers approach a roundabout and look left for any approaching vehicles that could conflict with their travel path. If there is no possible conflict, the approaching driver can enter the roundabout without any delay. If there is a vehicle, or many conflicting vehicles, the approaching drivers stop and yield to the conflicting vehicle(s) on their left and wait for a safe gap to enter the roundabout.

In simple terms, a roundabout capacity analysis determines the number of vehicles seeking to enter a roundabout from each approach and the availability of gaps. Based on this gap acceptance analysis, the number and type of approach and departure lanes can be determined to provide the desired level of operation. Since roundabouts keep traffic moving, they have greater capacity than both signalized and stop-controlled intersections. Roundabout designer Michael Wallwork, P.E., has observed about a 30 percent increase in intersection capacity with roundabouts over traffic signals.

Advantages and Disadvantages

Roundabouts reduce vehicle-to-vehicle and vehicle-to-pedestrian conflicts and, because there is a substantial reduction in vehicle speeds, they reduce all forms of crashes and crash severity. In particular, roundabouts eliminate the most dangerous and common crashes at signalized intersections: left-turn and right angle crashes.

Other benefits of roundabouts include the following:

- Little to no delay for pedestrians, who have to cross only one direction of traffic at a time

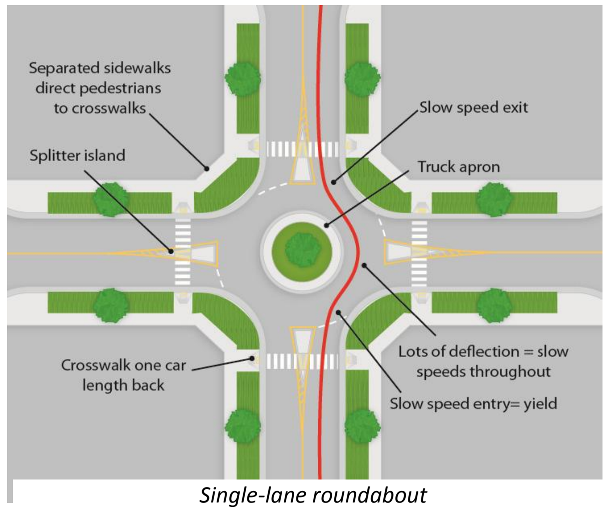
- Improved accessibility to intersections for bicyclists through reduced conflicts and vehicle speeds
- A smaller carbon footprint (no electricity is required for operation, and fuel consumption is reduced as motor vehicles spend less time idling and don't have to accelerate as often from a dead stop)
- The opportunity to reduce the number of vehicle lanes between intersections (e.g., to reduce a five-lane road to a two-lane road, due to increased vehicle capacity at intersections)
- Little to no stopping during periods of low flow
- Significantly reduced maintenance and operational costs because the only costs are related to the landscape and litter control
- Reduced delay, travel time, and vehicle queue lengths
- Lowered noise levels
- Less fuel consumption and air pollution
- Simplified intersections
- Facilitated U-turns
- The ability to create a gateway and/or a transition between distinct areas through landscaping
- When constructed as a part of a new road or the reconstruction of an existing road, the cost of a roundabout is minimal and can be cheaper than the construction of an intersection and the associated installation of traffic signals and additional turn lanes
- Light rail can pass through the center of a roundabout without delay because rail has the right of way

The primary disadvantage is that sight-impaired people can have difficulty navigating around large roundabouts without the use of ground level way finding devices. Roundabouts may also require additional right of way.

Roundabouts are not always the most appropriate solution, as they require location specific analysis. In addition, roundabouts may not be the best solution near active railroad crossings.

General Design Elements of Roundabouts

Central Island



Single-lane roundabout
(Credit: Michele Weisbart)

The design of the central island is an important element of a roundabout. In conjunction with well-designed approach and departure lanes, the central island controls vehicle speeds through deflection and controls the size of vehicles that can pass through and turn at a roundabout. It provides space for landscaping to beautify an intersection or create a focal point or community enhancement, but it also provides space for the inclusion of a vertical element such as a tree, which is important in providing long-range conspicuity of a roundabout.

Splitter Islands

Splitter islands and/or medians on each approach serve several functions. Most importantly, they provide a refuge for pedestrians crossing at the roundabout, breaking the crossing into two smaller crossings. This allows pedestrians to select smaller gaps and cross more quickly. Splitter islands and medians direct vehicles toward the edge of the central island and limit the ability of drivers to make left turns the wrong way into the circulating roadway. Splitter islands should have a minimum width of 6 feet, and preferably 8 feet, from the face-of-curb to the opposite face-of-curb.

Truck Apron

A Truck Apron is a paved, load-bearing area. Because central islands must be large enough to deflect, and hence control, the speed of passenger vehicles, they can limit the ability of trucks to pass through or turn at a roundabout.

To accommodate large vehicles, a truck apron is included around the edge of the central island. The truck apron is often paved with a rough texture, and raised enough to discourage encroachment by smaller high-speed passenger cars. The truck apron should be 3 inches high.

City of Lakeland, FL Traffic Calming Project,
www.lakelandgove.net

Pedestrian Crossings

Pedestrian crossings are located one car length away from the circulating roadway to shorten the crossing distance, separate vehicle-to-pedestrian conflicts from vehicle-to-vehicle conflicts, and allow pedestrians to cross between waiting vehicles.

Signing and Marking

Signing and marking should follow the current version of the MUTCD. For detailed design guidance on roundabouts, refer to the NCHRP Report 672*, Roundabouts: An Informational Guide,* Second Edition, 2010. However, do not over-sign roundabouts by including every sign allowed at roundabouts, except for needed directional signs; the design of roundabouts is such that their function and use are self-explanatory.

Roundabout Design Criteria

Before designing a roundabout, it is very important to determine the following:

- The number and type of lane(s) on each approach and departure as determined by a capacity analysis
- The design vehicle for each movement
- The presence of on-street bike lanes
- The goal/reason for the roundabout, such as crash reduction, capacity improvement, speed control, or creation of a gateway or a focal point
- Right-of-way and its availability for acquisition if needed
- The existence or lack of sidewalks
- Effects on pedestrian route directness
- The approach grade of each approach

- Transit, existing or proposed

SINGLE-LANE ROUNDABOUTS

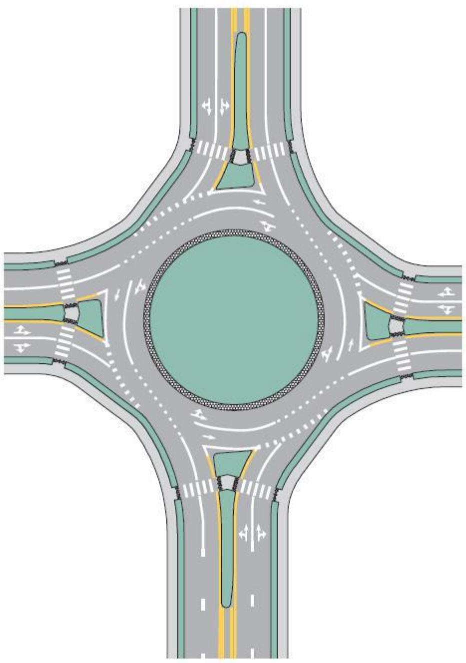
Single-lane roundabouts can vary in size with central island diameters from 12 to 90 feet to fit a wide range of intersections and accommodate through movements and different turn movements by various design vehicles. As such, they are useful at a large number of intersections to achieve various objectives.

In some cases, roundabouts are constructed to accommodate through movements by large articulated trucks but do not permit them to make turn movements. However, they do accommodate turn movements by single unit trucks such as ladder trucks and garbage trucks. In some cases, restricting or not accommodating turn movements by articulated trucks enables the construction of a smaller roundabout without acquisition of right-of-way and with all the benefits of roundabouts at the cost of forcing the occasional large truck to take an alternate route.

Design

Following a careful assessment of the need to accommodate some or all design vehicle movements and the impact of those accommodations, determine the size of the roundabout to select and prepare a concept plan. The concept plan is then refined with the simultaneous application of design vehicle templates and design speed checks until a suitable design is prepared that meets design requirements. Pedestrian and bike facilities are as applicable and the overall design is refined with the signing and marking, along with construction details. In some cases, the addition of right turn lanes can accommodate specific high right turn volumes.

MULTI-LANE ROUNDABOUTS



Multi-lane roundabout
(Credit: 2009 Manual on Uniform Traffic Control Devices, Figure 3C-6)

When single-lane roundabouts prove to be inadequate for the traffic volume, consider using roundabouts that have two through lanes on the major street and a single lane on the minor street with or without additional turn lanes before automatically designing a full multilane roundabout. Because these roundabouts are larger than single-lane roundabouts, they often accommodate all turn movements by most large vehicles. However, it is still necessary to confirm the size and movements by the design vehicle(s) because these roundabouts often have to accommodate larger trucks or special vehicles.

With many old style freeway interchanges failing, often because of a lack of storage for turning vehicles, retrofitting a roundabout on both sides of the freeway can reduce congestion and improve pedestrian mobility without widening the freeway bridge. Sometimes, the retrofit of a standard interchange with roundabouts can reduce the space allocated to the interchange, freeing the land for other community uses.

Multi-lane roundabout with lane shifts

<u>Accessibility</u>

Multi-lane roundabouts are more complex for pedestrians and bicyclists to use because of the additional lanes, slightly higher speeds, and longer crossing distances. Crossing by some pedestrians with disabilities is a more complex task. As a consequence, the current draft, (Proposed Right-of-Way Accessibility Guidelines), PROWAG includes a requirement to install accessible pedestrian signals at all crosswalks across any roundabout approach with two or more lanes in one direction. The PROWAG requirement does not specify the type of signal except that it must be accessible, including a locator tone at the pushbutton, with audible and vibro-tactile indications of the pedestrian walk interval.

Metering Signals

During one peak period and often for only a short period traffic may exceed the capacity of a roundabout. Rather than constructing a larger multi-lane roundabout, consider constructing a smaller roundabout that is adequate for 23 hours a day and adding a metering signal for the short peak period when congestion can occur. A metering signal meters the approaching vehicle queue and a part time signal stops the conflicting vehicle flow to allow vehicles in the congested approach to enter the roundabout. The result is a smaller, slower roundabout that is more appropriate for all users for most of the day.

Design

Multi-lane roundabouts are more complex to design. However, the design process is the same as for single-lane roundabouts: confirm the design vehicle for each movement, prepare a concept plan, and refine it with the simultaneous use of design vehicle templates or software like AutoTURN and speed curves.

MINI-ROUNDABOUTS

Mini-roundabouts are a new form of roundabout that includes a traversable central island and traversable splitter islands to accommodate large vehicles.

Appropriate Applications

Mini-roundabouts are useful in low-speed urban environments, where operating speeds are 30 mph or less, and right-of-way constraints preclude the use of a standard roundabout. The design employs passenger vehicles passing through the roundabout without travelling over the central

City of Lakeland, FL Traffic Calming Project, www.lakelandgov.net

island, whereas large vehicles will turn over the central island and in some cases, the splitter islands.

Design

The design of mini-roundabouts is similar to other roundabouts in that the design vehicle for each movement must be determined following a capacity analysis. The design is undertaken using the same combination of design vehicle templates and speed curves.

NEIGHBORHOOD TRAFFIC CIRCLES

Neighborhood traffic circles are very small circles retrofitted into local street intersections to control vehicle speeds within a neighborhood. Typically, a tree and/or landscaping are located within the central island to provide increased visibility of the roundabout and enhance the intersection. Neighborhood traffic circles should generally have similar features as roundabouts, including yield-on-entry and painted or mountable splitter islands.

Neighborhood traffic circles are useful on low-volume, neighborhood streets. In these environments, larger vehicles can turn left in front of the central island.

Design

The design of neighborhood traffic circles depends upon selecting a central island size to achieve the appropriate design speed of around 15 mph. See Chapter 10, “Traffic Calming,” for more information.

6. UNIVERSAL PEDESTRIAN ACCESS

INTRODUCTION

Nowhere is the concept of universal access more important than in the design of the pedestrian environment. While perhaps not intuitively obvious at first glance, this is the realm of streets with the greatest variation in user capabilities, and thus the realm where attention to design detail is essential to effectively balance user needs. This is also the realm where signs and street furniture are located, and where transitions are made between modes (e.g., driver or passenger to pedestrian via parking, bus stop/train station, or bike rack). The pedestrian environment includes sidewalks, curb ramps, crosswalks, bus stops, signs, landscaping, and street furniture.

With well-defined guidelines, sidewalks are built to accommodate pedestrians of all ages and physical abilities, and become inviting pedestrian environments as the adjacent picture shows.

Without design guidelines, sidewalks are often too narrow, utility poles obstruct travel, steep driveway ramps are impassable to wheelchair users, and bus stops become blocked by the disorderly placement of shelters, poles, trash receptacles, and bike racks.

Pedestrian environment features (Credit: City of Fort Myers)

Sidewalks constructed adequate design guidelines (Credit: City of Fort Myers)

Designing the pedestrian realm for universal access enables persons with disabilities to live independently and lead full, enriched lives; they are able to go to work and to school, to shop, and otherwise engage in normal activities. Moreover, walking environments that accommodate people with disabilities improve walking conditions for everyone. People with strollers and rolling suitcases can make their way about with ease. Children can mature by learning to navigate through their neighborhoods with independence. Inaccessible pedestrian networks, on the other hand, can lead to people becoming housebound, reclusive, and socially isolated, which in turn can lead to a decline in well-being and a host of associated negative health outcomes such as depression.

This chapter describes the legal framework for accessible design of streets and sidewalks; various users of streets, sidewalks, and their needs; and important elements of pedestrian facility design. The chapter ends with sidewalk design guidelines for a number of street classifications.

ESSENTIAL PRINCIPLES OF UNIVERSAL PEDESTRIAN ACCESS

The following design principles and recommendations should be incorporated into the pedestrian improvement:

- The walking environment should be safe, inviting, and accessible to people of all ages and physical abilities.
- The walking environment should be easy to use and understand.
- The walking environment should seamlessly connect people to places.

- The walking environment should be continuous and include complete sidewalks with well-designed curb ramps, street crossings, landscaping, and street furniture.

LEGAL FRAMEWORK

Under Title II of the Americans with Disabilities Act (ADA) of 1990, state and local governments and public transit authorities must ensure that all of their programs, services, and activities are accessible to and usable by individuals with disabilities. They must ensure that new construction and altered facilities are designed and constructed to be accessible to persons with disabilities. State and local governments must also keep the accessible features of facilities in operable working condition through the duration of maintenance measures, including sidewalk repair, landscape trimming, and accessibility through work zones.

Under the ADA, the U.S. Access Board is responsible for developing the minimum accessibility guidelines needed to measure compliance with ADA obligations when new construction and alteration projects are planned and engineered. These guidelines for public rights-of-way are found in draft form in the Public Rights-of-Way Accessibility Guidelines (draft version: PROWAG). The U.S. Department of Transportation has recognized this document as current best practices in pedestrian design and has indicated its intent to adopt the final PROWAG

.

Sidewalks constructed adequate design guidelines (Credit: City of Fort Myers)

In addition to the PROWAG guidelines, Title II of the ADA also requires states and localities to develop ADA Transition Plans that remove barriers to disabled travel.

These plans must:

- Inventory physical obstacles and their location
- Provide adequate opportunity for residents with disabilities to provide input into the Transition Plan
- Describe in detail the methods the entity will use to make the facilities accessible
- Provide a yearly schedule for making modifications
- Create a position and name an official responsible for implementing the Transition Plan
- Set aside a budget to implement the Transition Plan

ADA Transition Plans are intended to ensure that existing inaccessible facilities are not neglected indefinitely and that the community has a detailed plan in place to provide a continuous pedestrian environment for all users.

USERS AND NEEDS

To fully accommodate everybody, designers must consider the widely varying needs and capabilities of the people in the community. People walk at different speeds. Some are able to endure long treks, while others can only go short distances. Some use wheelchairs and are particularly sensitive to uneven pavement and surface materials. Others have limited sight and may rely on a cane. People's strengths, sizes, and judgmental capabilities differ significantly. The needs of one group of users may be at odds with those of another group of users. For instance, gradual ramps and smooth transitions to the street help people in wheelchairs, but present challenges for the sight-impaired when they can't easily find the end of the sidewalk and beginning of the street.

The text below identifies the unique constraints individuals with different types of disabilities and limitations face as pedestrians. Understanding their needs will help ensure more universal design of the sidewalk network.

People with Mobility Impairments

People with mobility impairments range from those who use assistive devices, such as wheelchairs, crutches, canes, orthotics, and prosthetic devices, to those who use no such devices but face constraints walking long distances on non-level surfaces or on steep grades.

Wheelchair and scooter users are most affected by the following:

- Uneven surfaces that hinder movement
- Rough surfaces that make rolling difficult and can cause pain, especially for people with back disabilities
- Steep uphill slopes that slow the user
- Steep downhill slopes that may cause a loss of control
- Cross slopes that make the assistive device unstable
- Narrow sidewalks that impede the ability of users to turn or to cross paths with others
- Devices that are hard to reach, such as push buttons for walk signals and doors
- The lack of time to cross the street

Walking-aid users are most affected by the following:

- Steep uphill slopes that make movement slow or impossible
- Steep downhill slopes that are difficult to negotiate
- Cross slopes that cause the walker to lose stability
- Uneven surfaces that can cause these users to trip or lose balance
- Long distances to important destinations
- Situations that require fast reaction time
- The lack of time to cross the street

Prosthesis users often move slowly and have difficulty with steep grades or cross slopes.

People with Visual Impairments

People with visual impairments include those who are partially or fully blind, as well as those who are colorblind. Visually impaired people face the following difficulties:

- Limited or no visual perception of the path ahead
- Limited or no visual information about their surroundings, especially in a new environment
- Changing environments where they rely on memory
- Lack of non-visual information
- Slow reaction time
- Decision making associated with unpredictable situations, such as skewed and complex intersections
- Inability to distinguish the edge of the sidewalk from the street
- Compromised ability to detect the proper time to cross a street

- Compromised ability to cross a street along the correct path
- Inadequate time to cross the street

People with Cognitive Impairments

People with cognitive impairments encounter difficulties in thinking, learning, responding, and performing coordinated motor skills. Cognitive disabilities can cause some to become lost or have difficulty finding their way. They may also not understand standard street signs and traffic signals. Some may not be able to read or benefit from signs with symbols and colors.

Children and Older Adults

Children and many older adults don't fall under specific categories for disabilities, but they must be taken into account in pedestrian planning. Children usually have an adult to rely on in traffic, but they are less mentally and physically developed than adults, possessing the following characteristics:

- Less peripheral vision
- Limited ability to judge speed and distance
- Difficulty locating sounds
- Limited or no reading ability and inability to understand textual signs
- Occasional impulsive and unpredictable behavior
- Little familiarity with traffic situations
- Difficulty in carrying packages

Small children are also more difficult for drivers to see than adults.

The natural aging process generally results in at least some decline in sensory and physical capability. As a result, many senior adults experience the following dilemmas:

- Declining vision, especially at night
- Decreased ability to hear sounds and/or locate the origin of the sound
- Decreased strength to walk up hills and less endurance overall
- Impaired balance, especially on uneven or sloped sidewalks
- Slower reaction times to dangerous situations
- Slower walking speed
- Increased fragility and frailty: their bodies are more likely to be seriously injured in a fall or vehicular crash, and their recovery period is usually longer.

These traits make older pedestrians the most vulnerable of all pedestrians.

MASTER PLAN VISION

With respect to the City's Master Plan Vision, reference is given to the City of Fort Myers – Bicycle and Pedestrian Plan, Section 5

PEDESTRIAN FACILITIES

Sidewalks are to serve pedestrians and are an integral part of a pedestrian system: they connect buildings and facilities along a street and allow pedestrians safe passage away from the threat of moving vehicles. This plan recommends that sidewalks be placed on both sides of any street contributing to the effective street network, or any street that connects to two or more streets.

The City will prioritize the construction needs of streets regarding those that do not contribute to the effective network ('non-network streets'), with the goal of making them effective streets to the degree possible . Within this general policy, the following three priorities will be used to determine an order of construction:

First priority: All streets within a half-mile (0.5-mile) distance of schools or parks, as measured by walking distance along public rights of way.

Second priority: All collector and arterial streets and any local streets between a half-mile and a mile distance from schools or parks.

Third priority: All other effective network streets.

Pedestrians are also considered users of greenways (Section 5.1) and multipurpose trails (section 5.4) and the design of these facilities and their amenities (such as fountains, benches, and trailheads) should reflect the needs of users moving at walking speed.

MULTIPURPOSE TRAILS

Multipurpose trails allow joint bicycle and pedestrian activities on facilities that are separated from the street. As they are intended to be separate from greenways, these trails are conceived as accommodating bicycles and pedestrians on high speed and/or high volume roads. For purposes of this plan, they are fundamentally the same facility type as the greenway trails defined in Section 5.1 (accommodating both pedestrians and bicyclists in a single facility) and may use the same general facility design standards.

The primary difference between these two types is that multipurpose trails serve the needs of bicycles and pedestrians along roadways and offer a safer alternative to on-street bicycle lanes on roads which pose potential safety conflicts. It is important to include these trails on both sides of the streets where they have been designated to help preserve safety along these roads.

Curb Ramps

Curb ramps shall follow the City of Fort Myers Standards and Specifications, as well as the American Disabilities Act - rules and regulations.

Signals

All pedestrian signals, solely under the jurisdiction of the Lee County Department of Transportation, require specialized consideration of citizens with disabilities.

For more information, consult the following:

- Primary: ADAAG/PROWAG
- Secondary:
  - MUTCD
  - AASHTO "Green Book"
  - FDOT Design Standards
  - FHWA's Designing Sidewalks and Trails for Access
  - NCHRP Project 20-7 (232) ADA Transition Plans: Guide to Best Management Practices
  - NCHRP Project 3-62, Guidelines for Accessible Pedestrian Signals

7. PEDESTRIAN CROSSINGS

INTRODUCTION

Walking requires two important features within the human-made space in which people live, work, and recreate. People must walk along streets, and they must get across streets. Crossing a street should be easy, safe, convenient, and comfortable. While pedestrian behavior and intersection crossing design affect the street crossing experience, motorist intersection behavior, whether/how in fact motorists stop for pedestrians, is the most significant factor in pedestrian safety.

Crossings are a necessary part of the pedestrian experience
(Credit: City of Fort Myers)

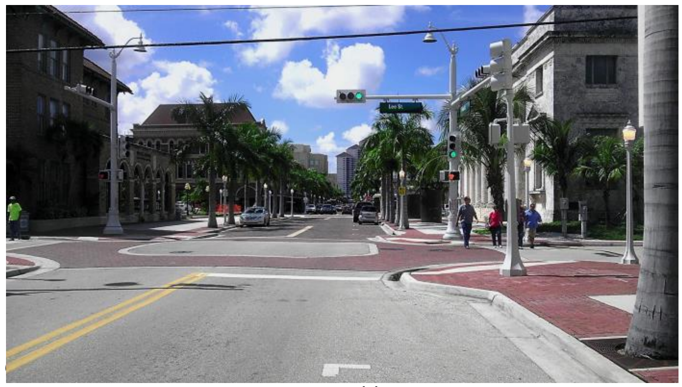
Pedestrian networks and vehicle networks overlap at intersections, posing conflicts between the various modes of travel. A number of engineering treatments and traffic management techniques exist to improve pedestrian safety and to make crossing streets easier, but tools from enforcement, education, and planning tool boxes are also important. A motorist driving at slower speeds has more time to see, react, and stop for a pedestrian. The volume of pedestrians crossing at an intersection also affects safety. Motorists are more aware of crossing pedestrians when more pedestrian are around.

Marked crosswalks guide pedestrians to walk at the safest location. To a lesser extent, marked crosswalks also alert vehicle operators to the potential presence of pedestrians. However, because crosswalks and crossing pedestrians often are less visible to motorists, supplemental crosswalks with pedestrian warning (W11-2) signs are typically added to provide more visibility. This is especially true at mid-block crossings and at intersections where only the minor street is Stop control. Providing marked crosswalks is only one of several safety solutions that are available to engineers. When considering how to provide safer crossings for pedestrians, the question should ***not*** be: "*Should I provide a marked crosswalk?*" Instead, the question should be: "*What **are** the most effective measures that can be used to help pedestrians safely cross a street?*" For example, crossings often need to be supplemented with median refuges, flashing beacons, and signage to accommodate pedestrians crossing in a safe and comfortable manner.

Deciding whether to mark or not mark crosswalks is only one consideration in creating safe and convenient pedestrian crossings. This chapter describes a number of measures to improve pedestrian crossings, including marked and unmarked crosswalks, raised crossing islands and medians, beacons, and lighting.

ESSENTIAL PRINCIPLES OF PEDESTRIAN CROSSINGS

The following principles should be incorporated into pedestrian crossing improvements:



manageable.
(Credit: City of Fort Myers)

- Pedestrians must be able to cross roads safely. FDOT and local governments have an obligation to provide safe and convenient crossing opportunities.
- The safety of all street users, particularly the more vulnerable groups, such as children, the elderly, those with disabilities, and the more vulnerable modes, such as walking and bicycling, must be considered when designing streets.
- Pedestrian crossings must meet accessibility standards and guidelines. See Chapter 6 for more information on accessibility.

Real and perceived safety must be considered when designing crosswalks. As such, the following principles should be considered:

- Crossing must be "comfortable."
- Crossing treatments that have higher crash reduction factors (CRFs) should be used when designing crossings.
- Safety should not be compromised to accommodate traffic flow.
- Good crossings begin with appropriate speed. In general, urban arterials should be designed to a maximum of 30 mph or 35 mph, depending on the local environment.
- Crossings service varying needs and should be selected and designed to fit their specific environment.
- Ideally, uncontrolled crossing distances should be no more than 28 feet, which allows for two 11-foot lanes and one 6-foot bicycle lane. This would allow pedestrians to cross an uncontrolled crossing in 8 seconds, assuming a conventional walking speed of 3.5 feet per second.
- Uncontrolled crosswalks should still be considered if the crossing distance is greater than 28 feet within a context sensitive approach, such as in locations where transit passengers cross the street, in urban transects (T4, T5 or T6), where marked crosswalks would

effectively channel pedestrians to a single crossing location, and unsignalized intersections with no signalized crossing within 600 feet (see *Accessing Transit: Designing Handbook for Florida Bus Passenger Facilities*, Florida State University (2008), accessed from FDOT Transit website).

- Uncontrolled crosswalks on streets wider than 28 feet should be augmented with additional crossing safety devices. Ideally, streets wider than 28 feet should be divided, effectively creating two streets, by installing a median or crossing islands, especially when traffic volumes are greater than 12,000 vehicles per day. On multi-lane roads with traffic volumes above 12,000 vehicles per day, having a marked crosswalk without other substantial crossing safety improvements is associated with a higher pedestrian crash rate compared to an unmarked crosswalk.[1] Substantial crossing safety improvements were considered to include raised medians, speed-reducing or traffic calming measures, traffic signals, and beacons.
- The number of lanes crossed should be limited to a maximum of three lanes per direction on all roads, plus a median or center turn lane.
- There must be a safe, convenient crossing at every transit stop.
- Double or triple left or right turns concurrent (permissive) with pedestrian crossings at signalized intersections must never be allowed.
- Right-turns from single lanes should be supplemented with R10-15 signs and tight corner radii to control speeds.
- People should never have to wait more than 90 seconds to cross at signalized intersections.
- Pedestrian signals should be provided at all signalized crossings where pedestrians are allowed.
- Marked crosswalks should be provided on all approaches of signalized intersections.
- Locations where pedestrian bulb-outs can be provided can enhance the viability of a crossing location.
- Driver expectancy must be considered.

[1] *Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations* (Zegeer et al, 2005)

FLORIDA STATE STATUTES RELATED TO PEDESTRIAN CROSSINGS

Florida traffic laws for pedestrians and drivers are found in *Florida State Statute 316.003*, *316.075*, and *316.130*. A brief summary is provided below.

- A crosswalk is legally present on each leg of an intersection whether marked or unmarked.
- The intersection of two public streets constitutes a legal crossing and should include marked striping, signage, and appropriate pedestrian crossing safety infrastructure.
- Pedestrians crossing at mid-block locations are permitted, providing either of the two nearest intersections are unsignalized.
- A driver is obligated to yield the right-of-way to a pedestrian lawfully crossing in a crosswalk. Safe yielding may require stopping.

PERFORMANCE MEASURES

Performance measures are typically used to study uncontrolled crossing locations. Performance measures establish how well a crossing is performing. In all cases, baseline data should be collected to allow for before and after analysis. To establish an accurate analysis, entire corridors should be analyzed, since occurrences at any one location may be an anomaly. Performance measures for pedestrian crossings include the following:

- The number of pedestrians crossing at a particular crossing location goes up.
- The pedestrian crash rates go down.
- Pedestrian fatalities and serious injuries should decrease.
- The numbers of children, seniors, and people with disabilities crossing the street should reflect their percentage in the vicinity population.
- The speed of motorists either turning at an intersection or traveling at a mid-block crossing goes down.
- Motorists do not block intersections (including crosswalks).
- At uncontrolled intersections, the percentage of motorists who stop for pedestrians goes up (measure compliance with stop or yield requirement).

PEDESTRIAN CROSSING TOOLBOX

Many engineering measures may be used at a pedestrian crossing, depending on site conditions and potential users. Marked crosswalks are commonly used at intersections and sometimes at mid-block locations. Marked crosswalks are often the first measure in the toolbox followed by a series of other measures that are used to enhance and improve marked crosswalks. The decision to mark a crosswalk should not be considered in isolation, but rather in conjunction with other measures to increase awareness of pedestrians. Without additional measures, marked crosswalks alone may not increase pedestrian safety, particularly on multi-lane streets.

MARKED CROSSWALKS

Marked crosswalks alert drivers to expect crossing pedestrians and direct pedestrians to desirable crossing locations. Although many motorists are unaware of their precise legal obligations at crosswalks, the Florida Uniform Traffic Control Law requires drivers to yield to pedestrians in any crosswalk, whether marked or unmarked. Crosswalks are present by law on all approaches of all intersections unless the pedestrian crossing is specifically prohibited by signs. At mid-block locations, crosswalks only exist where marked. Note that mid-block crossings are legally allowed if the nearest intersection in each direction is unsignalized. Crosswalks should be considered at mid-block locations where there is strong evidence that pedestrians want to cross there, due to origins and destinations across from each other and an overly long walking distance to the nearest controlled crossing (see mid-block crossing sub-section below).

Marked Crosswalk with Decorative Pavement (Credit: City of Fort Myers)

Crosswalk Markings

According to the MUTCD, the minimum crosswalk marking shall consist of solid white lines. They shall not be less than 6 inches or greater than 24 inches in width. FDOT Standard Index 17346 states that crosswalk lines shall be a minimum of 12 inches in width. Local jurisdictions should follow the 12 inch minimum standard for crosswalk markings.

Placement

Locations to ideally install marked crosswalks are as follows:

- Signalized intersections
- Crossings near transit facilities
- Shared use path intersections
- High-pedestrian land use generators
- School walking routes
- Where there is a preferred crossing location due to sight distance
- Where needed to enable comfortable crossings of multi-lane streets between controlled crossings spaced at convenient distances
- Unsignalized intersections in urban transects (T4, T5, or T6)
- Unsignalized intersections with no signalized crossing within 600 feet

Controlled Intersections

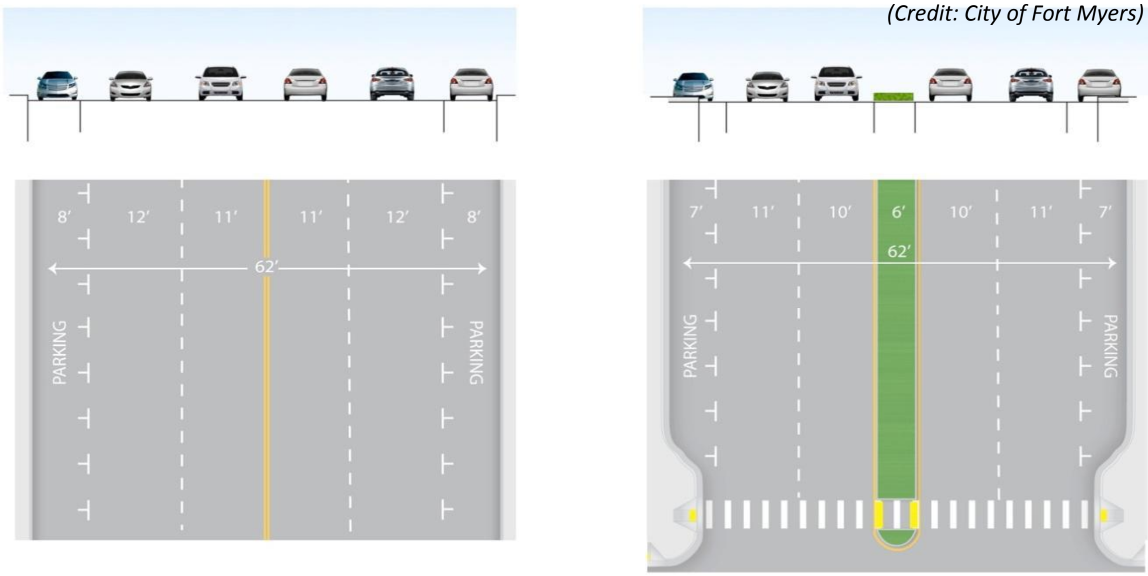
Intersections can be controlled by traffic signals or STOP signs. Marked crosswalks should be provided on all intersection legs controlled by traffic signals, unless the pedestrian crossing is specifically prohibited by signs. Marked crosswalks may be considered at STOP controlled intersections. Factors to be considered include high pedestrian volumes, high vehicle volumes, school zone location, high volume of elderly or disabled users, or other safety related criteria.

Controlled intersection
(Credit: City of Fort Myers)

Uncontrolled Intersections

Intersections without traffic signals or STOP signs are considered uncontrolled intersections. The decision to mark a crosswalk at an uncontrolled intersection should be guided by an engineering study. Factors considered in the study should include vehicular volumes and speeds, roadway width and number of lanes, stopping sight distance and triangles, distance to the next controlled crossing, night time visibility, grade, origin destination of trips, left turning conflicts, and pedestrian volumes. The engineering study should be based on the FHWA study, *Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations* (Zegeer et al, 2005). The list below provides key recommendations from the study.

Pedestrian crossing at an uncontrolled intersection (Credit: City of Fort Myers)



Uncontrolled crossings of four-lane streets can be difficult to cross without special treatments like medians and curb extensions.

- It is permissible to mark crosswalks at uncontrolled locations on two-lane roadways.
- On multi-lane roadways, uncontrolled marked crosswalks should be enhanced by additional safety features under the following conditions (the other tools listed in this section can be considered to enhance the crosswalk):
  - ADT > 12,000 without median
  - ADT > 15,000 with median
  - Speeds greater than 40 mph
- Raised medians can be used to reduce risk.
- Signals or other treatments should be considered where there are many young and/or elderly pedestrians.

Mid-block Crosswalks

A mid-block crosswalk can be controlled or uncontrolled.

A controlled, mid-block crosswalk includes a traffic signal to control motor vehicles based on pedestrian-actuation of the signal. Although the pedestrian crossing traffic signal is not the sole solution to facilitating pedestrian access to street crossings, it is often a necessary solution at multi-lane facilities having high vehicular volume. The mid-block pedestrian signal should be guided by an engineering study and a comparison to the signal warrants found in the MUTCD.

Uncontrolled, mid-block crosswalks can also be provided under certain circumstances. The criteria for marking an uncontrolled mid-block crosswalk provided below are adapted from the Center for Urban Transportation Research (CUTR) report *Pedestrian Safety at Midblock Locations* (Chu, 2006).

Mid-Block Crosswalk
(Credit: City of Fort Myers)

- **Pedestrian Demand.** Any block under consideration for a possible mid-block crosswalk should show a well-defined pattern of pedestrian generators, pedestrian attractors, and pedestrian flow between them. Considerations should also include presence of bus stops. Sufficient pedestrian crossing demand generally is 25 pedestrians during the peak hour of pedestrian crossing traffic or 75 pedestrians during the peak four hours of pedestrian crossing traffic.
- **Shared-Use Path Crossing.** Well-designed mid-block crosswalks should be strongly considered at any mid-block location that is an integral part of a designated shared-use path regardless of demand.
- **Existence of Alternatives.** The minimum distance to the nearest controlled or protected crossing is 300 feet. A well-designed crossing should be provided at least every 660 feet in urbanized areas.
- **Traffic Volume.** For local streets, a minimum threshold for average daily traffic (ADT) typically falls in the range of 1,500 to 3,000. Mid-block crossings should be augmented with enhanced safety devices. As presented in the Uncontrolled Intersections sub-section, mid-block crossings should be augmented with enhanced safety devices when daily traffic and speeds above the following average thresholds exist:
  - ADT > 12,000 w/o median
  - ADT > 15,000 w/ median

    - Speeds greater than 40 mph
- **Stopping Sight Distance.** Stopping sight distance should be calculated and compared to minimum sight distance criteria found in the FDOT *Plans Preparation Manual* (PPM) Chapter 2 or AASHTO guidance. The consideration of sight distance should account for the presence of on-street parking when applicable.
- **Lighting.** A minimum illumination level of 2.5 horizontal foot-candles is desirable for both approaches. When regular street lighting is not present or is inadequate to reach this minimum illumination level, separate crosswalk lighting should be considered. Crossing locations with high night-time demand should include separate crosswalk lighting, which may include in-street lighting.

These basic safety criteria are consistent with MUTCD guidance and help achieve the objective of increasing positive effects of marked crosswalks while reducing negative behavioral adaptation.

Frequency of Marked Crosswalks at Uncontrolled Locations

Along urban streets, a well-designed crossing should be provided at least every 1/8 mile (660 feet). Marked crosswalks should be spaced so people can cross at preferred locations. If people are routinely crossing streets at non-preferred locations, consideration should be given to installing a new crossing. Pedestrians need crossings with appropriate devices (islands, curb extensions, advanced yield lines, etc.) on multilane streets where significant pedestrian crossing traffic is prominent.

Special Emphasis Crosswalks

Because of the low viewing angle at which pavement markings are observed by drivers, the use of longitudinal stripes, in addition to or in place of transverse markings, can significantly increase the visibility of a crosswalk to oncoming traffic. Special emphasis crosswalks have been shown to increase motorist's decision-making abilities regarding the yielding and channelization of pedestrians. This has led the Federal Highway Administration to conclude that high-visibility pedestrian crosswalks have a positive effect on pedestrian and driver behavior. Research, however, has not shown a direct link between increased crosswalk visibility and increased pedestrian safety,

Colored and stamped crosswalks should only be used at controlled locations, and should always be bordered by white lines.

Local jurisdictions should be consistent with FDOT criteria for special emphasis crosswalks as in the following guidelines:

- Lines must always be white
- Longitudinal stripes must be 24 inches wide
- Longitudinal stripes should be spaced to avoid the wheel-paths of vehicles up to a maximum spacing of 60 inches.

<u>Crosswalks and Accessibility</u>

Example of in-accessible ramp.
(Credit: City of Fort Myers)

The pedestrian access route continues through the crosswalk and must conform to the surface condition - width and slope requirements, as discussed in Chapter 6, "Universal Pedestrian Access."

Longitudinal crosswalk markings provide the best visibility for pedestrians with limited vision.

Decorative crosswalk pavement materials should be chosen with care to ensure that smooth surface conditions and high contrast with surrounding pavement are provided. Textured materials within the crosswalk are not recommended. Without reflective materials, these treatments are not visible to drivers at night. Decorative pavement materials often deteriorate over time and become a maintenance problem while creating uneven pavement. The use of color or material to delineate the crosswalks as a replacement of retro-reflective pavement marking should not be used, except in slow speed districts where intersecting streets are designed for speeds of 20 mph or less.

Raised Crossing Islands/Medians

Raised islands and medians are the most important, safest, and most adaptable engineering tool for improving street crossings. *Note on terminology: a median is a continuous raised area separating opposite flows of traffic. A crossing island is shorter and located just where a pedestrian crossing is needed.* Raised medians and crossing islands are commonly used between intersections when blocks

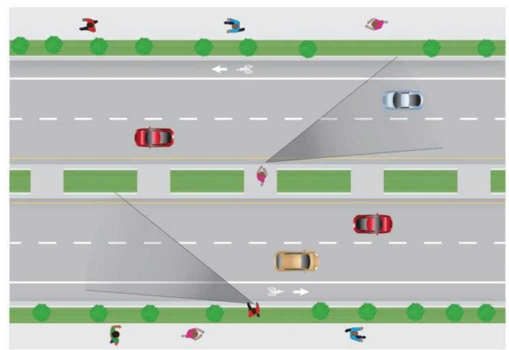
Staggered median crossing
(Credit: Marcel Schmaedick)

are long (500 feet or more in downtowns) and in the following situations:

- Speeds are higher than desired
- Streets are wide
- Traffic volumes are high
- Sight distances are poor

Raised islands have nearly universal applications and should be placed where there is a need for people to cross the street. They are also used to slow traffic.

Raised crossing islands and medians have been identified by FHWA as the most effective tool to enhance crossing safety, (*Pedestrian Countermeasure Policy Best Practice Report*, FHWA, and *Pedestrian Safety Engineering and ITS-Based Countermeasures*, FHWA).



Medians and crossing islands allow pedestrians to complete the crossing in two stages. (Credit: Michele Weisbart)

<u>Reasons for Efficacy</u>

The use of raised crossing islands and medians changes a complex task, crossing a wide street with traffic coming from two opposing directions all at once, into two simpler and smaller tasks. With their use, conflicts occur in only one direction at a time, and exposure time can be reduced from more than 20 seconds to just a few seconds.

Although crossing Islands can be used with signals, as a general rule, crossing islands are preferable to signal-controlled crossings due to their lower installation and maintenance cost, reduced waiting times, and their safety benefits. Crossing islands are also used with “road diets,” taking four-lane undivided, high-speed roads down to better performing, three-lane roadways (two travel lanes and a center turn lane); portions of the center turn lane can be dedicated to crossing islands.

On streets with traffic speeds higher than 30 mph, it may be unsafe to cross without a median island. At 30 mph, motorists travel 44 feet each second, placing them 880 feet out when a pedestrian starts crossing an 80-foot wide multi-lane road. In this situation, this pedestrian may still be in the last travel lane when the car arrives there; that car was not within view at the time he or she started crossing. With an island on multi-lane roadways, people would cross two or three lanes at a time instead of four or six. Having to wait for a gap in only one direction of travel at a time significantly reduces the wait time to cross. Medians and crossing islands have been shown to reduce crashes by up to 40 percent (*Designing for Pedestrian Safety course,* FHWA).

Angled pedestrian crossings through pedestrian refuges force pedestrians to look for oncoming vehicles.

Placement of Crossing Islands

Crossing islands are often used for trails, high pedestrian flow zones, transit stations, schools, work centers, and shopping districts

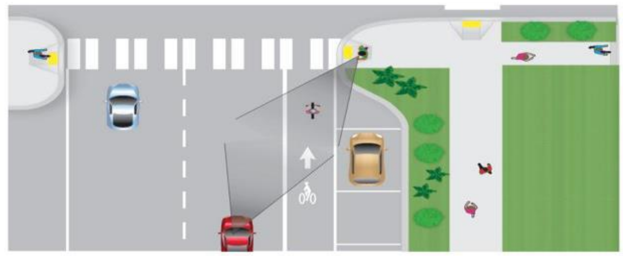
Design Detail

Crossing islands, like most traffic calming features, perform best with both tall trees and low ground cover. This greatly increases their visibility, reduces surprise, and lowers the need for excessive signage. Where roadway curves or hill crests exist, they complicate crossing locations. Under these conditions, median islands are often extended over the crest or around the curve, which allows the motorists to have a clear sight line of the downstream change in conditions (six second or longer). Lighting of median islands is essential. The suggested minimum width of a crossing island is 6 feet. Where there is space available, inserting a 45-degree bend to the right helps orient pedestrians to the risk they encounter from motorists during the second half of *Crossing Isles: Berkley, CA* their crossing.

Raised Crosswalk

Raised crosswalks slow traffic and put pedestrians in a more visible position. They are trapezoidal in shape on both sides and have a flat top where the pedestrians cross. The level crosswalk area must be paved with smooth materials; any texture or special pavements used for aesthetics should be placed on the beveled slopes, where they will be seen by approaching motorists. They are most appropriate in areas with significant pedestrian traffic and where motor vehicle traffic should move slowly, such as near schools, on college campuses, in Main Street retail environments, and in other similar places. They are especially effective near elementary schools where they elevate small children by a few inches and make them more visible.

Curb Extensions



Curb extensions extend the sidewalk or curb line out into the parking lane, which reduces the effective street width. Curb extensions significantly improve pedestrian crossings by reducing the pedestrian crossing distance, visually and physically narrowing the roadway, improving the ability of pedestrians and motorists to see each other, and reducing the time that pedestrians are in the street. Reducing street widths improves signal timing since pedestrians need less time to cross.

Motorists typically travel more slowly at intersections or mid-block locations with curb extensions, as the restricted street width sends a visual cue to slow down. Turning speeds are lower at intersections with curb extensions (curb radii should be as tight as is practicable). Curb extensions also prevent motorists from parking too close to the intersection.

Curb extensions also provide additional space for two curb ramps and for level sidewalks where existing space is limited, increase the pedestrian waiting space, and provide additional space for pedestrian push button poles, street furnishings, plantings, bike parking, and other amenities. A benefit for drivers is that extensions allow for better placement of signs (e.g., stop signs and signals).

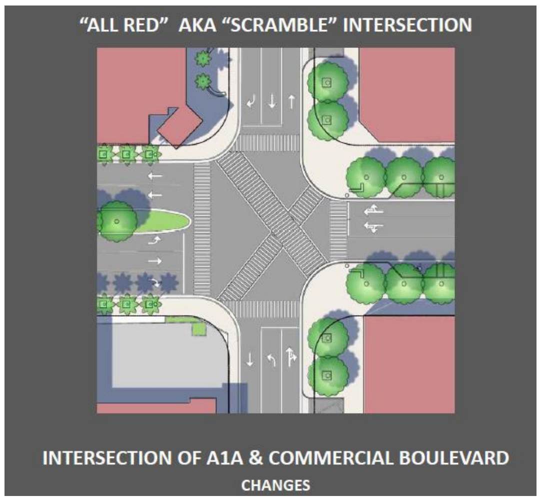
Curb extensions are generally only appropriate where there is an on-street parking lane. Where street width permits, a gently tapered curb extension can reduce crossing distance, without creating a hazard at an intersection, along streets without on-street parking. Curb extensions must not extend into travel lanes or bicycle lanes.

Curb extensions can impact other aspects of roadway design and operation as they may:

- Impact street drainage and require catch basin relocation;
- Impact underground utilities;
- Require loss of curbside parking, though careful planning often mitigates this potential loss, for example by relocating curbside fire hydrants, where no parking is allowed, to a curb extension;
- Complicate delivery access and garbage removal;
- Impact street sweepers and other maintenance vehicles; and,
- Affect the turning movements of larger vehicles such as school buses and large fire trucks.

ALL-PEDESTRIAN PHASES

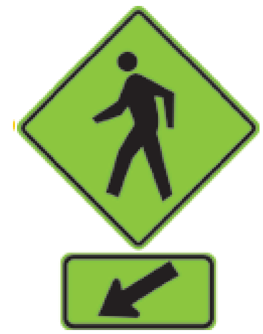
Exclusive pedestrian phases (i.e. pedestrian 'scrambles') may be used where turning vehicles conflict with very high pedestrian volumes and pedestrian crossing distances are short. Although pedestrians can cross in any direction during the pedestrian phase, pedestrians typically have to wait for both vehicle phases before they get the walk signal again. This creates delays for pedestrians travelling straight, but can be mitigated by allowing pedestrians, continuing along in the same direction, to get a "WALK" signal during the green signal phase and while turns are prohibited for traffic. Diagonal crosswalk markings are consistent with 2009 MUTCD Chapter 3B.18.



Proposed all-pedestrian phase and diagonal crosswalk markings (Credit: City of Lauderdale-By-The-Sea)

Proposed all-pedestrian phase and diagonal crosswalk markings (Credit: City of Lauderdale-By-The-Sea)

SIGNS



Pedestrian warning sign (MUTCD W11-2) with diagonal downward pointing arrow

Signs convey important information to motorists by letting them know what to expect, so that they can react in a safe manner. Sign usage and placement must be implemented judiciously, as overuse contributes to sign clutter and confusion.

Regulatory signs, such as STOP, YIELD, and turn-restriction signs, require driver actions and are enforceable. Warning signs provide information, especially to motorists and pedestrians unfamiliar with an area, by cautioning drivers about atypical situations.

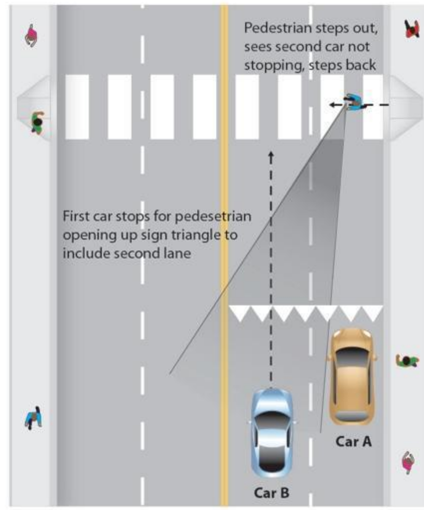
Advance pedestrian warning signs or pedestrian warning signs with distance supplemental plaques should be used where pedestrian crossings may not be expected by motorists, especially if there are many motorists who are unfamiliar with the area. The fluorescent yellow/green color is designated specifically for pedestrian, bicycle, and school warning signs (Section 2A.10 of the 2009 MUTCD) and should be used for new and replacement installations. This bright color attracts the attention of drivers because it is unique.

Sign R1-5 should be used in conjunction with advance yield lines, as described below. Sign R1-6 may be used on median islands, where they will be more visible to motorists than signs placed on the side of the street, especially where there is on-street parking. Since Florida is a "yield" state, local jurisdictions should use R1-5, R1-5a, and R1-6 signs. It should be noted that *Florida State Statute 316* recognizes that the act of yielding may include stopping.

All signs should be periodically checked to make sure that they are in good condition, free from graffiti, reflective at night, and continue to serve their purpose.

All sign installations need to comply with the provisions of the MUTCD.

ADVANCED YIELD/STOP LINES



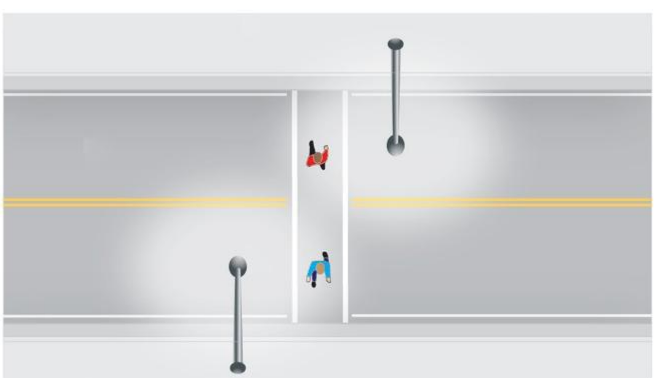
Advanced yield markings
(Credit: Michele Weisbart)

Stop lines are solid white lines 12 to 24 inches wide, extending across all approach lanes to indicate where vehicles must stop in compliance with a stop sign or signal. Advance stop lines reduce vehicle encroachment into the crosswalk and improve drivers' view of pedestrians. At signalized intersections, a stop line is typically set back between 4 and 6 feet.

At uncontrolled crossings of multi-lane roads, advance yield lines can be an effective tool for preventing multiple threat vehicle and pedestrian collisions. Section 3B.16 of the MUTCD specifies placing advanced yield markings 20 to 50 feet in advance of crosswalks, depending upon location and specific variables such as vehicle speeds, traffic controls, street width, on-street parking, potential for visual confusion, nearby land uses with vulnerable populations, and demand for queuing space. Thirty feet is the preferred setback for effectiveness at many locations. This setback allows a crossing pedestrian to see if cars in the second or third lanes are stopping after a driver in the first lane has stopped.

LIGHTING

Lighting is important to include at all pedestrian crossing locations for the comfort and safety of the road users. Lighting should be present at all marked crossing locations. Lighting enables better field vision for drivers, which allows them to see pedestrians quicker, thereby improving reaction times.



Proper placement of crosswalk illumination
(Credit: Michele Weisbart)

FHWA HT-08-053, *The Information Report on Lighting Design for Mid-block Crosswalks*, found that a vertical illumination of 20 lux in front of a crosswalk, measured at a height of 5 feet from the road surface, provided adequate detection distances in most circumstances. Although the research was constrained to mid-block placements of crosswalks, the report includes a brief discussion of considerations in lighting crosswalks co-located with intersections.

The same principle applies at intersections. Illumination just in front of crosswalks creates optimal visibility of pedestrians.

Another good reference on crosswalk lighting levels is the Illuminating Engineering Society of North America (IESNA). This resource provides intersection guidance relating to the illumination of crosswalks, which enables pedestrians to be visible to motorists (see the adjacent image). Crosswalk lighting should provide color contrast from standard roadway lighting.

Table 7.1 Recommended Illumination by Street Type

Functional Classification	Average Maintained Illumination at Pavement by Pedestrian Area Classification [FC]		
	High	Medium	Low
Major / Major (boulevard)	3.4 fc	2.6 fc	1.8 fc
Major / Collector (boulevard / avenue)	2.9 fc	2.2 fc	1.5 fc
Major / Local (avenue)	2.6 fc	2.0 fc	1.3 fc
Collector / Collector (avenue)	2.4 fc	1.8 fc	1.2 fc
Collector / Local (street)	2.1 fc	1.6 fc	1.0 fc
Local / Local (street)	1.8 fc	1.4 fc	0.8 fc

There is uniformly distributed flux of one lumen. ANSI-IESNA RP-8-00, “Roadway Lighting,” P. 15

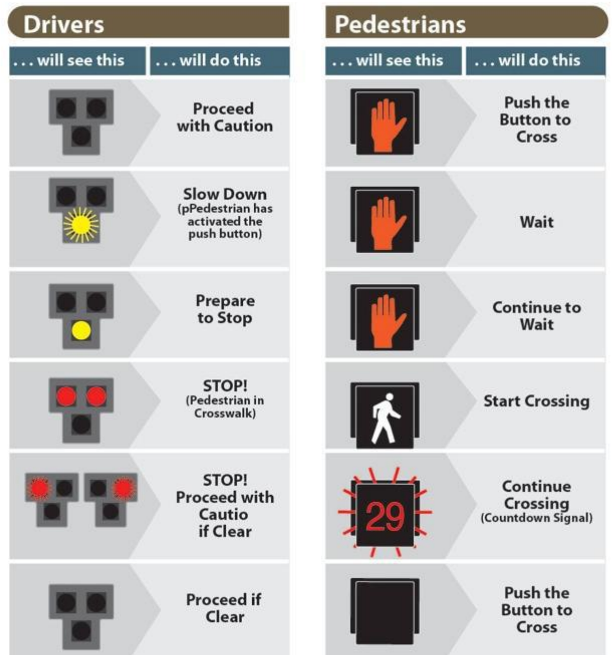
Rectangular Rapid Flashing Beacon

The Rectangular Rapid Flashing Beacon (RRFB) signal system uses rectangular-shaped high intensity LED-based indications, flashes rapidly in a wig-wag "flickering" flash pattern, and is mounted immediately between the crossing sign and the sign's supplemental arrow plaque.

The FHWA Office of Transportation Operations has reviewed available data and considers the RRFB to be highly successful for the applications tested (uncontrolled crosswalks). The RRFB offers significant potential safety and cost benefits because it achieves very high rates of compliance at a very low cost compared to other more restrictive devices such as full mid-block signalization. The components of the RRFB are not proprietary and can be assembled by any jurisdiction with off-the-shelf hardware. The FHWA believes that the RRFB has a low risk of safety or operational concerns. However, because proliferation of RRFBs in the roadway environment to the point that they become ubiquitous, thereby reducing their effectiveness, use of RRFBs should be limited to locations with the most critical safety concerns, such as pedestrian and school crosswalks at uncontrolled locations.

The RRFB has received Interim Approval via FHWA’s “Interim Approval for Optional Use of Rectangular Rapid Flashing Beacons (IA-11) dated July 16, 2008.

Pedestrian Hybrid Beacon



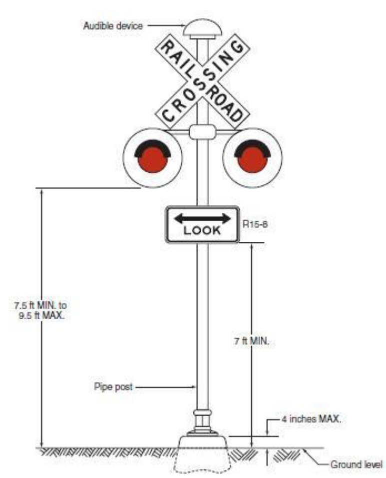
A Pedestrian Hybrid Beacon (PHB) system is used to warn and control traffic at an unsignalized location so as to help pedestrians cross a street or highway at a marked crosswalk.

A PHB can be used at a location that does not meet traffic signal warrants or at a location that meets traffic signal warrants, but where a decision has been made to not install a traffic control signal. A minimum number of 20 pedestrians per hour is needed to warrant installation. This is substantially less than the 93 minimum needed for a signal installation.

If a PHB is used, it should be placed in conjunction with signs, crosswalks, and advanced yield lines to warn and control traffic at locations where pedestrians enter or cross a street or highway. A PHB should only be installed at a marked crosswalk.

Installations should be done according to the MUTCD Chapter 4F, "Pedestrian Hybrid Beacons."

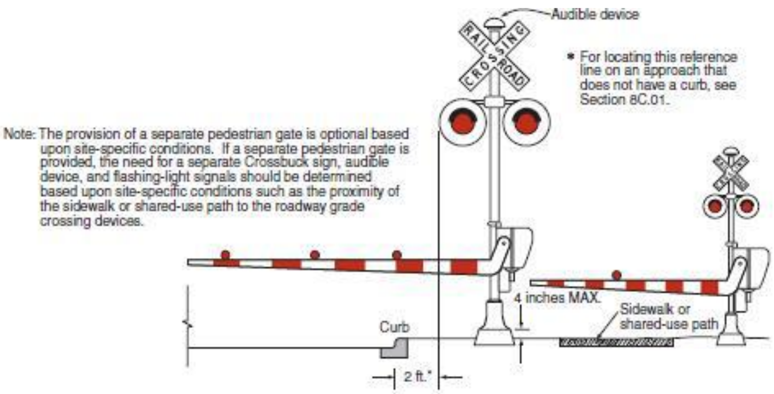
Pedestrian Toolbox for Railroad Crossings



Pedestrian crossings of railroad tracks apply a special set of tools. The following are the primary tools to apply.

- Pedestrian gates
- Channelization of pedestrians through gates and across tracks
- Warning flashers
- Signs
- Audible signals

More details can be found in the MUTCD.



Separate pedestrian gate at a railroad crossing (Source: 2009 MUTCD Figure 8C.6)

Flashing-light signal assembly for pedestrian railroad crossing (Source: 2009 MUTCD Figure 8C.4)

8. BIKEWAY DESIGN

INTRODUCTION

Since the bicycle is a non-motorized vehicle and is human-powered, it is the cleanest and greenest form of vehicular transportation. As such, bicycles should be integrated as part of the the essential principles of planning, design, and construction of bikeways.

Bicycle transportation is active transportation. Therefore, traveling by bicycle is not only environmentally-friendly, it promotes healthy living. Bicycle transportation helps individuals address many modern public health concerns including obesity, stress, and anxiety disorders.

Today, bicycling use is on the rise in the United States and crash rates have decreased over time through proven education, encouragement, and engineering techniques. However, bicyclists are still vulnerable road users who experience fatality rates significantly higher than the general mix of road users. According to research conducted by the Portland Bureau of Transportation, most bicyclists that use on-road bicycle facilities are classified as "strong and fearless" and are generally comfortable operating a bicycle intermixed with high traffic volumes and fast speeds. However, most bicyclists prefer local streets with slower vehicular speeds, which tends to limit the number of destinations that they can comfortably reach, given the disconnected street network that is typically prevalent in most developed areas. Therefore, significant progress is still ahead of us; a growth process that can be successfully accomplished by creating truly bicycle-friendly infrastructure for all user types, as part of an infrastructure design that enhances comfort, directness, accessibility, and a safe traffic environment.

Bicycling for All Ages and Reasons

Bicycling occurs at all ages, in all places, among all income groups, and for all kinds of reasons. Apart from its use for daily, functional journeys, the bicycle also plays a major role in recreational activities. Recreational bicycling is not just for fun; recreational bicycling should be given a high priority for public health reasons.

Bicycle facilities and attractive surroundings are essential for people traveling on bicycling trips. If these bicycle facilities are close to home, they improve the livability and hence, the quality of the living environment.

Bicyclist on Winkler Avenue
(Credit: City of Fort Myers)

ESSENTIAL PRINCIPLES OF BIKEWAY DESIGN

The following principles define the bikeway facility guidelines for City of Fort Myers:

- Bicyclists should have safe, convenient, and comfortable access to all destinations.
- Every local street is a bicycle street, regardless of whether a designated bicycle facility or bicycle route is present.
- Street design should accommodate all types, levels, and ages of bicyclists.
- Bicyclists should be separated from pedestrians, except under special circumstances such as shared-use pathways or shared-space streets.
- Bikeway facilities should consider vehicle speeds and volumes, as follows:
  - Shared use on low volume, low-speed roads; and,
  - Separation on higher volume, higher-speed roads.
- Bikeway treatments should provide clear guidance to enhance safety for all users.
- Since most bicycle trips are short, a complete network of designated bikeways should be developed with a grid spacing of approximately ½ mile.

PLANNING FOR A RANGE OF BIKEWAY USERS

Many early bikeway designs assumed that bicyclists resembled pedestrians in their travel behavior. This led to undesirable situations, including:

- Bicyclists being under-served by inadequate facilities;
- Pedestrians resenting bicyclists in their space; and,
- Motorists being confused by bicyclists entering and leaving the traffic stream in unpredictable ways.

Only under special circumstances (e.g., on shared-use paths less than 8 feet in width or streets with shared-use facilities) should bicyclists and pedestrians share the same space.

CHARACTERISTICS OF BICYCLISTS AND THE BICYCLE VEHICLE

As stated in Florida Statue 316.2065, bicyclists operate a vehicle and are legitimate road users. However, they are slower and less visible than motor vehicles.

The ability for bicyclists to safely and efficiently negotiate a bicycle facility, should be the primary design parameter for the design of bikeway facilities. Bicycling requires both the physical and mental capacities of a bicyclist. The physical capacity is required to initiate the vehicle's movement and to keep it moving. The mental capacity, both consciously and subconsciously, is required to ride the bicycle safely. Conscious, mental capacity is required to operate the vehicle within traffic flow. Subconscious mental capacity is required to steer the bicycle, maintain balance, and ride within a straight line.

It is noted that the perceived dangers of bicycling tend to limit the ability of bicycling to attract new riders, as a viable transportation mode in many urban areas. The perceived dangers of bicycling on busy streets, within the general public, is one reason why enhanced bicycle facilities - going beyond the design minimums, will likely be necessary to attract a significant mode shift to bicycling.

BICYCLIST SKILL LEVEL

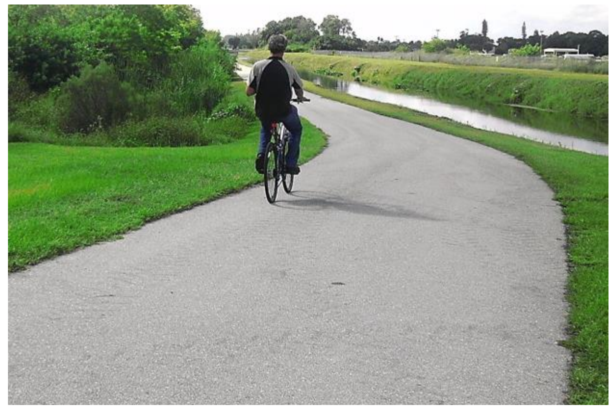
Bicyclist skill level also provides a wide variety of speeds and expected behaviors. Several systems of bicyclist classification are used within the bicycle planning and engineering professions. These classifications can be helpful in understanding the characteristics and infrastructure preferences of different cyclists. However, these classifications may change in type or proportion over time as infrastructure and culture evolve. To accommodate as many user types as possible and provide a comfortable experience for the greatest number of cyclists, bicycle infrastructure should use planning and designing options from shared roadways to separate facilities.

Proficient bicycle riders

A classification system developed by the City of Portland, Oregon, provides a definition for the following bicycle user types:

- **Strong and Fearless.** Bicyclists who will ride anywhere, regardless of roadway conditions. These bicyclists can ride faster than other user types, prefer direct routes, and will typically choose roadways, even if shared with vehicles, over separate bicycle facilities such as shared-use paths. This bicyclist type comprises a low percentage of the bicycle population.
- **Enthused and Confident**. This group encompasses intermediate bicyclists who are mostly comfortable riding on all types of bicycle facilities, but will usually prefer low traffic streets, bike lanes, or separate paths when available. They may deviate from a more direct route in favor of a preferred facility type. This group includes commuters, utilitarian cyclists, and recreational riders, and probably represents less than 10 percent of the bicycle population.

- **Interested but Concerned.** This user type makes up the bulk, which is likely between one-half and two-thirds of the bicycling or potential bicycling population. They are cyclists who typically ride only on low traffic streets or paths under favorable conditions and weather. They perceive traffic and safety as significant barriers toward increased use of bicycling. These bicyclists may become "Enthused and Confident" with encouragement, education, and experience.
- **No Way, No How.** People in this category are not cyclists; they perceive severe safety issues associated with riding in traffic and will never ride a bicycle in traffic under any circumstances. However, some riders may eventually give bicycling a second look, and therefore may progress to the user types above, should better facilities be provided. This group likely comprises something between a quarter and a third of the population.



Less-experienced bicycle riders prefer paths (Credit: City of Fort Myers)

Of particular interest to the discussion of bicyclist skill level are children. Children, riding on their own or with their parents, may not travel as fast as their adult counterparts, yet still require access to key destinations in their community, such as schools, convenience stores, and recreational facilities. Residential streets, having low motor vehicle speeds linked with shared-use paths compared to busier streets that have well-defined pavement markings between bicycles and motorists, can accommodate children without encouraging them to ride in the travel lanes of major arterials.

BIKEWAY TYPES AND DESIGNS

A designated bikeway network provides a system of facilities that offers rider enhancements, travel guidance, and/or mobility priority to bicyclists over other roadway users within the network. However, it is important to remember that all streets in an urbanized area should safely and comfortably accommodate bicyclists, regardless of whether the street is designated as a bikeway. Several general types of bikeways are listed in this section with no implied order of preference.

In Florida, local jurisdictions should follow minimum width and geometric criteria, as defined in the Florida Manual of Uniform Minimum Standards (Florida Greenbook), or follow proper procedures for exemptions and experiments. It should be noted that the Florida Greenbook contains minimum design standards. Local jurisdictions should not interpret this to mean *exact* dimensions or preferred treatments. In many circumstances, exceeding these minimum standards provides for a more desirable bicycling environment.

It should be noted that many of the bikeway facility types and geometric criteria established in this manual, which go beyond minimum design standards found in the Florida Greenbook, have been implemented and evaluated in other metropolitan areas, and found to be successful from safety, mobility, and encouragement perspectives. These bikeway facility types are found in several planning and engineering guidebooks such as the National Association of City Transportation Officials (NACTO) *Urban Bikeway Design Guide* and the Institute of Transportation Engineers (ITE) *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach*. In particular, the NACTO *Urban Bikeway Design Guide* is intended to help practitioners make good decisions about urban bikeway design. The treatments outlined in the guide are based on real-world experience in some of the most bicycle-friendly cities and have been selected for inclusion in the Guide, because of their utility in helping local jurisdictions meet their goals for bicycle transportation.

Many signs and pavement markings are available for use by planners and designers of bikeways, as designated in the Federal Highway Administration (FHWA) *Manual on Uniform Traffic Control Devices* (MUTCD). Signs are referenced in this section by the acronym MUTCD and their MUTCD sign designation number for easy reference. Designers will find detailed design information, including sign size and sign placement, in the latest version of the MUTCD, available online.

The Florida Department of Transportation (FDOT) provides designers with criteria for bicycle symbol markings and striping in *FDOT Standard Index 17347*. The *FDOT Plans Preparation Manual,* or PPM Chapter 8, provides guidance for bicycle facility design on the State Highway System (SHS).

BIKE LANES

A bike lane is that portion of the roadway that has been designated by striping and pavement markings for the preferential or exclusive use of bicyclists. Bike lanes should also be signed with the MUTCD R3-17 sign. It should be noted that the MUTCD now considers the R3-17 sign optional; therefore, this consideration should not be interpreted as “not required.” Instead, designers have flexibility to justifiably utilize spacing of the R3-17 sign, as deemed appropriate. In general, most urban bike lanes should include R3-17 signs. Prevalent factors for not providing the R3-17 signs include situations where extreme sign clutter exists, such as in downtown districts where such signage would block pedestrian clear width necessities, and in situations where dense, natural landscaping would block the visibility and effectiveness of signage, which in turn would detract from the natural beauty of the landscape.

<u>Advantages of Bike Lanes</u>

Bike Lane Sign
(Credit: City of Fort Myers)

- Bike lanes enable bicyclists to position themselves such that they will be visible to motorists.
- Bike lanes facilitate predictable behavior and movements between bicyclists and motorists.
- Bike lanes encourage bicyclists to ride on the travel way rather than the sidewalk.
- Bike lanes encourage bicyclists to ride in the direction of traffic.
- Bike lanes enable bicyclists to ride at their preferred speed without interference from prevailing road traffic conditions.
- Bike lanes enable bicyclists to ride at a constant speed, which minimizes energy loss especially when traffic in the adjacent travel lanes speeds up or slows down, as in stop-and-go traffic.

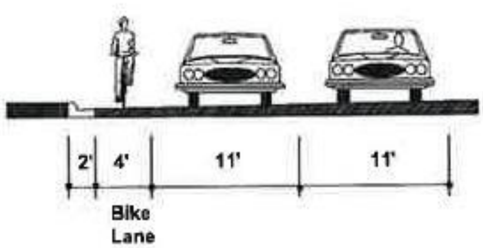
Motorists are prohibited from using bike lanes for driving and parking, but may use them for emergency avoidance maneuvers or vehicular breakdowns. Bike lanes are one-way facilities that carry bicycle traffic in the same direction as the adjacent motor vehicles travel.

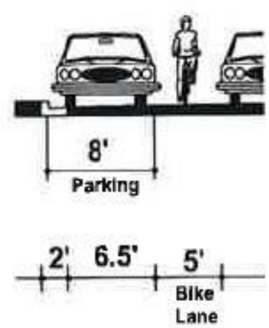
Bike lanes may also have enhanced treatments, which are further addressed in subsequent sub-sections of this chapter. In general, the information presented in the Bike Lanes sub-section of this chapter refers to conventional bike lanes, most commonly found in engineering manuals and corresponding design criteria.

Bike lanes are appropriate on arterial boulevards, avenues, and collectors. Bike lanes may also be provided on rural roads where there is high bicycle use. Bike lanes are generally not recommended on local streets with relatively low traffic volumes and speeds, where a shared roadway is the appropriate facility. Although there is no exact criteria, NACTO guidance states that bike lanes are most helpful on streets with greater than 3,000 motor vehicle average daily traffic and streets with a posted speed limit of 25 MPH or higher. Bike lanes may be used on other streets where bicycle travel and demand is substantial, such as within parks. Where on-street parking is provided, bike lanes are generally striped on the left side of the parking lane.

The following geometric design criteria has been established for bike lanes:

- Preferred bike lane width, or rideable surface, is 6 feet. The absolute minimum width is 4 feet. The preferred dimensions should be used unless other street elements have been reduced to their minimum dimensions.
- Absolute minimum bike lane width, adjacent to on-street parking, is 5 feet unless there is a marked buffer distance between the bike lane and on-street parking. Where on-street parking is permitted, delineating the bike lane with two stripes, one on the street side and one on the parking side, is preferable to a single stripe.
- The desirable bike lane width adjacent to a guardrail or other physical barrier is 2 feet wider, in order to provide a minimum shy distance from the barrier.
- Gutter seams, drainage inlets, and utility covers should be flush with the existent pavement and oriented to prevent conflicts with bicycle tires.
- Streets, with high volumes of traffic and/or higher speeds, need wider bike lanes of 6 feet to 8 feet.
- Bike lanes on one-way streets should generally be on the right side of the travel way and should always be provided on both legs of a one-way couplet. The bike lane may be placed on the left of a one-way street, if it decreases the number of conflicts, e.g., those caused by heavy bus traffic or parking, and if bicyclists can safely and conveniently transition in and out of the bike lane. If sufficient width exists, the bike lanes can be striped on both sides of a one-way street.





Bike Lane Width Minimums

(Source: Broward County Final Report on Alternative Roadway Design Guidelines)

Buffered Bike Lanes

Buffered bike lanes are conventional bike lanes paired with a designated buffer space separating the bicycle lane from the adjacent motor vehicle travel lane and/or parking lane. A buffered bike lane is optional for all bike lane facilities per MUTCD guidance for buffered preferential lanes found in 2009 MUTCD Section 3D-01.

Nine in ten bicyclists preferred a buffered bike lane to a conventional bike lane, seven in ten bicyclists indicated they would go out of their way to ride on a buffered bike lane over a conventional bike lane, and bicyclists indicate they feel lower risk of being "doored" in the buffered bike lanes when adjacent to on-street parking.[1]

[1]*Evaluation of Innovative Bicycle Facilities: SW Broadway Cycle Track & SW Stark/Oak Street Buffered Bike Lanes* (Portland State University, Center for Transportation Studies, 2011),

Buffered bike lanes provide the following advantages when compared to conventional bike lanes:

Buffered bike lane
(Source: NACTO Urban Bikeway Design Guide)

- Greater shy distance between bicyclists and motor vehicles.
- Space for faster moving bicyclists to pass slower moving bicyclists without having to encroach into the motor vehicle travel lane.
- Greater space for bicycling without making the bike lane appear too wide that it might be mistaken for a travel lane or a parking lane.
- Appeal to a wider range of bicyclists and encourages bicycling.

There is no standard criterion for when buffered bike lanes are required; however, buffered bike lanes can be considered anywhere a standard bike lane is being considered. In general, buffered bike lanes should be considered on streets with high travel speeds, high volumes, high percentage of trucks or buses, and streets with extra space within the travel way.

The buffer should be marked with a wide, solid, angled, white line across both edges of the buffer space. The buffer should be at least 2 feet in width. Diagonal hatching should be used if the buffer is 3 feet in width or greater. Consider dashing the inside buffer boundary where cars are expected to cross, such as adjacent to on-street parking. The combined width of the buffer and bike lane should be considered the "bike lane width". Where buffers are used, bike lanes can be narrower because the shy distance function is assumed by the buffer. For example, a 4-foot bike lane and a 3-foot buffer could be provided adjacent to on-street parking since the bike-lane width would be considered 7 feet. For a parking side buffer, parking T's are acceptable to mark between a parking lane and the buffer.

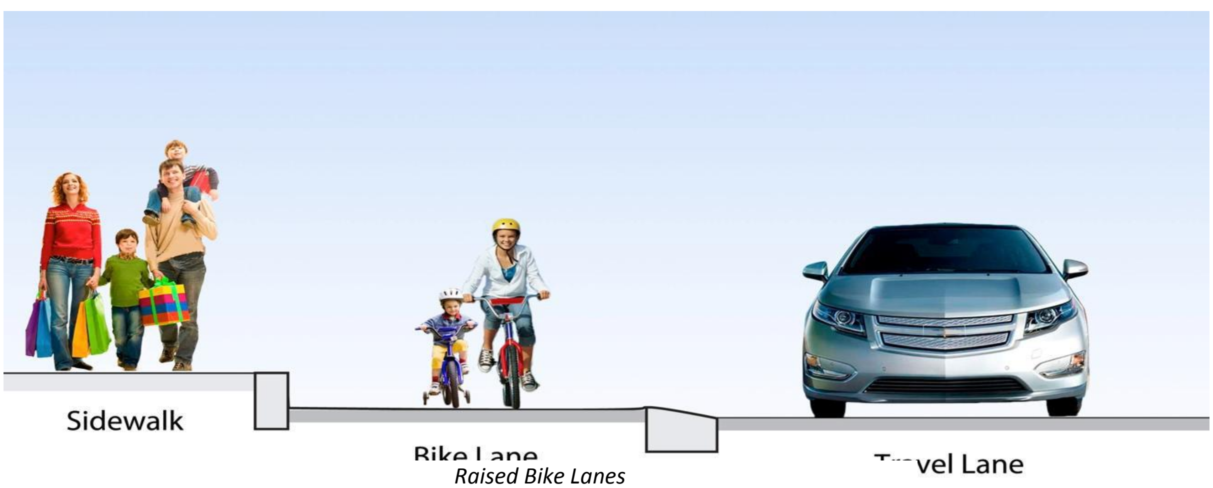
RAISED BIKE LANES

Bike lanes are typically an integral portion of the traveled way and are delineated from motor vehicle lanes with painted stripes. Although some bicyclists ride on these facilities comfortably, others prefer more separation. Raised bike lanes incorporate the convenience of riding on the street with some physical separation. This is accomplished by elevating the bicycle lane surface 2 to 4 inches above street level, while providing a traversable curb to separate the bikeway from the adjacent motor vehicle travel lane.

Advantages of Raised Bike Lanes

- Motorists know they are straying from the travel way when they feel the slight bump created by the traversable curb.
- The traversable curb allows motorists to make turns into and out of driveways.
- The traversable curb allows cyclists to enter or leave the bike lane (e.g., for turning left or overtaking another cyclist).
- The raised bike lane drains towards the centerline, leaving it clear of debris and puddles.
- Novice bicyclists are more likely to ride in the bike lane, leaving the sidewalk for pedestrians.

Raised bike lanes can be constructed at little additional expense for new roads. Retrofitting streets with raised bike lanes is more costly; it is best to integrate raised bike lanes into a larger project to remodel the street due to drainage reconstruction. Special maintenance procedures may be needed to keep raised bike lanes swept.



Raised Bike Lanes
(Credit: Michele Weisbart)

SHARED BUS AND BIKE LANES

Shared bus and bike lanes should be considered on roadways where bus rapid transit (BRT) improvements are desired, such as dedicated bus lanes, but not enough space exists to provide a bus lane and a bike lane.

Ideally, shared bus and bike lanes should be 13 feet to 15 feet wide to allow passing by both buses and bicyclists. On routes heavily traveled by both bicyclists and buses, separation can reduce conflicts; stopped buses hinder bicycle movement and slower moving bicycles hinder buses.

Separate bus lanes and bike lanes should be considered to reduce conflicts between passengers and bicyclists, with the bus lane at the curbside. Buses will be passing bicyclists on the right, but the fewer merging and turning movements reduce overall conflicts.

SHARED USE PATHS

Shared use paths are facilities separated from motor vehicle traffic by an open space or barrier. Shared use paths can be either within a roadway right-of-way or within an independent right-of- way. Examples of independent rights-of-way that can include waterways, utility corridors, and rail lines. Bicyclists, pedestrians, joggers, and skaters often use shared use paths. They are often elements of a community trail plan. Shared use paths may also be integrated into the street network with new subdivisions as described in Chapter 3, “Street Networks and Classifications.”

Example of a shared-use path
(Credit: City of Fort Myers)

Shared use paths provide the following advantages:

a. They are attractive to bicyclists who are uncomfortable riding in mixed traffic.
b. They are often part of designated bike route systems.

c. In independent rights-of-way, they can provide travel time savings for bicyclists by making connections that would otherwise be significantly longer through the roadway network.

The following geometric design criteria are established for shared use paths:

- Preferred shared use path width is 12 feet. The absolute minimum path width is 8 feet, which should be used unless right-of-way constraints dictate.
- A graded shoulder of 2 feet should be provided on each side of the shared use path.
- Wider pavement may be needed in high-use areas. Where significant numbers of pedestrians, bicyclists, skaters, and other users share the path, either wider pavement or separate walkways should be used to help to eliminate conflicts. A minimum width of 14 feet is typically recommended for separating users, two 4-foot lanes, one in each direction, for wheeled users, and a 6-foot space for pedestrians.

- Shared use paths are not substitutes for on-road bicycle facilities. Many advanced bicyclists choose on-road bicycle facilities even when shared-use paths are provided within the same right-of-way.
- The intersections of shared-use paths with roads are of critical importance to the overall environment and safety experienced by users. Intersections should be designed with crossing safety treatments that assist path users to cross the road. Consistent with FDOT's PPM Chapter 8.3.2, curb

Examples of signage associated with shared-use paths
(Credit: City of Fort Myers)

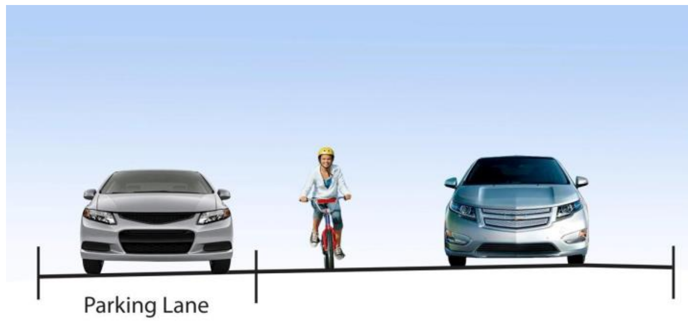
ramps on shared-use paths should be the same width as the path itself to minimize conflicts between bicyclists and pedestrians. The trail crossing warning sign, MUTCD W11-15, should be used to warn motorists of the shared use path crossing location.

Shared Roadways (Shared Space)

A shared roadway, or shared space, is a street in which bicyclists comfortably ride in the same travel lanes as other traffic because of the low-volume, low-speed characteristic of the roadway. Shared roadways as a bikeway type should not be confused with other shared situations, such as bicycle boulevards, shared lane markings, called sharrows, or wide curb lanes, which are discussed later in this section.

A good example of shared roadways are most local residential neighborhood streets where motor vehicle traffic volume and traffic speeds are low enough that even novice bicyclists feel comfortable riding in the street.

Shared roadways are the most common bikeway type. There are no specific width standards for shared roadways. Most are fairly narrow; they are simply the streets as constructed. Under certain conditions, a narrow width may increase the viability of a shared roadway as a bikeway because it means that a motorist is forced to remain behind a bicyclist without attempting an overtaking maneuver if there is oncoming traffic. The suitability of a narrow lane or a wide lane for shared roadways is the subject of many factors, such as the intensity of bicycle traffic and the presence of on-street parking.



The suitability of a shared roadway decreases as motor vehicle traffic speeds and volumes increase. Many local streets carry excessive traffic volumes at speeds higher than they were designed to carry. These can function better as shared roadways if traffic speeds and volumes are reduced. For a local street to function acceptably for bicyclists as a shared roadway, traffic volumes should not be more than 3,000 to 5,000 vehicles per day, and speeds should be 25 mph or less. If traffic speeds and volumes exceed these thresholds, separated facilities, e.g., bike lanes, should be considered or traffic calming should be applied to reduce the vehicle speeds/volumes. Many traffic calming techniques can make these streets more amenable to bicycling while also solving other community goals related to livability.

Centerline Removal

On low-volume, low-speed streets with one travel lane in each direction, removal of the solid, double yellow centerline, providing there are no corresponding safety or sight distance issues, is one strategy to facilitate passing of bicyclists by motor vehicles. Motorists may be unwilling to cross over a centerline to pass a bicyclist, resulting in instances where motorists feel like they are stuck behind a slower moving bicyclist and attempt to pass the bicyclist too closely. Bicyclists in these situations may feel pressured to ride to the extreme far right or in the gutter to allow motorists to pass. Removal of the centerline, where safe conditions permit, opens the entire travel way for passing, and allows bicyclists to position themselves at a safe and comfortable distance from the curb or roadside obstacles. Lack of centerlines is also a traffic calming technique, as drivers tend to drive slower without the visible separation from oncoming traffic. The MUTCD mandates centerline stripes on urban streets with ADT of 6,000 or more; most neighborhood streets suitable for shared roadway bicycle facilities are well below that threshold.

Bicycle Boulevards

A bicycle boulevard is an enhanced shared roadway; it is a local street that has been modified to prioritize through bicycle traffic, but discourage through motor vehicle traffic. Bicycle boulevards can be thought of as bicycle arterials.

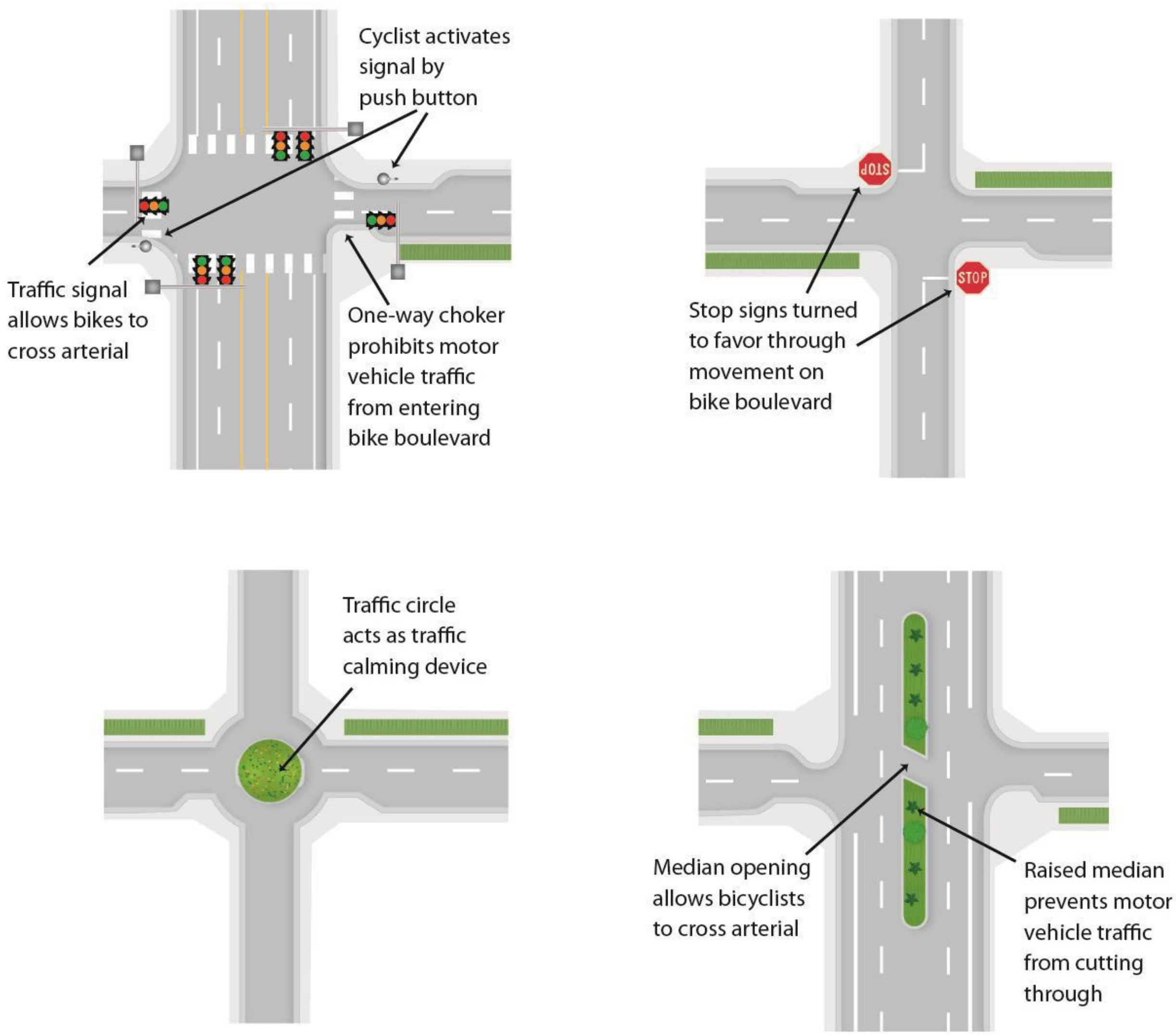
To create a bicycle boulevard, a local street is modified to function as a prioritized through street for bicyclists while maintaining local access for automobiles. This is done first by adding traffic calming devices to reduce motor vehicle speeds and through trips, and secondly, by installing traffic controls that limit conflicts between motorists and bicyclists and give priority to through bicyclist movement.

One key advantage of bicycle boulevards is that they attract bicyclists who do not feel comfortable on busy streets and prefer to ride on lower traffic streets. Bicycle travel on local streets is generally compatible with local land uses (e.g., residential and some retail). Residents who want slower traffic on neighborhood streets often like measures that support bicycle boulevards. By reducing traffic and improving crossings, bicycle boulevards also improve conditions for pedestrians. Successful bicycle boulevard implementation requires careful planning with residents and businesses to ensure acceptance.

Elements of a Bicycle Boulevard

A successful bike boulevard includes the following design elements:

- Direct and continuous streets, rather than circuitous routes that wind through neighborhoods. Bike boulevards work best on street grids. Should traffic diversions result due to the bike boulevard bicycle traffic, selecting streets that have parallel, higher-level streets, can prevent unpopular traffic diversions to other residential streets.
- Motor vehicle traffic diverters located at key intersections to reduce through motor vehicle traffic. Diverters are designed to allow through bicyclist movements.
- Stop signs that face intersecting streets, so bicyclists can ride with few interruptions.
- Mini-roundabouts that replace Stop-controlled intersections to reduce the number of stops that cyclists have to make.
- Traffic-calming devices to lower motor vehicle traffic speeds.
- Wayfinding and other signs or markings that route cyclists to key destinations, guide cyclists through difficult situations, and alert motorists of the presence of bicyclists.



Components of bicycle boulevards (Credit: Michele Weisbart)

Where the bicycle boulevard crosses high-speed or high-volume streets, crossing improvements such as the following should be provided:

- Signals, where a traffic study has shown that a signal will be safe and effective. To ensure that bicyclists can activate the signal, loop detection should be installed in the pavement where bicyclists ride.
- Roundabouts where appropriate.
- Median refuges, a minimum of 8 feet long, with an opening that is approximately 6 feet wide, which is enough to allow bicyclists to pass through in both directions. The design should allow bicyclists to see the travel lanes they must cross.

Shared Lane Markings (Sharrows)

Shared Lane Markings, commonly called "Sharrows," may be used as an additional pavement marking treatment for shared roadways. Sharrows serve a number of purposes, including the following:

- Remind bicyclists to ride farther from parked cars to prevent "dooring" collisions.
- Make motorists aware of the expectation that bicycles are sharing the travel lane.
- Provide lateral spacing guidance for bicyclists.
- Identify the correct direction of travel for motorists and bicyclists.

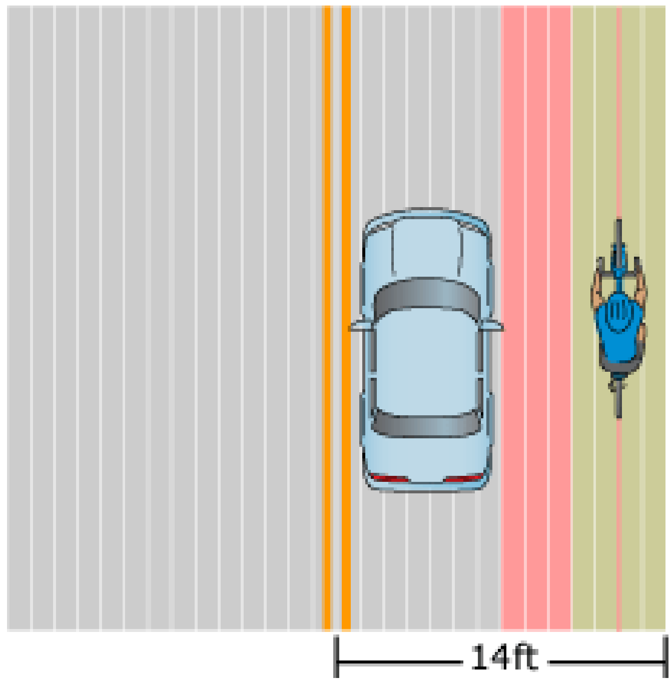
The 2009 MUTCD outlines guidance for Sharrows under Section 9C.07. In addition, FDOT Standard Index 17347 provides guidance for the geometric design criteria and spacing of Sharrows. Because Shared Lane Markings are relatively new, guidance on the application of their usage is still evolving. However, Shared Lane Markings should not be considered a substitute for bike lanes, cycle tracks, or other designated bicycle facilities where these types of facilities are otherwise warranted or space permits. Shared Lane Markings can be used as standard element in the development of bicycle boulevards and may be accompanied by a "**Bicycles May Use Full Lane**" sign (MUTCD R4-11).

Placing the Sharrow marking designation between the vehicle tire tracks of the lane, increases the life of the markings, thereby decreasing long-term maintenance costs.

WIDE OUTSIDE LANES

Wide outside lanes may be provided on streets where bike lanes would be more appropriate; however, insufficient width exists for bike lanes. This situation may occur on resurfacing projects where there are physical constraints and all other options, such as narrowing travel lanes, have been exhausted. Wide outside lanes are not particularly attractive to most bicyclists; if bicyclists are riding far enough to the right, they simply allow a motorized vehicle to pass bicyclists within a travel lane without encroaching into an adjacent lane.

Wide curb lanes may also encourage higher motor vehicle speed, which is contrary to the design principles of this manual. Wide lanes should never be used on local residential streets. A 14-foot minimum wide lane allows a passenger car to pass a bicyclist in the same lane. Widths of 16 feet or greater encourage the undesirable operation of two motor vehicles in one lane. In this situation, a designated bike lane should be striped.



Wide Outside Lane
(Credit: Florida Bicycle Association)

UNDESIGNATED LANE (URBAN SHOULDER)

On streets where bike lanes would be more appropriate, but with insufficient width for bike lanes, an undesignated lane (urban shoulder) may be provided as an alternative to the wide outside lane.

Undesignated Lane
(Credit: City of Fort Myers)

If provided, a minimum 3-foot wide smooth surface should be provided between the lip of the gutter pan and edge line stripe. This minimum width enables bicyclists to ride far enough from the curb to avoid debris and drainage grates and far enough from other vehicles to avoid conflicts. By riding away from the curb, bicyclists are more visible to motorists than when hugging the curb.

Undesignated lanes have similar characteristics as wide curb lanes, but with the added benefit of an edge line striping between motor vehicles and bicyclists. However, it is likely that only the "strong and fearless" bicyclists feel comfortable in this undesignated space.

PAVED SHOULDERS

Paved shoulders may accommodate bicycle travel on rural highways and country roads by providing a suitable area for bicycling and reducing conflicts with faster moving motor vehicles. Paved shoulders have similar characteristics as bike lanes, but are not designated through pavement marking symbols and signage. However, paved shoulders are only a rural area bicycle facility. Paved shoulders in urban areas must be signed and marked as bike lanes.

The FDOT Roadway Design bulletin, ***"Bicyclist Facilities and How to Ride Them,"*** states that *paved shoulders, or other areas striped outside the travel lane, are not "marked for bicycle use" unless there is a bike lane marking. Without this marking, you are not required to treat the area as a legal bike lane.*

Occasionally, cyclists do get cited by police for failure to observe this law, perhaps even when the cyclist is exercising one of the listed exceptions. If this happens to you - don't argue with the police! You won't win! If you feel you were wrongly cited, please get all the pertinent information and *forward it to your local Bicycle/Pedestrian Coordinator, or the [Florida Bicycle Association www.floridabicycle.org].*

Paved shoulders are provided on rural highways for a variety of safety, operational, and maintenance reasons. When providing paved shoulders, bicycle use should be assumed.

- A preferred width of 6 feet is recommended. This allows a bicyclist to ride far enough from the edge of pavement to avoid debris and far enough from passing vehicles to avoid conflicts.
- On rural roads with prevailing speeds of over 45 mph, 8 feet is preferred.
- An absolute minimum width of 4 feet for a paved shoulder bicycle facility may be used under constraints.
- When rumble strips are provided on the paved shoulder, care should be exercised to ensure at least a minimum rideable surface of 4 feet is provided to the outside of the rumble strip. When designed properly, rumble strips can be a benefit to bicyclists using a paved shoulder by notifying motorists when they begin to encroach upon the shoulder. Since rumble strips are approximately 1.5 feet wide, and are typically offset from the edge line striping by approximately 0.5 feet, a paved shoulder with a rumble strip must be a minimum of 6 feet in total width to accommodate bicyclists within the outer 4 feet.

BIKE ROUTE WAYFINDING

A bicycle route wayfinding system consists of comprehensive signing and/or pavement markings to guide bicyclists to their destinations along preferred bike routes. A bike route is a term used for planning purposes or to designate recommended bicycle transportation or recreation routes. A bike route is not a facility type. A bike route can be any bikeway type.

- Wayfinding signs are typically placed at decision points along bike routes.
- There are three general types of wayfinding signs:
    - Confirmation Signs - These indicate to bicyclists that they are on a designated bikeway. Confirmation signs can include destinations, distance, and time but do not include

Bicycle route destination signage
(Credit: City of Fort Myers)

arrows. Confirmation signs have an added benefit of making motorists aware of the bicycle route.

- Turn Signs –These signs indicate where a bikeway turns from one street to another street. Turn signs include arrows, and may include destinations and distance/time. Turn signs should be placed on the near-side of intersections and may be supplemented with pavement markings.
- Decision Signs – A decision sign marks the junction of two or more bike routes. Decision signs inform bicyclists of the designated bike route to access key destinations. Decision signs include destinations and arrows. Distances and travel times are recommended, but are optional.

INTEGRATING WITH THE STREET SYSTEM

Bicycle route signage at a path end (Credit: City of Fort Myers)

Most bikeways are part of the street; therefore, well-connected street systems are very conducive to bicycling, especially those with a fine-meshed network of low-volume, low-speed streets suitable for shared roadways. In less well-connected street systems, where wide streets carry the bulk of traffic, bicyclists need supplementary facilities, such as short sections of paths and bridges, to connect otherwise unconnected streets.

There are no hard and fast rules for when a specific type of bikeway should be used, but some general principles guide selection. As a general rule, as traffic volumes and speeds increase, greater separation from motor vehicle traffic is desirable. Other factors to consider are user type (more children or recreational cyclists may warrant greater separation), adjacent land uses (multiple driveways may cause conflicts with shared-use paths), available right-of-way (separated facilities require greater width), and costs.

As a general rule, designated bicycle facilities, e.g., bike lanes, should be provided on all major streets, avenues and boulevards, as these roads generally offer the greatest level of directness and connectivity in the network, and are typically aligned where destinations are located. There are occasions when it is not feasible to provide bikeways, such as a busy street, or perhaps where the street does not best serve the mobility and access needs of bicyclists.

The following design parameters should be considered when determining whether or not to provide alternate facilities on a parallel local street:

- Conditions exist such that it is not economically or environmentally feasible to provide adequate bicycle facilities on the street in question.
- The street in question does not provide adequate access to destination points within reasonable walking distances, or separated bikeways on the street would not be considered safe.
- The parallel route provides better continuity and more convenient access to destinations than is served by the street in question.
- Costs to improve the parallel route are no greater than the costs to improve the street in question.

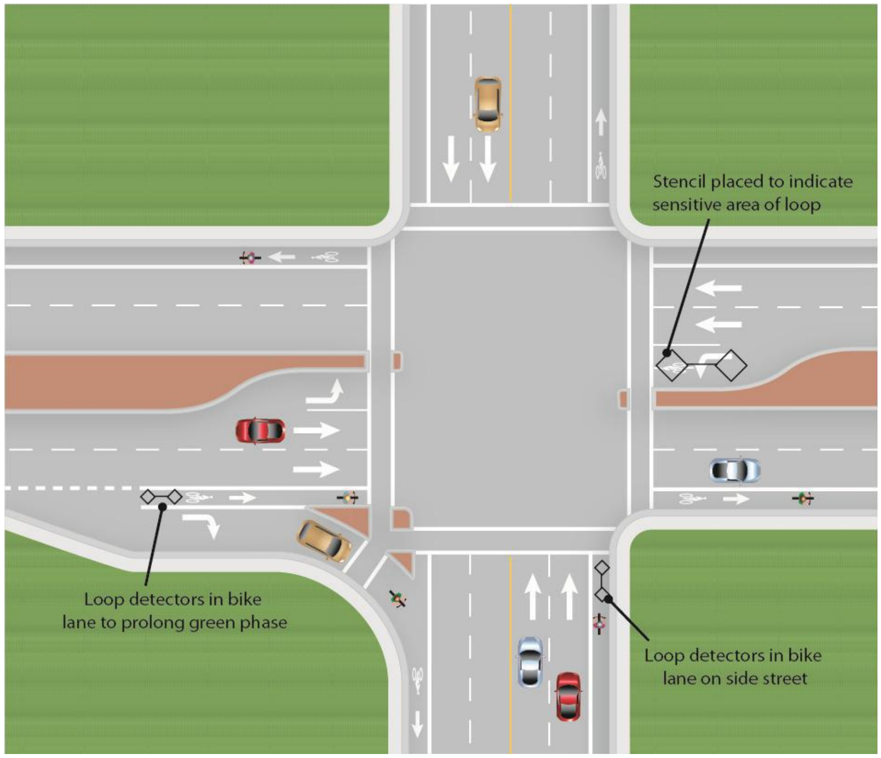
Should any of the above factors be satisfied, bicyclists may actually prefer the parallel local street facility, since it likely offers a higher level of comfort, which is the essence of what bicycle boulevards are intended to severe.

Off-street paths can also be used to provide transportation in corridors otherwise not served by the street system, such as:

- Along utility corridors and canals;
- Through parks;
- On abandoned railroad tracks; and,
- Along active railroad rights-of-way.

While off-street paths offer the safety and scenic advantages of separation from traffic, they must also offer frequent connections to the street system and to destinations such as residential areas, employment sites, shopping, and schools. Street crossings must be well designed and include safety measures such as signals or median refuge islands.

INTERSECTIONS

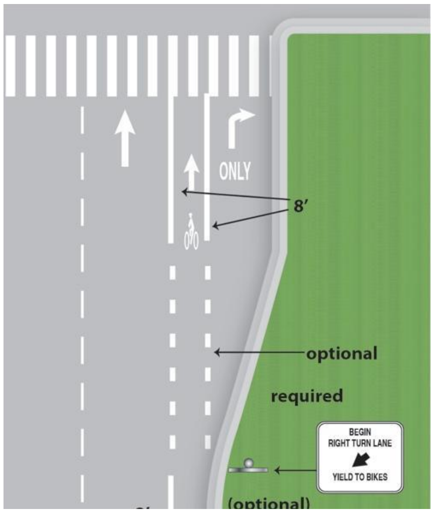


As previously stated, intersections are junctions that accommodate the crossings of various modes of transportation and where the facilities overlap.

A well-designed intersection facilitates the interchange between bicyclists, pedestrians, motorists, and transit, such that traffic flows in a safe and efficient manner. Designs for intersections with bicycle facilities should reduce conflicts between bicyclists and other vulnerable road users and/or vehicles by heightening visibility, denoting a clear right-of-way, and ensuring that the various users are aware of each other. Intersection treatments can resolve both queuing and merging maneuvers for bicyclists, and are often coordinated with timed or specialized signals.

Chapter 5, “Intersection Design,” provides general principles of geometric design; all these recommendations will benefit cyclists. The configuration of a safe intersection for bicyclists may include additional elements such as color, signs, medians, signal detection, and pavement markings. Intersection design should take into consideration existing and anticipated bicyclist, pedestrian, and motorist movements. In all cases, the degree of mixing or separation between bicyclists and other modes is intended to reduce the risk of crashes and increase bicyclist comfort. The level of treatment required for bicyclists at an intersection will depend on the types of bicycle facilities that are used, whether the bicycle facilities are intersecting, the adjacent street functions, and the adjacent land uses.

Bikeway Markings at Intersections



Continuing marked bicycle facilities up to the crosswalk location of intersections ensures that separation, guidance on proper positioning, and awareness by motorists are maintained through the potential conflict areas. The appropriate treatment for right-turn-only lanes is to place a bike lane pocket (a.k.a. "keyhole lane"), between the right turn lane and the rightmost through lane. The MUTCD R4-4 sign may also be posted to inform motorists that they must yield to bicyclists crossing the taper of the right-turn only lane.

Bike lane markings at intersections with right-turn lanes
(Credit: City of Fort Myers)

If a full bike lane pocket cannot be accommodated, a combined bicycle lane/right-turn lane can be installed that places a standard width bike lane on the left side of a dedicated right-turn lane. A dashed strip delineates the space for bicyclists and motorists within the shared lane (this is another form of an "advisory bike lane" discussed earlier in the chapter under Centerline Removal). This treatment must include pavement markings and signs advising motorists and bicyclists of proper positioning within the lane. Regulatory signage should be provided stating that bicyclists are allowed to make a through movement from the right-turn lane.

Sharrows present another option for marking a bikeway through an intersection where a bike lane pocket cannot be accommodated.

Bicycle Signal Detection

Bicycle detection is used at actuated traffic signals to alert the signal controller of bicycle crossing demand on a particular approach. Bicycle detection occurs either through the use of pushbuttons or by automated means, e.g., in-pavement loops, video, and microwave. Inductive loop vehicle detection at many signalized intersections is calibrated to the size or metallic mass of a vehicle, which means that bicycles may often go undetected. The result is that bicyclists must either wait for a vehicle to arrive, dismount and push the pedestrian button, if available, or cross illegally. However, loop sensitivity can be increased to detect bicycles.

Proper bicycle detection must accurately detect bicyclists; be sensitive to the mass and volume of a bicycle and its rider, and provide clear guidance to bicyclists on how to actuate detection, e.g., what button to push or where to stand.

Near-side bicycle signals may incorporate a "countdown to green" display to provide information about how long until the green bicycle indication is shown, enabling riders to push off as soon as the light turns green.

Leading Bicycle Intervals

Based on the Leading Pedestrian Interval, a Leading Bicycle Interval (LBI) can be implemented in conjunction with a bicycle signal head. Under an LBI, bicyclists are given a green signal while the vehicular traffic is held at all red for several seconds, providing a head start for bicyclists to advance through the intersection. This treatment is particularly effective in locations where bicyclists are required to make a challenging merge or lane change, e.g., to access a left turn pocket, shortly after the intersection. The LBI would give them sufficient time to make the merge before being overtaken by vehicular traffic. This treatment can be used to enhance a bike box.

Colored Bike Lanes

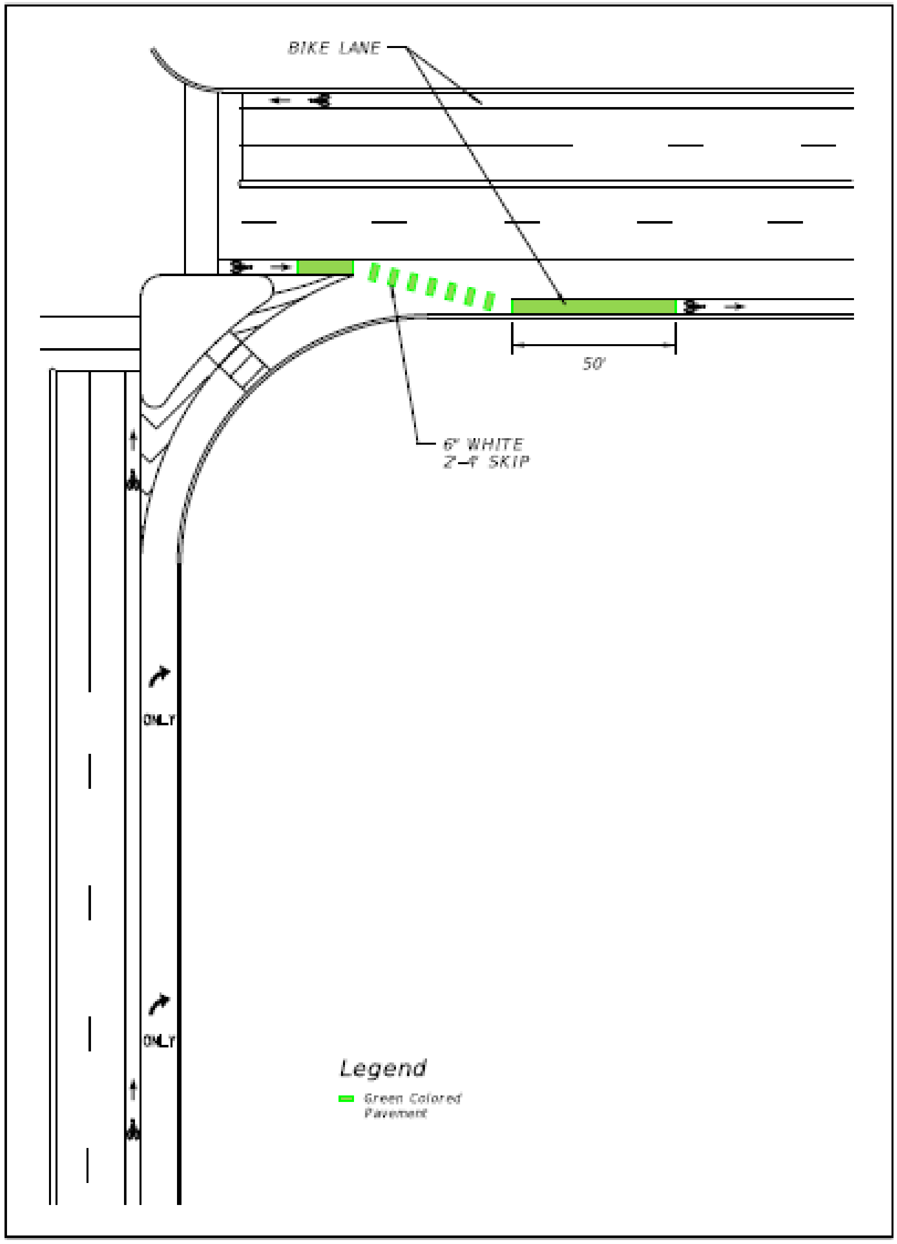
The Federal Highway Administration (FHWA) has issued an Interim Approval for the optional use of green colored pavement in designated bike lanes and in extensions of designated bike lanes through intersections and other traffic conflict areas. FDOT has requested and received approval from FHWA for the use of green colored pavement in locations consistent with the FHWA's Interim Approval memorandum. According to FDOT, the effectiveness of green colored pavement for bike lanes is maximized if the treatment is used only where the path of bicyclists crosses the path of other road users, and where road users should yield to bicyclists.

A traffic conflict area may include locations where the bike lane crosses an exclusive right-turn lane, a channelized free-flow right-turn lane, an add lane situation, a drop lane situation, or adjacent to a dedicated bus bay.

FDOT provides more information about the optional use of green colored pavement for bike lanes in the Plans Preparation Manual, Chapter 8.4.2.2.

It should be noted that use of colored pavement within a bicycle lane increases the visibility of the facility and reinforces priority to bicyclists in conflict areas.

While a variety of colored treatments have been used, the FHWA approval is for green as the preferred color for bicycle facilities of this type in areas where conflicts or shared use is intended. Maintenance of color and surface condition are considerations. Traditional traffic paints and coatings can become slippery. Long life surfaces with good wet skid resistance should be considered.



Bicycle Parking

Secure bicycle parking at likely destinations is an integral part of a bikeway network. Bicycle thefts are common and lack of secure parking is often cited as a reason people hesitate to ride a bicycle. The same consideration should be given to bicyclists as to motorists, who expect convenient and secure parking at all destinations. Bicycle parking should be located in well-lit, secure locations close to the main entrance of a building, no further from the entrance than the closest automobile parking space. Bike parking should not interfere with pedestrian movement.

Bicycle racks can double as public art
(Credit: City of Fort Myers)

Bike racks along sidewalks should satisfactorily support the bicycle, typically, two points of contact with the frame, and make it easy to secure a U-shaped lock to the frame of the bike and the rack. The example shows an art design rack that meets these criteria. Refer to the Association of Pedestrian and Bicycle Professionals (APBP) *Bike Parking Guidelines* for additional information.

Maintenance

Maintenance is a critical part of safe and comfortable bicycle access. Two areas that are of particular importance to bicyclists are pavement quality and drainage grates. Rough surfaces, potholes, and imperfections, such as joints, can cause a rider to lose control and fall. Care must be taken to ensure that drainage grates are bicycle-safe; otherwise a bicycle wheel may fall into the slots of the grate, causing the cyclist to fall. The grate and inlet box must be flush with the adjacent surface. Inlets should be raised after a pavement overlay to the new surface. If this is not possible or impractical, the new pavement should taper into drainage inlets so that the inlet edge is not abrupt.

The most effective way to avoid drainage-grate problems is to eliminate them entirely with the use of inlets in the curb face. This may require more grates to handle bypass flow, but is the most bicycle-friendly design.

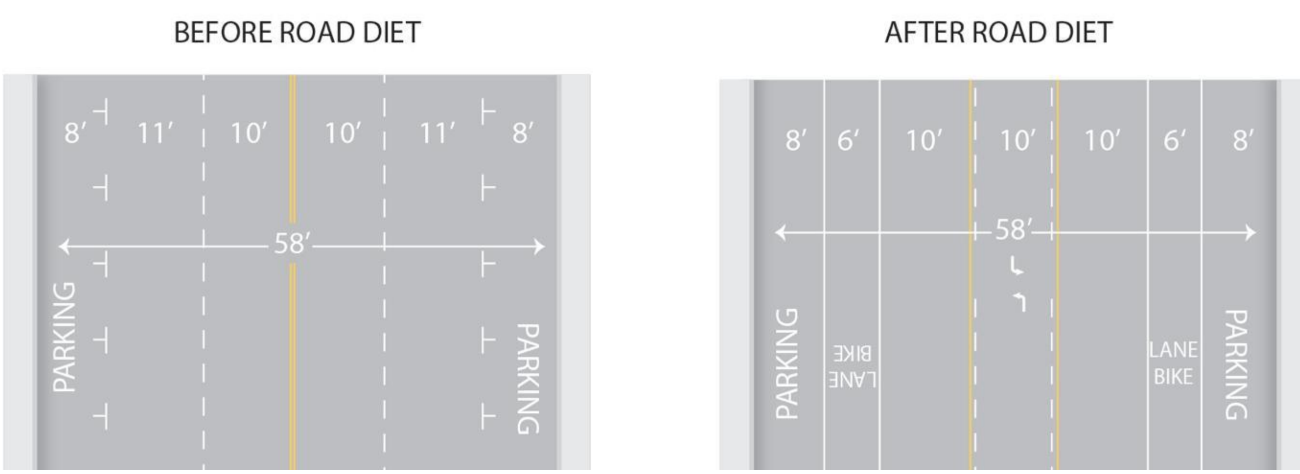
Resurfacing

The cost of striping bicycle lanes is negligible when incorporated with resurfacing projects, as this approach avoids the high cost of stripe removal; the fresh pavement provides a blank slate. Jurisdictions will need to anticipate opportunities and synchronize restriping plans with repaving and reconstruction plans. If new pavement is not anticipated in the near future, grinding out the old lane lines can still provide the opportunity to install bike lanes.

There are three basic techniques used to achieve the necessary space to accommodate bike lanes:

- **Lane narrowing**. Where all existing or planned travel lanes must be retained, travel lanes can be narrowed to provide space for bike lanes. Recent studies have indicated that the use of 10-foot travel lanes does not result in decreased safety in comparison with wider lanes for vehicle speeds up to 35 mph. Eleven-foot lanes can be used satisfactorily at higher speeds especially where trucks and buses frequently run on these streets. Where a choice between a 6-foot bike lane and an 11-foot travel lane must be made, it is usually preferable to have the 6-foot bike lane. Parking lanes can also be narrowed to 7 feet to create space for bike lanes. More information on lane narrowing is provided in Chapter 14.

- **Road Diets**. Reducing the number of travel lanes provides space for bicycle lanes. Many streets have more space for vehicular traffic than necessary. Some streets may require a traffic and/or environmental analysis to determine whether additional needs or impacts may be anticipated. The traditional Road Diet changes a four-lane undivided street to two



Fitting in bicycle lanes with road diets (Credit: Michele Weisbart) travel lanes, a continuous left-turn lane (or median), and bike lanes. In other cases, a four-lane street can be reduced to a two-lane street without a center-turn lane if there are few left turns movements. One-way couplets are good lane-reduction candidates if they have more travel lanes in one direction than necessary for the traffic volumes. For example, a four-lane one-way street can be reduced to three lanes and a bike lane. Since only one bike lane is needed on a one-way street, removing a travel lane can free enough room for other features, such as on-street parking or wider sidewalks. Both legs of a couplet must be treated equally, so there is a bike lane in each direction. More information on Road Diets is provided in Chapter 14.

- **On-Street Parking Removal.** On-street parking is vital on certain streets such as residential or traditional central business districts with little or no off-street parking, but other streets have allowable parking without a significant visible demand. In these cases, parking prohibition can be used to provide bike lanes with minimal public inconvenience. On-street parking removal should always be preceded by a district-wide parking study to ensure adequate shared parking is provided for local businesses and residences.

Utility Work

Utility work often requires reconstructing the street surface to complete restoration work. This provides opportunities to implement bike lanes and more complex bikeways such as bike boulevards, cycle tracks, or paths. It is necessary to provide plans for proper implementation and design of bikeway facilities prior to the utility work. It is equally necessary to ensure that existing bikeways are replaced where they exist prior to utility construction.

Redevelopment

When streets are slated for reconstruction in conjunction with redevelopment, opportunities exist to integrate bicycle lanes or other facilities into the redevelopment plans.

Paved Shoulders

Adding paved shoulders to existing roads can be quite expensive if done as stand-alone capital improvement projects, especially if adjacent drainage ditches have to be moved, or if open drains are changed to enclosed drains. However, paved shoulders can be added at little extra cost if they are incorporated into projects that already disturb the area beyond the pavement, such as installing utility lines or drainage work.

ADDITIONAL RESOURCES

Federal Highway Administration (FHWA), *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD), 2009 Edition.

National Association of City Transportation Officials*, Urban Bikeway Design Guide*, 2011

Florida Department of Transportation (FDOT) *2012 Plans Preparation Manual*, Chapter 8

Florida Department of Transportation (FDOT) *Standard Index 17347*

Florida Department of Transportation (FDOT) *Manual of Uniform Minimum Standards for Design, Construction, and Maintenance for Streets and Highways* (The Florida Greenbook)

AASHTO *Guide for the Development of Bicycle Facilities*

Association of Pedestrian and Bicycle Professionals (APBP) *Bike Parking Guidelines*

9. TRANSIT ACCOMMODATIONS

INTRODUCTION

Public transit serves a vital transportation function for many people. It is their access to jobs, school, shopping, restaurants, recreation, visitation, worship, and other daily functions. Except for subways and rail lines on exclusive rights-of-way, most transit uses streets. For transit to provide optimal service, streets must accommodate transit vehicles while providing access to stops. Transit connects passengers to destinations and is an integral component of shaping future growth into a more sustainable form. Transit design should also support a place and opportunity for all users.

On-board a Broward County Transit (BCT) bus (Credit: Broward County Transit)

This chapter provides design guidance for both transit stops and operating of transit in the streets This includes bus stop layout and placement, and the use of bus bulbs and transit lanes. The chapter ends with a discussion of ways to accommodate light rail, trolley, and Bus Rapid Transit (BRT).

FDOT Transit Facilities Guidelines

The Florida Department of Transportation (FDOT) developed the publication, *Accessing Facilities Design Handbook for Florida Bus Passenger Facilities, Version III, 2013* to provide a basis for development of transit facilities for engineers to interact with local agencies or private entities developing transit facilities. According to the publication, it is the intention of FDOT to facilitate the design process for transit facilities through the development of the handbook. Project teams are encouraged to work with the FDOT staff, Lee County DOT, Lee County Transit (LeeTran), the Metropolitan Planning Organization (MPO), The Fort Myers Community Redevelopment Agency, and local government transportation planners during the planning and design process for projects that affect transit facilities to ensure early consideration of transit needs and identification and resolution of design conflicts and decisions.

ESSENTIAL PRINCIPLES OF DESIGNING STREETS FOR TRANSIT

Public transit should be planned and designed as part of the street system. It should interface seamlessly with other modes, recognizing that successful transit depends on customers getting to the service via walking, bicycling, car, taxi, or paratransit.

To the extent feasible, transit should be planned based on the following principles:

- Transit vehicles should have higher priority than private vehicles on certain streets.
- The busiest transit lines should have designated bus lanes.
- Where ridership justifies, some streets, called transit hubs, may permit only buses or trains in the travel way. However, these locations may also allow bicycles.
- Technology should be applied to increase average speeds of transit vehicles, where appropriate.
- Transit stops should be easily accessible, with safe and convenient crossing opportunities.
- Transit stops should be active and attractive public spaces to people every day of the week.
- Transit stops function as community destinations. The largest stops and stations should be designed to facilitate programming for a range of community activities and events.
- Transit stops should include amenities for passengers waiting to board such as real time traveler information systems, natural or artificial canopies, wayfinding signs, route maps, system maps, benches, and trash receptacles.
- Transit stops should provide space for a variety of amenities in commercial areas, to serve residents, shoppers, and commuters alike.
- Transit stops should be eye-catching and visible from a distance.
- Transit stop placement and design influences accessibility to transit and network operations, and influences travel behavior/mode choice.
- Zoning codes, local land use ordinances, and design guidelines around transit stations should encourage walking and a mix of land uses. See Chapter 13, "Designing Land Use along Complete Streets".
- Streets that connect neighborhoods to transit facilities should be especially attractive, comfortable, safe, and inviting for pedestrians and bicyclists.

Old Town Transit Center in San Diego
(Credit: Kimley-Horn and Associates, Inc.)

ACCESS TO TRANSIT

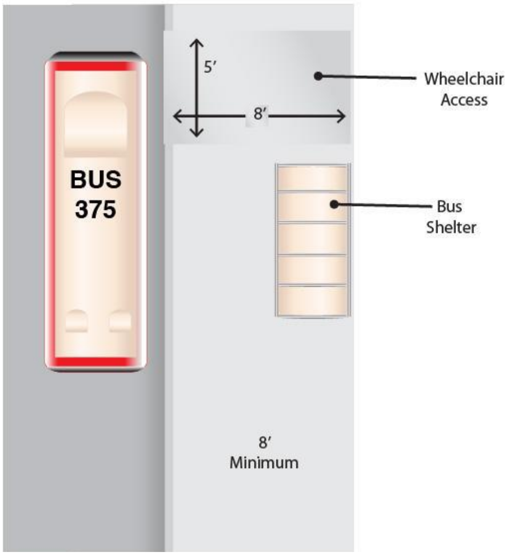
Transit depends primarily on most transit users walking to and from transit stops. Sidewalks on streets served by transit and on the streets that lead to transit corridors provide basic access. Bicycle-friendly streets do the same for those who access transit by bicycle.

Every transit trip also requires a safe and convenient street crossing at the transit stop; a disproportionally high number of pedestrian crossing crashes occur at transit stops, some due to blind spots for motorists. Every transit stop should be evaluated for its transit connection and crossing opportunities with respect to comfort and safety for all users.

Bus approaching well-situated bus stop near enhanced crosswalk (Credit: National Complete Streets Coalition)

If the crossing is deemed unsafe, mitigation can occur in two ways: a crossing could be provided at the existing stop, or the stop can be moved to a safer crossing location.

However, simply moving a stop is not always a service to transit users who may have to walk further to access their stop. Convenient access by passengers must remain at the forefront of all transit stop planning. Eliminating stops because they are perceived as unsafe will not be satisfactory to riders who cannot walk very far. Yet, eliminating or consolidating stops can be beneficial to transit operations and users by reducing the number of times a bus, streetcar, or light rail train has to stop. The trade offs are added walking time for users, but reduced transit operator delay, resulting in a shorter trip overall. For example, this might mean a two to three-minute longer walk for some passengers, however, an eight to 10 minute shorter bus ride for all.



ADA compliant bus stop (Credit: Michele Weisbart)

BUS STOPS

The following sections provide guidance for designing bus stops.

LAYOUT

A well-placed and configured transit stop offers the following characteristics:

- Clearly defines the stop as a special place;

- Provides a visual cue on where to wait for a transit vehicle;
- Does not block the path of travel on the adjacent sidewalk; and,
- Allows for ease of access between the sidewalk, the transit stop, and the transit vehicle.

Layout guidelines include the following:

- Consolidate streetscape elements to create a clear waiting space and minimize obstructions between the sidewalk, waiting area, and boarding area.
- Consider the use of special paving treatments or curb extensions (where there is on-street parking) to distinguish transit stops from the adjacent sidewalks.
- Integrate transit stops with adjacent activity centers whenever possible to create active and safe places.
- Avoid locating bus stops adjacent to driveways, curb cuts, and land uses that generate a large number of automobile trips, such as gas stations, or drive-thru restaurants.

Bus Stop Shelter
(Credit: Sky Yim)

Transit stops are required, by the Americans with Disabilities Act (ADA), to be accessible. Specifically, the ADA requires a clear loading zone having a minimum area of 5 feet by 8 feet and a maximum 2 percent cross-slope perpendicular to the curb, which will allow a transit vehicle to extend its lift, thereby enabling citizens with disabilities to board. The loading zone should be located where the transit vehicle has its lift, and it must be accessible directly from a transit shelter. The stop must also provide 30 by 40 inches of clear space within a shelter to accommodate wheelchairs. The greater use of low-floor transit vehicles may make this requirement moot; however, it will still be necessary to provide enough room so wheelchair users can access all doors.

TRANSIT-SPECIFIC STREETSCAPE ELEMENTS

The essential streetscape elements for transit include signs, shelters, and benches.

Benches. Benches should be provided at transit stops with headways longer than five minutes.
Shelters. A shelter keeps waiting passengers out of the rain and sun and provides increased comfort and security. Shelters typically vary in size and design. They include covered seating and sign panels that can be used for transit information. Shelters should:

- Be provided at transit stops with headways longer than 10 minutes.
- Have electrical connections to power lighting and/or real-time transit information, or accommodate solar power.
- Be set back from the front of the bus stop to allow for the bus to merge into travel lanes when the stop is located at the far side of an intersection or at a mid-block location. This setback is not required when the stop is located at the near side of the intersection or at a bus bulb.
- Be located in a sidewalk's furniture zone so they don't conflict with the pedestrian zone. Shelters may be placed in the sidewalk's frontage zone provided that they do not block building entrances or the pedestrian zone.

Transit shelter with bench and bicycle parking adjacent to park-and-ride lot, Pembroke Pines
(Credit: Kimley-Horn and Associates, Inc.)

Transit shelter with solar power
(Credit: Maribel Feliciano)

Transit stops should also provide other amenities to make waiting for the next bus comfortable:

- Trash/recycling receptacles should be provided and maintained at most stops.
- Depending on headways and the number of passengers boarding and alighting, electronic “next bus” readouts can be used to inform passengers when to expect the next bus.

- Very busy bus stops and transit stations should include space for vendors to sell newspapers, magazines, flowers, and other goods to keep the stops lively.
- BRT lines can include facilities that allow passengers to pay their fare before boarding the bus. Along with wide doors on buses, this allows buses to reduce their travel time by reducing dwell time at stops.

BUS STOP PLACEMENT

A bus stop's optimal placement depends on the operational characteristics of both the roadway and the transit system. The placement of bus stops at the far side of signalized intersections is generally considered to be preferable to near side or mid-block locations. However, each location has its advantages and disadvantages, as shown in Table 9.1 below.

Pre-boarding fare collection, TransMilenio, Bogotá, Colombia (Credit: Stewart Robertson)

Table 9.1 Bus Stop Placement Considerations

Location	Advantage	Disadvantage
Near Side	• Minimizes interference when traffic is heavy on the far side of an intersection • Provides an area for a bus to pull away from the curb and merge with traffic • Minimizes the number of stops for buses • Allows passengers to board and alight while the bus is stopped at a red light • Allows passengers to board and alight without crossing the street if their destination is on the same side of the street. This is most important where one side of the street has an important destination, such as a school, shopping center, or employment center that	• Increases conflicts with right-turning vehicles • Stopped buses may obscure curb-side traffic control devices and crossing pedestrians • Obscures sight distances for vehicles crossing the intersection that are stopped to the right of the buses • Decreases roadway capacity during peak periods due to buses queuing in through lanes near bus stops • Decreases sight distance of on-coming traffic for pedestrians crossing intersections

	generates more passenger demand than the far side.	● Can delay buses that arrive during the green signal phase and finish boarding during the red phase ● Less safe for passengers crossing in front of the bus
Far Side	● Minimizes conflicts between right-turning vehicles and buses ● Optimal location for traffic signal synchronized corridors ● Provides additional right-turn capacity by allowing traffic to use the right lane ● Improves sight distance for buses approaching intersections ● Requires shorter deceleration distances for buses ● Signalized intersections create traffic gaps for buses to reenter traffic lanes ● Improves pedestrian safety as passengers cross in back of the bus	● Queuing buses may block the intersection during peak periods ● Sight distance may be obstructed for vehicles approaching intersections ● May increase the number of rear-end accidents if drivers do not expect a bus to stop after crossing an intersection ● Stopping both at a signalized intersection and a far-side stop may interfere with bus operations
Mid-Block	● Minimizes sight distance problems for pedestrians and vehicles ● Boarding areas experience less congestion and conflicts with pedestrian travel paths ● Can be located adjacent to or directly across from a major transit midblock use generator	● Decreases on-street parking supply (unless mitigated with a curb extension) ● Requires a mid-block pedestrian crossing ● Increases walking distance to intersections ● Stopping buses and mid-block pedestrian crossings may disrupt mid-block traffic flow perimeter of the development.

In general, bus stops should be located at the far side of a signalized intersection in order to enhance the effectiveness of traffic signal synchronization or bus signal priority projects. Nearside bus stops are appropriate for stop-sign-controlled intersections. However, in all cases, priority should be given to the location that best serves the passengers.

SIGNAL TREATMENT

Signal prioritization is a component of technology-based “Intelligent Transportation Systems” (ITS). These signal systems are often used by road authorities in conjunction with transit agencies to help improve a roadway system’s overall operations in the following ways:

- Reduce traffic signal delays for transit vehicles;
- Improve an intersection’s person quantity;
- Reduce the need for transit vehicles to stop for traffic at intersections;
- Help reduce transit vehicles’ travel time; and,
- Help improve transit system reliability and reduce waiting time for people at transit stops.

Signal prioritization projects include **signal timing** or phasing projects and **transit signal** priority projects.

Signal Timing. Signal timing projects optimize the traffic signals along a corridor to make better use of available green time capacity by favoring a peak directional traffic flow. These passive systems give priority to roadways with significant transit use within a district-wide traffic signal timing scheme. Transit signal prioritization can also be achieved by timing a corridor's traffic signals based on a bus's average operating speed instead of an automobile's average speed.

Transit signal. Transit signal-priority projects alter a traffic signal's phasing as a transit vehicle approaches an intersection. This active system requires the installation of specialized equipment at an intersection's traffic signal controller and on the transit vehicle. It can either give an early green signal or hold a green signal that is already being displayed in order to allow buses that are operating behind schedule to get back on schedule. Signal-priority projects also help improve a transit system's schedule adherence, operating time, and reliability.

Although they may use similar equipment, signal-priority and pre-emption are two different processes. Signal-priority modifies the normal signal operation process to better accommodate transit vehicles, while signal pre-emption interrupts the normal signal to favor transit or emergency vehicles.

Signal treatments should be used along streets with significant bus service. The placement of a bus stop at the far side of a signalized intersection increases the effectiveness of transit signal-priority projects.

BUS BULBS

Bus bulbs are curb extensions that extend the length of the transit stop on streets with on-street parking. They improve transit performance by eliminating the need for buses to merge into mixed traffic after every stop. They also facilitate passenger boarding by allowing the bus to align directly with the curb; waiting passengers can enter the bus immediately after it has stopped. They improve pedestrian conditions by providing additional space for people to wait for transit and by allowing the placement of bus shelters where they do not conflict with a sidewalk's pedestrian zone. Bus bulbs also reduce the crossing distance of a street for pedestrians if they are located at a crossing. In most situations, buses picking up passengers at bus bulbs block the curbside travel lane; but this is mitigated by the reduced dwell time, as it takes less time for the bus driver to position the bus correctly, and less time for passengers to board.

One major advantage of bus bulbs over pulling over to the curb is that they require less parking removal: typically, two on-street parking spots for a bus bulb instead of four for pulling over. The following conditions should be given priority for the placement of transit bus bulbs:

- Where transit performance is significantly slowed by the transit vehicle's merging into a mixed-flow travel lane;
- Roadways served by express or BRT lines;
- Stops that serve as major transfer points; and,
- Areas with heavy transit and pedestrian activity and where narrow sidewalks do not allow for the placement of a bus shelter without conflicting with the pedestrian zone.

Bus bulbs should not be considered for stops with any of the following:

- A queue-jumping lane provided for buses;
- On-street parking prohibited during peak travel periods; and,
- Near-side stops located at intersections with heavy right-turn movements, except along streets with a "transit-first" policy.

CHARACTERISTICS

At a minimum, bus bulbs should be long enough to accommodate all doors of a transit vehicle to allow for the boarding and alighting of all passengers, or be long enough to accommodate two or more buses (with a 5-foot clearance between buses and a 10-foot clearance behind a bus) where there is frequent service such as with BRT or other express lines. Bus bulbs located on the far side of a signalized intersection should be long enough to accommodate the complete length of a bus so that the rear of the bus does not intrude into the intersection.

Vehicle	Length (feet)	Number of Buses at Stop	Platform Length (feet)	
			Near Side	Far Side
Standard Bus	40	1	35	45
		2	55	65
Articulated Bus	60	1	80	90
		2	120	130

Federal Transit Administration, August 2004. *Characteristics of Bus Rapid Transit for Decision Making* Project NO: FTA-VA-26-7222-2004.1

URBAN DESIGN

Bus stops and amenities vary in complexity and design from standardized off-the-shelf signs and furniture to specially designed elements. The design of the bus stop elements, location of the bus stop in relation to adjacent land uses or activities, and the quality of the roadway's pedestrian environment contribute to a bus stop's placement. Transit operators like a branded look to their stops so they are easily identified, but often there is room for customized designs to fit in with the neighborhood, with at least some of the features and amenities.

BICYCLE CONNECTIONS

Connecting bicycle facilities to transit stations helps extend the trip length for cyclists and reduces automobile travel. Secure bicycle parking must be provided at or within close proximity to a bus stop, preferably sheltered. At a minimum, the accommodations can be bike racks or lockers. Bike stations and automated bicycle parking can be located at areas with high levels of transit and bicycle use.

BUS LANES

Bus lanes provide exclusive or semi-exclusive use for transit vehicles to improve the transit system's travel time and operating efficiency by separating transit from congested travel lanes. They can be located in an exclusive right-of-way or share a roadway right-of-way. They can be physically separated from other travel lanes or differentiated by lane markings and signs. Bus lanes can be located within a roadway median or along a curb-side lane, and are identified by lane markings and signs. They should generally be at least 11 feet wide, but where bicycles share the lane with buses, 13 to 15 feet wide is preferred. When creating bus lanes, local jurisdictions should consider the following:

- Exclusive transit use may be limited to peak travel periods or shared with high-occupancy vehicles.
- On-street parking may be allowed depending on roadway design, especially with bus lanes located in the center of the street.
- A mixed-flow lane or on-street parking may be displaced; this is preferable to adding a lane to an already wide roadway, which increases the crossing distance for pedestrians and creates other problems discussed in other chapters.
- Within a mixed-flow lane, the roadway can be delineated by striping and signs.
- High-occupancy vehicles and/or bicycles may be permitted to use bus lanes.

Pedestrian access to stations becomes an issue when bus lanes are located in roadway medians.

ACCOMMODATING LIGHT RAIL, TROLLEYS, and BUS RAPID TRANSIT

A growing number of streets have light rail lines, street cars, or BRT. These need to be carefully designed into the street. The various options for accommodating light rail, trolleys (street cars), and BRT within streets are as follows:

- Center-running;
- Two-way split-side, with one direction of transit flow in each direction;
- Two-way single-side, with both directions of transit flow on one side of the street right-of-way; and,
- One-way single-side, with transit running one direction (either with or against the flow of vehicular traffic) and usually operating in a one-way couplet on parallel streets.

For each configuration, transit can operate in a reserved guideway or in mixed street traffic. When installing light rail or street cars within streets, the safety of pedestrians and bicyclists needs to be fully provided for. If poorly designed, these transit lines introduce hazards and serve to divide neighborhoods where crossings are highly limited and/or difficult or inconvenient. See Chapter 7, "Pedestrian Crossings" for more guidance. In general, in areas of high pedestrian activity, the speed of the transit service should be compatible with the speed of pedestrians.

The potential for each configuration is influenced by the street type. Some transit configurations will not work effectively in combination with certain street types. The table below outlines the compatibility of each configuration with the four street types.

	Center Running		Two-Way Split Side		Two-Way Single Side		One-Way Single Side	
Street Type	Reserved Guideway	In Street	Reserved Guideway	In Street	Reserved Guideway	In Street	Reserved Guideway	In Street
Boulevard	Y	N	N	Y	Y	N	Y*	Y
Multi-way Boulevard	Y	N*	Y	Y	N	N	Y*	Y
Avenue	Y	Y	Y*	Y	Y*	N	Y	Y
Street	N	Y	Y	Y	N*	N	Y	Y

Notes
Y = Recommended street type/transit configuration combination
N = Not recommended/possible street type/transit configuration combination
*Denotes configurations that mat be possible under certain circumstances, but are not usually optimal
Source: Integration of Transit into Urban Thoroughfare Design, DRAFT White Paper prepared by the Center for Transit-Oriented Development, updated: November 9, 2007.

10. TRAFFIC CALMING

DEFINITION

Traffic calming is the combination of mainly physical measures that (i) reduce the negative effects of motor vehicle use, (ii) alter driver behavior, and (iii) improve conditions for non-motorized street users.

The phrase, “the combination of mainly physical measures,” means physical measures plus a supportive policy environment such that traffic calming is permitted and encouraged.

“Reduce the negative effects of motor vehicle use” means changing the role and design of streets to accommodate motorists in ways that reduce the negative social and environmental effects on individuals, neighborhoods, districts, retail areas, corridors, downtowns, and society in general (e.g., reduced speeds, reduced sense of intrusion/dominance, reduced energy consumption and pollution, reduced sprawl, and reduced automobile dependence).

“Alter driver behavior” means that the street design helps drivers self-enforce lower speeds, resulting in less aggressive driving and increased respect for non-motorized users of the streets. “Improve conditions for non-motorized street users” means promoting walking and cycling, changing expectations of all street users to support equitable use of the street, increasing the feeling of safety and comfort, improving the aesthetics of the street, and supporting the context of the street.

The definition of traffic calming is broad enough to apply to an abundance of contexts and situations, but specific enough to have independent meaning so that it is not confused with other street design elements and design approaches.

Through design, traffic calming aims to slow the speeds of motorists to the “desired speed” (usually 25 mph or less for residential streets and 30 to 35 mph for boulevards and avenues) in a context-sensitive manner by working with the stakeholders (i.e., residents, business owners, and agencies). Traffic calming is applicable on all street types where pedestrians are allowed.

Traffic calming typically connotes a street or group of streets that employ traffic calming measures with a self-enforcing quality that encourages motorists to drive at the desired speed. When a group of streets are involved, it is normally referred to as "area-wide calming."

Traffic calming measures can also be designed to treat and manage stormwater runoff.

CATEGORIES

The correct terminology for traffic calming measures focuses on "measures" not the use of "devices." "Devices" implies a degree of portability that does not apply to most traffic calming measures. The use of "devices" also causes confusion with the contents of the Manual of Uniform Traffic Control Devices, (MUTCD). Adding street trees and changing the paving material to provide texture or contrast, for example, are measures to alter behavior and perceptions, but they are clearly not "devices."

(Credits: City of Fort Myers)

"Route modification measures" are not traffic calming measures. Examples of route modification measures include street closures, partial closures, turn prohibitions, diverters, and one-way streets. Route modifications effectively remove parts of the network. Route modifications result in circuitous and out-of-direction routing. The resulting trips are longer and burn more fuel; thus, circuitous routing can increase driver frustration and result in higher speeds. Route modification should be used sparingly and generally where traffic is diverted to boulevards to reduce cut-through traffic, or on bike boulevards to reduce their use by through motor vehicle traffic.

Lastly, signs and pavement markings are often used in conjunction with traffic calming measures, but they are traffic control devices, not traffic calming measures.

SAFETY

The greatest benefit of traffic calming is increased safety. Compared with conventionally designed streets, traffic calmed streets typically have fewer collisions and even higher reductions in injuries and fatalities. These dramatic safety benefits are mostly the result of slower speeds for motorists that result in greater driver awareness, wider fields of vision, shorter stopping distances, and less kinetic energy during a collision. At 25 mph or less, chances are very high that a motorist will not kill or severely injure a pedestrian in a collision. Other contributing factors to these superior safety results include a more legible street environment and design advantages for pedestrians and cyclists. Bulb-outs on corners of intersections, for example, allow pedestrians to see past parked cars prior to crossing the street.

The accommodation and comfort of pedestrians increases greatly as speeds lower. For example, acceptable gaps between moving vehicles are better judged at slower speeds. Also, at 25 mph or less, drivers are much more likely to yield to pedestrians and let them cross the street than at speeds over 25 mph. The chart below shows that it takes a longer distance to brake and come to a full stop as speeds increase.

MPH	Ft./Sec.	Braking Deceleration Distance	Perception Reaction Distance	Total Stopping Distance
10	14.7	5	22	27
15	22	11	33	44
20	29.3	19	44	63
25	36	30	55	85
30	44	43	66	109
35	51.3	59	77	136

GENERAL POLICY GUIDANCE

For a City initiating a traffic calming policy, the most important items to include are the following:

- The correct definition of traffic calming;
- General statements of support for traffic calming throughout the city and experimentation with traffic calming for a variety of rationales;
- A chart depicting examples of acceptable measures applicable categories of streets; and,
- A reference to traffic calming practices and procedures that will be maintained at the staff level.

The last bulleted item is important because local jurisdictions need the flexibility to adapt their programs, include updated practices and measures as they are developed or discovered, and react to changing circumstances. If practices and procedures are adopted by ordinance or resolution, then the traffic calming policy will be out-of-date quickly or will hamper local jurisdictions' ability to address unique contexts.

TORT LIABILITY

The low speed environment of a traffic calmed street is a difficult place for someone to be "victimized" by a fault in the road design. Consequently, there are very few tort actions associated with traffic calming. Furthermore, there are fewer collisions and far fewer injuries and deaths on traffic calmed streets than streets with higher speeds. There is very little exposure to liability if some simple and routine actions are followed:

- In local jurisdictions' statements for supporting traffic calming, some broad rationale should be listed so that traffic calming cannot be considered impulsive. Examples should include:
    a. To increase safety,
    b. To increase walkability,
    c. To increase community cohesion,
    d. To increase business viability; historic preservation and environmental protection, and
    e. To further the goals and objectives of the community and city in a variety of contexts.
- Local jurisdictions should conduct normal monitoring for maintenance, complaints, incidents, and collisions. This need not be anything more than the

normal reporting systems, but with some additional attention paid to streets with new modifications.

TRAFFIC CALMING CONTEXTS

Early traffic calming efforts in North America started as *programs* and often used a variety of warrants and petitions; however, traffic calming has evolved. There are many reasons to calm traffic; a city doesn't need special permission or warrants to increase the safety and comfort of its streets. In many ways, traffic calming is synonymous with other terms that are used to encourage better street designs. Depending on the context, the emphasis may differ, but in all cases traffic calming measures play a role.

Context-Sensitive Design

Context-Sensitive Design implies that the context; the social, historical, physical, fiscal, political, environmental, and policy contexts, drive the design as opposed to the conventional street hierarchy. In the past under "old-school thinking," conventional practices used general design guidelines that were indifferent to the context. Often, contexts along conventional streets in local jurisdictions suffered from some combinations of negative effects of motor vehicle use, poor driver behavior, and poor conditions for non-motorized street users. Under "new-school thinking," context-sensitive design now employs traffic calming measures that respect the context of the street and neighborhood.

Smart Transportation

Smart transportation describes the transportation aspects of smart growth. The idea is to consider *transportation planning and design* as integral with *land use planning and design*, as opposed to separate ideas. Too often, the two are done by separate specialists and for independent reasons. Traffic calming measures play an important role in the design of all types of streets in local jurisdictions where integration with the adjacent land use is desired.

Safe Routes to School

Safe routes to school includes a series of operational and physical changes that help students safely walk and cycle to and from schools. Traffic calming measures are routinely employed with other strategies and changes to create slower traffic, and thus safer walking and bicycling routes to school.

Neighborhood Traffic Management

Neighborhood traffic management describes application of the following techniques:

- Route modifications, e.g., turn prohibitions, closures, partial closures, diverters, and one-way streets, to remove parts of the street network, sever linkages, create mazes, or reduce connectivity; and,
- Traffic calming devices, such as speed bumps, speed tables, chokers, and chicanes, to reduce poor driver behavior such as speeding and aggressive driving.

Please note that in most situations, diminishing the street network is not considered good practice. Bicycle boulevards are a primary exception to this rule; traffic control devices are desirable on bicycle boulevards to discourage through motor vehicle traffic. Route modification may also be used to reduce cut-through traffic where the traffic will be diverted to a boulevard.

Road Diet

The term "road diet" describes the narrowing and/or removal of motor vehicle lanes from the cross-section. Both of these changes are traffic calming measures. Typically, the reclaimed space is used for other purposes such as wider sidewalks, landscaped spaces, bicycle lanes, linear parks, and/or on-street parking. Often, road diet projects employ other traffic calming measures as well. Roundabouts often enable implementation of road diets, especially on busier boulevards since they have greater capacity to handle traffic at intersections with fewer lanes than other controls.

Competent Street Design

Early in the design process, it is critical for any community to incorporate traffic calming measures into normal street design practices and procedures as part of competent street design. This process will help any new/future streets avoid the deficiencies often associated with conventionally designed streets. With respect to existing roadway infrastructure built under "old-school" practices, implementing competent street design is more difficult. Rebuilding or retrofitting these streets should be prioritized based on the context, as part of the Competent Street Design process. Candidates for traffic calming may include the following:

- Key shopping area streets in the downtown district;
- Waterfront streets, which commonly attract pedestrians who would benefit from traffic calming measures;
- Neighborhood streets and/or playground environments; and

- Major arterials (boulevards) that create barriers to pedestrians and bicyclists in the city.

Consequently, allocating street redesign money based on warrants or numerical scores is not recommended because the contexts and scopes vary too much. In the early days of North American traffic calming, special traffic calming programs were established with warrants that focused primarily on motor vehicle speeds, volumes, and collisions on residential streets. Warrants were popular in the early traffic calming programs because, at the time, traffic calming was new and unfamiliar. Traffic calming was thought of as an independent program for residential streets only.

Instead, traffic calming should be a normal part of the city, district, downtown, corridor, and neighborhood incorporated into their plans as a normal part of their budgeting process. To the degree possible, traffic calming should be included in resurfacing, utility replacement, and other programs. Every time a conventional street needs improvements, the replacement design should include traffic calming as normal practice. Traffic calming should be the rule, not the exception, and special permission to *not* implement traffic calming measures should be sought in those instances. Competing areas, neighborhoods, and districts that desire traffic calming measures should express their desires through the normal planning and capital works programs.

<u>Traffic Calming and Stormwater Management</u>

Traffic calming measures, such as bulb-outs, modern roundabouts, chicanes, lane narrowing, and other similar treatments, can be used as stormwater management tools. Some of these can create space for bio retention, detention, and pervious pavement.

PLANNING AND DESIGN PROCESSES

Traffic calming should be a normal part of any city’s planning and design processes. The processes will vary dramatically depending on the context. For example, implementing a road diet in conjunction with a transit facility along a five-mile boulevard would require a different process than reverting a one-way street operation back to a two-way street operation in a downtown. Similarly, a neighborhood traffic calming plan would require a different process than designing a people friendly Main Street. Also, identifying boulevard streets that are barriers in a city during comprehensive planning would require a different process than altering streets on a college campus or hospital campus.

The common threads that link all of the processes include the following:

- Gaining a good understanding of the context;

- Making a clear project statement, which defines the project goals and includes the stakeholders;
- Educating the stakeholders such that they can have meaningful involvement;
- Aligning the project with a broader vision for the community; and
- Achieving an informed community consent regarding the plan.

Traffic calming is best done in conjunction with projects such as development, revitalization, utility, or maintenance in the downtown area, corridor, transit plan, or a new street design. Then the traffic calming layer is simply incorporated into the larger project's processes.

CITY OF FORT MYERS TRAFFIC CALMING PLAN

A major portion of the development of the traffic calming plan for the City-Wide Traffic Calming Comprehensive Consultant Plan required a two-step process of meetings with the citizenry of each ward. The first set of ward meetings was conducted with a small group of citizens designated as the Steering Committee. The second set of meetings was the Public Workshops that included all of the ward residents.

In addition to the steering committee and the public workshop meetings, the Consultant team spent a great deal of time with each individual City Council member and all City department heads, including Police and Fire, as well as Lee County representatives. This collaborative effort was necessary in order to understand all the issues confronting the respective wards and their traffic calming needs, and the City of Fort Myers.

STEERING COMMITTEE

As previously noted, the Consultant team's first set of meetings were held with residents from each of the City's five wards which constituted the Steering Committee for this project.** Each ward Steering Committee was comprised of the Council member for the ward and a select group of residents within the ward who, over time, provided specific comments and identified problematic locations that needed to be addressed as part of the project. Following this series of developmental Steer Committee meetings, a suggested conceptual traffic calming plan was developed. These conceptual traffic calming plans were later used in presentations at the overall public workshop meetings that were held for each ward.

On occasion, because of the fact that certain wards had multiple homeowners associations or civic groups, there were several Steering Committee meetings held in each ward. Additionally, these multiple Steering Committee meetings created the need for two meetings, rather than one public workshop meeting. Other reasons for two public workshop meetings included the fact that some traffic calming plans for one ward had a significant impact beyond the specific ward's boundaries; the overall traffic calming plan for McGregor Boulevard.

Representation at each Steering Committee meeting was coordinated with the administrative assistant of each Council member in terms of stakeholder participation within each ward. Prior to commencing each meeting, the Consultant team coordinated with City staff to establish the best location, date, and time for holding the meeting. The Steering Committee identified both problematic traffic locations and the particular traffic issues facing their neighborhoods. The Steering Committee, Consulting team, and the City collectively worked to develop a recommended traffic calming plan.

The approach used to conduct these meetings included presenting information that was divided into two levels. Level 1 was Education, and Level 2 was Plan Development. The process began with a PowerPoint presentation educating the group on traffic calming. Traffic calming was defined as follows:

> *"Traffic Calming is the combination of mainly physical measures that reduce the negative effects of motor vehicular use and alter driver behavior to improve conditions for non-motorized street users."*

During presentation of the educational process, the Consultant team illustrated alternative traffic calming measures or treatments using a "traffic calming tool kit." See the graphic below. This tool kit contained 12 measures, or treatments identified within.

A double-sided, laminated tool kit graphic was used as a visual aid. The sheet included a listing of the treatment names on one side and a photographic example of each treatment on the other side. The double-sided sheet is presented in **Figure X**. The presentation concluded with the identification of pro's and con's for each of the 12 measures/treatments, the meeting took on a different context functioning primarily as a design workshop.

Figure X

The Consultant team brought conceptual traffic calming plans for the respective wards and placed them on tables. The Consultant also used a dry erase easel to describe the problematic locations identified by each ward. Stakeholders then assigned potential traffic calming measures that addressed each of the defined problem issues. This afforded them the opportunity to have a say in the problem issues and solutions facing their neighborhood. Armed with a very basic traffic calming education and the traffic calming tool kits, this forum allowed Steering Committee members to essentially function as traffic calming engineers/planners at the meeting.

<u>Summary of Traffic Calming Treatments</u>

The following summarizes the traffic calming treatments presented at the meeting and illustrated in the tool kit graphic:

Chokers. Chokers use curb extensions, or “bulb-outs,” to narrow a roadway at an intersection. Chokers help shorten the pedestrian crossing distance. They also can be used for landscaping. Chokers help reduce speeds at intersections, as well as mid-block locations. They can also help designate and protect on-street parking. They improve pedestrian safety by shortening the distance pedestrians have to traverse to cross a street.

Chicanes. Chicanes or changes in the horizontal alignment, redesign a straight section of a road to include a narrow landscaped intrusion into the roadway. The landscaped intrusions can be designed as alternating patterns. The advantage of a chicane is that it produces a perception of a narrowed roadway in conjunction with a winding or curvilinear alignment of the road. This artificial bend, or bends, in the roadway can result in a two-lane road narrowing to a single-lane road or a two-lane road appearing to either change direction or become narrower, or both. The end result is reduced speeds and volumes of vehicles.

Median Islands. Median islands consist of a landscaped island in the middle of the roadway. The design involves widening a roadway slightly to provide room for the island. When completed, vehicles must slow down to negotiate the island and narrow lane width. Median islands can also provide a temporary refuge for pedestrians attempting to cross the road.

Street Closures. Street closures use a physical barrier to eliminate all traffic movements. The barrier can be landscaped to improve its appearance. The barrier effectively prevents traffic from proceeding down a street. Through traffic, that would normally attempt to use the roadway, is forced to find an alternative route.

Roundabouts. Roundabouts consist of a circular island that is normally designed for an intersection with more than two roads approaching it. Roundabouts generally are landscaped islands with a variety of other enhancements that may include water fountains, special plantings, statues, or other objects. A roundabout promotes efficient vehicular movement, eliminating the need for stop-signs or traffic signals. Roundabouts are normally designed to promote slower vehicle speeds. The roundabout has generally been credited with reducing vehicular conflicts and improving pedestrian safety. However, due to the regular occurrence of drivers that are not familiar with roundabouts, it is very important that roundabouts employ proper advanced warning signage, roundabout signage, sufficient lighting, and pavement markings to ensure the safety of both motorists and pedestrians.

Speed Humps. Street humps differ from speed bumps in that they consist of a wide raised section of pavement that is longitudinally much longer than a speed bump. Many speed humps are several inches high and several feet in length. The design naturally restricts vehicle speeds. While some vehicles may be able to traverse a speed bump quickly, speed humps are virtually impossible to drive over quickly. The end result is reduced vehicle speeds. They are most effective in neighborhoods with schools and high pedestrian activity. Frequency and placement of speed humps will be established from the Institute of Transportation Engineers (ITE), *Trip Generation*, 6th ed. guidelines. Each location will be specifically evaluated based on prevailing conditions such as intersecting roads, existing driveways, etc. Field conditions need to be evaluated prior to specific design for placement.

Roadway Narrowing. Roadway narrowing involves narrowing a straight stretch of roadway significantly at certain points to produce an uncomfortable feeling for speeding motorists. The desired effect is similar to chokers. However, roadway narrowing is usually used somewhat midway between intersections. The narrowed roadway causes motorists to slow down to a comfortable speed.

Directional Restrictions. Directional restrictions are accomplished by placing a physical barrier in the roadway; typically a raised island to prevent specific vehicular movements. They are frequently used to redirect traffic at intersections. For example, raised island at an intersection approach can prevent traffic from making left-turns. A diagonal diverter across the entire intersection can also restrict the through movements on both roads. The benefits of this treatment are reduced traffic volumes.

Forced-Turn Channelization. Forced-turn channelization uses a barrier to force vehicles to change direction. Channelization is often used to block a roadway, redirecting traffic from one roadway to another. The benefits include eliminating cut-through traffic and slowing vehicles.

Traffic Control Devices. Traffic control devices include a broad category of measures intended to control traffic. Examples include pavement markings, barricades, temporary signals, traffic cones; bright orange cones, vertical flexible markers, etc., and variable-message signs, to name a few. Traffic control devices are often used to redirect traffic and slow vehicles.

Textured Pavement and Crosswalk/Brick Pavers. Textured pavement and crosswalk/brick pavers consist of redesigning crosswalks from a smooth asphalt or concrete surface to a surface that is irregular. This can be accomplished with inlaid bricks, brick pavers, or stamped textured surfaces. The end result is a textured surface, and/or crosswalk, which is distinguishable from the adjacent pavement surfaces, thereby encouraging motorists to slow down. The obvious benefit is increased safety for pedestrians.

Gateway Sign. A gateway sign is a monument sign typically identifying the limits of a residential neighborhood. They are typically located within a raised median and are used on local streets adjacent to a major street to indicate to drivers that they are entering a neighborhood area where speeds are low.

Upon completion of the public workshop meetings, which presented each ward's conceptual traffic calming plans with input from the stake holders via comment cards, not all comments were incorporated into the final plans for several reasons. In some instances, the residents requested too many traffic calming treatments for a specific area. In other instances, the residents did not initially understand that the goal of a traffic calming plan is to calm traffic on neighborhood local streets, not on collector or arterial roadways. By calming major collector and arterial roadways, the transportation system would cease to function efficiently. Therefore, engineering judgment was used to determine which roadways warranted traffic calming and which roadways did not, based upon the public's input, the collected data, and subsequent analysis.

The results were incorporated into each ward's recommended conceptual Phase I, Phase II, and Phase III calming plans, which were expanded from the initial two-phase plans. The three plan phases were necessary to address the various design/construction considerations associated with design/construction times impacts Phase I traffic calming treatments have the lowest costs, enabling them to be implemented quickly. Phase II traffic calming treatments are more costly, requiring that they be implemented in future years, depending upon the annual budget set aside for traffic calming. Phase III traffic calming treatments affect only McGregor Boulevard. Maps depicting the recommended traffic calming plans, by phase, are presented in the following section of this report.

CONCLUSION

The recommended conceptual traffic calming plans for all wards and the McGregor Boulevard Corridor is the result of extensive data collection, interviews, observations, and a multitude of meetings with City officials, City staff, Consultant team, neighborhood groups, and the general public. The adopted plans reflect the consensus of the City's stakeholders regarding the type and location of the proposed traffic calming treatments for their respective wards. Implementation of these plans will enhance the quality of life for these neighborhoods, make their roadways safer, and effectively address the problem issues of each ward. These plans were unanimously adopted by the City Council on June 2, 2003.

11. STREETSCAPE ECOSYSTEM

*The street is a system;
A transportation system,
an eco-system, and
a system of socio-
economic interactions.*

Centennial Park Tree Canopy- (Credit: Henry Bley)

INTRODUCTION

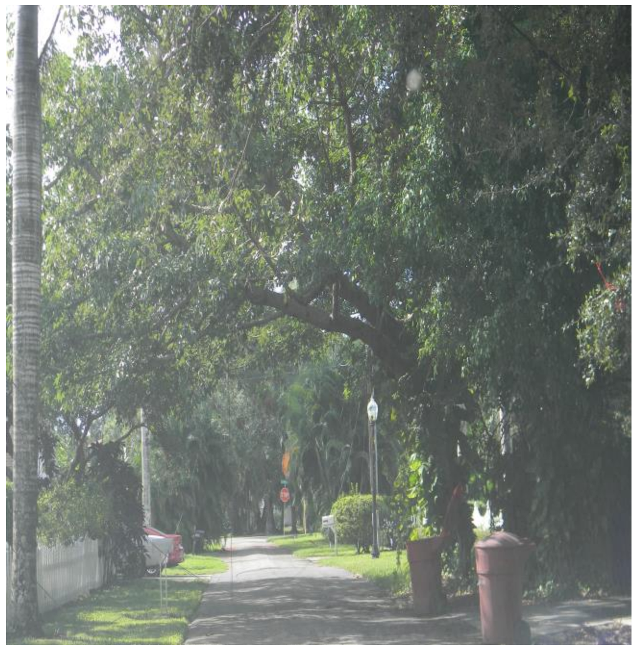
The idea of a streetscape ecosystem is to mimic nature, building reciprocal relationships within an interconnected system to sustainably enhance the local environment, its resources, the community, and the local economy. To do this, the tools addressed in this chapter should be integrated with those of the other chapters in this manual.

This chapter is organized into sections based on a natural hierarchy. The first section focuses on stormwater management because water is the fundamental ingredient for other components of a streetscape ecosystem. The storm water management section provides guidance on how to work with and maximize the beneficial aspects of rain, its byproduct, stormwater, and other sources of water. The second section addresses street trees and landscaping, providing guidance on how to design streets to include site-appropriate vegetation that maximizes environmental and social benefits. Canopy trees provide year-round shade that cools the streets and the hardscapes from which the stormwater is harvested. These sheltered micro-climates create ideal locations for people to gather, walk, and bike.

To help local jurisdictions achieve street designs that create great places fostering community, the final sections of this chapter address street furnishings, utilities, and lighting. The sections recommend that these elements (e.g., sheltered benches, bike racks, and bus shelters) should be placed where people can utilize them well. These sections also provide guidance as to the placement of utilities and how placement coordinates with other components of the streetscape. The elements described can help attract pedestrians to a street and thereby make the street safer, more dynamic, and more vibrant economically.

PRINCIPLES OF STREETSCAPE ECOSYSTEM DESIGN

Each section in this chapter includes design principles followed by tools to achieve these principles. These streetscape element-specific principles collectively support both the overarching principles of this chapter and the broader goals of this manual. The collective use of the tools in this chapter can provide numerous aesthetic and functional elements in the public rights-of-way, including the entire space between buildings, travel way, and sidewalks. The following overarching principles should be applied:



Street off McGregor Blvd., Fort Myers (Credit: Henry Bley

- **Coordinate all streetscape elements with travel way design to maximize ecological, economic, and social benefits.** No individual street project should be pursued in a vacuum, but rather planned as part of a comprehensive strategy. Use street medians, roundabouts, chicanes, curb extensions, and other road configurations as space for people and nature. They provide opportunities for spaces with vegetation, stormwater management tools, and other streetscape elements like benches and bike racks.
- **Create a contextualized sense of place.** Using the large menu provided in this chapter, select streetscape elements that reflect the context and unique character of the location as well as support connections to adjacent land uses. The street can then function as a shared living room for the community and a welcoming front door for the buildings along the street. Native plantings can be used to root the context in the surrounding natural landscape while acknowledging the local ecosystem and climate.

STORMWATER MANAGEMENT

Stormwater Management is from the City of Fort Myers Land Development Code, South Florida Water Management Rules and Regulations, and from the Florida Department of Environmental Protection.

GENERAL GUIDELINES

Site Considerations. Streetscape geometry, topography, and climate determine the types of controls that can be implemented under stormwater management that is under consideration by the City of Fort Myers. The initial step in selecting a stormwater tool is to determine the available open space and constraints. Although the maximum size of a selected stormwater facility may be determined by available area, the standard design storm should be used to determine the appropriate size, slope, and materials of each facility.

After identifying the appropriate stormwater facilities for a site, an integrated approach is encouraged: To increase water quality and functional hydrologic benefits, several stormwater management tools can be used in succession. This is called a “treatment train approach” which measures should be designed using available topography to take advantage of gravity for conveyance to and through each facility.

Traffic calming measures, such as medians, circles, chicanes, and curb extensions, should integrate stormwater management options discussed in this section. The first image below illustrates a center-draining street utilizing a rain garden integrated into a circle. These areas offer ideal opportunities for treating runoff as they typically intercept the flow path of water along a street and provide additional surface and subsurface space for treating and infiltrating stormwater. By integrating stormwater management tools at an early design stage, new facilities can be added with only marginal cost when paired with other streetscape construction projects. This idea, however, should also be incorporated into street repaving projects. The image below illustrates a possible treatment on a traditional crowned street with traffic calming measures.

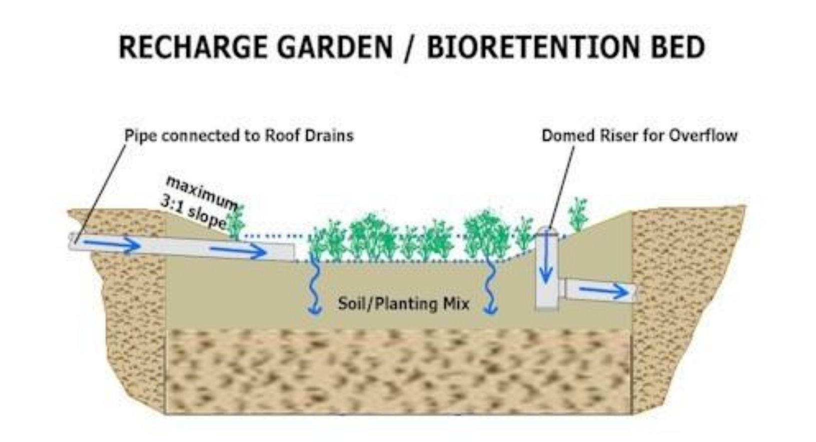
Infiltration Considerations. Appropriate soils, infiltration media, and infiltration rates should be used for infiltration BMPs. Ideally, a complete geotechnical or soils report should be undertaken to determine infiltration rates, soil toxicity and stability, and other factors that will affect the ability and the desirability of infiltration. At a minimum, the infiltration capacity of the underlying soils should be deemed suitable for infiltration and appropriate media should be used in the BMP itself.

Using certain techniques, stormwater tools can still be incorporated into areas of low permeability or where infiltration of stormwater is not desirable. Underdrains should be used in areas of low soil permeability. The location of the underdrain is an important consideration: if placed higher in a facility, the stored water below the perforated pipe will be infiltrated. If placed at the bottom of a sealed system, the perforated pipe will release the stored water slowly over time. These infiltration BMPs may overflow to appropriate locations such as catch basins and outfalls.

Details are important to the ultimate success or failure of an infiltration system. Poor soil conditions may cause stormwater to infiltrate either too quickly or too slowly. Over-compaction of subsurface soil during construction can lead to reduced infiltration capacity, flooding, and ponding. The bottom surface of infiltration areas should be level to allow even distribution. *Soils and gravels in an infiltration installation should be meticulously specified and verified in the field during construction.* Proper maintenance is crucial to the success of an infiltration BMP. To ensure proper caretaking, a maintenance plan or contract with a local agency is necessary.

BIORETENTION FACILITIES

Bioretention is an excavated shallow surface depression planted with specially selected native vegetation to treat and capture runoff. It is a stormwater management process that cleans stormwater by mimicking natural soil biology based filtration processes as water flows through a bioretention BMP. It incorporates mulch, soil pores, microbes, and vegetation to reduce and remove sediment and pollutants from stormwater. Bioretention is designed to slow, spread, and, to some extent, infiltrate water. Each component of the bioretention BMP is designed to assist in retaining water, evapotranspiration, and adsorption of pollutants into the soil matrix. As runoff passes through the vegetation and soil, the combined effects of filtration, absorption, adsorption, and biological uptake of plants remove pollutants. Biological and horticultural expertise should be employed in development of each system.



For areas with low permeability or other soil constraints, bioretention can be designed as a flow-through system with a barrier protecting stormwater from native soils. Bioretention areas can be designed with an underdrain system that directs the treated runoff to infiltration areas, cisterns, or the storm drain system, or may treat the water exclusively through surface flow.

Location and Placement. Bioretention facilities can be included in the design of all street components: adjacent to the travel way and in the frontage or furniture sidewalk zones. They can be designed into curb extensions, medians, traffic circles, roundabouts, and any other landscaped area. Depending on the feature, maintenance and access should always be considered in locating the device. Bioretention systems are also appropriate in constrained locations where other stormwater facilities requiring more extensive subsurface materials are not feasible.

Design. A sponge-like surface application of organic mulch can quicken the rate of absorption into the soil, slow soil moisture loss to evaporation, and reduce the solid waste stream if the mulch is generated from local organic matter. This strategy can also intercept and reduce sediment and nutrient concentrations in runoff via bioremediation.

Plants should be microclimate-appropriate and must be able to tolerate occasional saturation as well as dry periods (see the Urban Forestry section of this chapter for planting recommendations).

The use of multiple small devices is often more feasible in tight urban environments than the use of one large device. Small systems can be linked together to achieve the desired cumulative capacity.

Included in this section are discussions of swales, planters, and vegetated buffer strips.

SWALES

Swales are linear, vegetated depressions that capture rainfall and runoff from adjacent surfaces. The swale bottom should have a gradual slope to convey water along its length. Swales can reduce off-site stormwater discharge and remove pollutants along the way. In a swale, water is slowed by traveling through vegetation on a relatively flat grade. This gives particulates time to settle out of the water while contaminants are removed by the vegetation. Because the vegetation receives much of its needed moisture through stormwater, the need for irrigation is greatly reduced.

City of Sunny Isles Beach, Florida

Location and placement. Swales can easily be located adjacent to roadways, sidewalks, or parking areas. Roadway runoff can be directed into swales via flush curbs or small evenly-spaced curb cuts into a raised curb. Swale systems can be integrated into traffic calming devices such as chicanes and curb extensions.

Swales can be placed in medians where the street drains to the median. Placed alongside streets and pathways, vegetated swales can be landscaped with native plants which filter sediment and pollutants and provide habitat for wildlife. Swales should be designed to work in conjunction with the street slope to maximize filtration and slowing of stormwater.

Design. Soils that promote absorption and support vegetation, such as sandy loams, should be specified on a case-by-case basis. Base layers of rock and stabilizing filter fabric may also be specified. Swale length, width, depth, and slope should be determined by capacity needed for treatment of the design storm.

Swales are designed to allow water to slowly flow through. Depending on the landscape and design storm, an overflow or bypass for larger storm events may be needed. Curb openings should be designed to direct flow into the swale. Following the inlet, a sump may be built to capture sediment and debris. Mulch can be used in systems where it will not escape the swale system, such as in flatter, deeper swales. Check dams should be used to slow the velocity of water and catch sediment when the slope along the length of the swale exceeds 4 percent.

Swales should be landscaped with deep-rooted grasses and vegetation that tolerate short periods of inundation, deposits of sediment, and periods of drought. Vegetation will filter sediment and slow erosion, protecting the swale from failure. The sides of swales should be minimally sloped to protect the swale from erosion and slope failure.

PLANTERS

Planters are typically above-grade or at-grade with solid walls and a flow-through bottom. They are contained within an impermeable liner and use an underdrain to direct treated runoff back to the collection system. Where space permits, buildings can direct roof drains first to

building-adjacent planters. Both underdrains and surface overflow drains are typically installed with building-adjacent planters.

At-grade street-adjacent planter boxes, are systems designed to take street runoff and/or runoff from sidewalks and incorporate bioretention processes to treat stormwater. These systems may or may not include underdrains.

Location and placement. Above-grade planters should be structurally separate from adjacent sidewalks to allow for future maintenance and structural stability per local department of public works' standards. At-grade planter systems can be installed adjacent to curbs within the frontage and/or furniture zones.

Design. All planters should be designed to pond water for less than 48 hours after each storm. Flow-through planters designed to detain roof runoff can be integrated into a building's foundation walls, and may be either raised or at grade.

For at-grade planters, small localized depressions may be included in the curb opening to encourage flow into the planter. Following the inlet, a sump (depression) to capture sediment and debris may be integrated into the design to reduce sediment loadings.

Vegetated Buffer Strips

Vegetated buffer strips are sloping planted areas designed to treat and absorb sheet flow from adjacent impervious surfaces. These strips are not intended to detain water, only to treat it as a flow-through feature. They should not receive concentrated flow from swales or other surface features, or concentrated flow from pipes.

Location and placement. Vegetated buffer strips are well-suited to treating runoff from roads and highways, small parking lots, and pervious surfaces. They may be commonly used on multi-way boulevards, park edge streets, or sidewalk furniture zones with sufficient space. Vegetated buffers can be situated so they serve as pre-treatment for another stormwater management feature, such as an infiltration BMP.

Design. Buffer strips cannot treat large amounts of runoff; therefore, the maximum drainage width (with the direction of flow being towards the buffer) of the contributing drainage area should be 60 square feet. In general, a buffer strip should be at least 15 feet wide in the direction of flow to provide the highest water quality treatment.

The top of the strip should be set 2 to 5 inches below the adjacent pavement or contributing drainage area, so that vegetation and sediment accumulation at the edge of the strip does not prevent runoff from entering.

Buffer strips should be sited on gentle slopes. Steep slopes in excess of 15 percent may trigger erosion during heavy rain events, thus eliminating water quality benefits.

DETENTION

Detention devices differ from retention in that they are designed and sized to hold a specific volume of water and then slowly release it over time. On the other hand, the bioretention BMPs described in the previous section are designed and sized based on flow—the rate of water passing through them. The objective of bioretention is to improve the quality of stormwater by promoting filtration and adsorption as water flows through vegetation and soil. Detention devices do not function as flow-through features, but rather the objective is to collect and contain water until it is removed by controlled release or infiltrated into the soil. Overflow outlets may be included to manage large storm events. Pollutants may be removed by vegetation and the topsoil layer as in bioretention BMPs so that stormwater is treated before it is infiltrated. Detention devices can greatly reduce the volume of runoff from streetscapes and for small storm events may completely eliminate runoff.

Rain Gardens

Rain gardens are shallow, vegetated depressions in the landscape that are planted with deep-rooted plants and grasses. Rain gardens can also be planted with native trees as space allows. This is especially desirable because one tree can reduce stormwater runoff by 4,000 gallons per year. Rain gardens have flat bottoms and gently sloping sides. Rain gardens can be similar in appearance to swales, but their footprints may be any shape. Rain gardens hold water on the surface, like a pond, and have overflow outlets. The detained water is infiltrated through the topsoil and subsurface drain rock unless the volume of water is so large that some must overflow. Rain gardens can reduce or eliminate off-site stormwater discharge while increasing on-site recharge.

GUIDELINES

Location and placement. Rain gardens may be placed where there is sufficient area in the landscape and where soils are suitable for infiltration. Rain gardens can be integrated with traffic calming measures installed along streets, such as medians, islands, circles, street ends, chicanes, and curb extensions (pedestrian bulb-outs). Rain gardens are often used to the terminus of swales in the landscape.

Design. Native soils should have a minimum permeability rate of 0.5 inches per hour. Sites that have more than a 5 percent slope may require other stormwater management approaches or special engineering. The topsoil layer should be designed on a case-by-case basis and may often be a type of sandy loam. Subsurface drain rock will promote infiltration and should also be designed for each installation. Local public works departments may have additional guidelines for rain garden design.

The size and shape of rain gardens will vary in each case and the available area in the landscape may determine the maximum footprint. Because rain gardens are volume-based BMPs, their surface area and depth will be designed to achieve the desired detention volume. Overflow outlets should be below the lip of the rain garden and at a height consistent with the desired detention volume. Sides should be gently sloping to prevent erosion.

Rain gardens should be landscaped with deep-rooted grasses and other vegetation that can tolerate short periods of inundation, deposits of sediment, and periods of drought. One can contact Extension Service for recommended plants.

INFILTRATION TRENCHES

Infiltration trenches are linear, rock-filled features that promote infiltration by providing a high ratio of sub-surface void space in permeable soils. They provide on-site stormwater retention and may contribute to groundwater recharge. Infiltration trenches may accept stormwater from sheet flow, concentrated flow from a swale or other surface feature, or piped flow from a catch basin. Because they are not flow-through BMPs, infiltration trenches do not have outlets but may have overflow outlets for large storm events.

Infiltration trenches are typically designed to infiltrate all flow they receive. In large storm events, partial infiltration of runoff can be achieved by providing an overflow outlet. In these systems, significant or even complete volume reduction is possible in smaller storm events. During large storm events, these systems may function as detention facilities and provide a limited amount of retention and infiltration.

GUIDELINES

Location and placement. Infiltration trenches typically have small surface footprints so they are potentially some of the most flexible elements of landscape design. However, because they involve sub-surface excavation, these features may interfere with surrounding structures. Care needs to be taken to ensure that surrounding building foundations, pavement bases, and utilities are not damaged by infiltration features. Once structural soundness is ensured, infiltration features may be located under sidewalks and in sidewalk planting strips, curb extensions, roundabouts, and medians. When located in medians, they may only be effective when the street is properly graded to drain to the median.

Infiltration features should be sited on uncompacted soils with acceptable infiltration capacity. They are best used where soil and topography allow for moderate to good infiltration rates (0.5 inches per hour) and the depth to groundwater is at least 10 feet. Prior to design of any retention or infiltration system, proper soil investigation and percolation testing should be conducted to determine appropriate infiltration design rates. Any site with potential for previous underground contamination should be investigated. Infiltration trenches can be designed as stand-alone systems when water quality is not a concern or may be combined in series with other stormwater tools.

Pre-treatment, design, and installation. Infiltration features do not treat stormwater and may become damaged by stormwater carrying high levels of sediment. In general, infiltration features should be designed in series with bioretention tools unless the infiltration features receive water from well-vegetated areas where sediment is not expected. Pre-treatment features should be designed to treat street runoff prior to discharging to infiltration features. Bioretention devices, sumps, and sedimentation basins are several pre-treatment tools effective at removing sediment.

Trenches are typically backfilled with coarse drain rock (coarse gravel) and may or may not be lined with filter fabric. Additional void space can be achieved by including materials such as perforated pipes, half pipes, or open blocks within the drain rock. The trench surface can be planted, covered with grating, covered with boardwalks, or simply remain as exposed drain rock. Local public works departments should be contacted for any local guidance on infiltration feature design.

The slope of the infiltration trench bottom should be designed to be level or with a maximum slope of 1 percent. Infiltration BMPs should be installed parallel to contours with maximum ground slopes of 20 percent and be located no closer than 5 feet to any building structure. Sub-soils should not be compacted. Drain rock and, if needed, filter fabric with an overflow drain should be designed for each installation.

Perforated pipes and piped inlets and outlets may be included in the design of infiltration trenches. Cleanouts should be installed at both ends of any piping, and at regular intervals in long sections of piping, to allow access to the system. Monitoring wells are recommended for both trenches and wells and can be combined with clean-outs. If included, the overflow inlet from the infiltration trench should be properly designed for anticipated flows.

PAVING

Permeable paving is a system with the primary purpose of slowing or eliminating direct runoff by absorbing rainfall and allowing it to infiltrate into the soil. This BMP is impaired by sediment-laden run-on which diminishes its porosity. Care should be taken to avoid flows from landscaped areas reaching permeable paving. In those cases, bioretention is a better choice for BMPs. Permeable paving is, in certain situations, an alternative to standard paving. Conventional paving is designed to move stormwater off-site quickly. Permeable paving, alternatively, accepts the water where it falls, minimizing the need for management facilities downstream.

Permeable paving:

- Filters and cleans pollutants such as petroleum deposits on streets
- Reduces water volumes for existing overtaxed pipe systems
- Decreases the cost of offsite or onsite downstream infrastructure

Location and placement. Conditions where permeable paving should be encouraged include:

- Sites where there is limited space in the right-of-way for other BMPs
- Parking or emergency access lanes
- Furniture zones of sidewalks especially adjacent to tree wells
- Alleyways

Conditions where permeable paving should be avoided include:

- Where runoff is already being harvested from an impervious surface for direct use, such as irrigation of bioretention landscape areas
- Steep streets
- Large traffic volume or heavy load lanes
- Gas stations, car washes, auto repair, and other sites/sources of possible chemical contamination
- Areas with shallow groundwater
- Within 20 feet of sub-sidewalk basements
- Within 50 feet of domestic water wells

Materials. When used as a road paving, pervious pavement that carries light traffic loads typically has a thick drain rock base material. Pavers should be concrete as opposed to brick or other light-duty materials. Other possible permeable paving materials include porous concrete and porous asphalt. These surfaces also have specific base materials that detain infiltrated water and provide structure for the road surface. Base material depths should be specified based on design load and the soils report.

Plazas, emergency roads, and other areas of limited vehicular access can also be paved with permeable pavement. Paving materials for these areas may include open cell paver blocks filled with stones or grass and plastic cell systems. Base material specifications may vary depending on the product used, design load, and underlying soils.

When used for pedestrian paths, sidewalks, and shared-use paths, appropriate materials include those listed above as well as rubber pavers and decomposed granite or something similar such as washed or pore-clogging fine material. Pedestrian paths may also use broken concrete pavers as long as ADA requirements are met. Paths should drain into adjoining landscapes and should be higher than adjoining landscapes to prevent run-on. Soil paths are not successful on slopes in excess of 4 percent. Any pervious materials used for sidewalks or paths should be very smooth for wheelchairs and bicyclists.

Design. Design considerations for permeable paving include:

- The location, the slope and load-bearing capacity of the street, and the infiltration rate of the soil
- The amount of storage capacity of the base course
- The traffic volume and load from heavy vehicles
- The design storm volume calculations and the quality of water
- Drain rock, filter fabrics, and other subsurface materials
- Installation procedures including excavation

A soil or geotechnical report should be conducted to provide information about the permeability and load-bearing capacity of the soil. Infiltration rate and load capacity are key factors in the functionality of this BMP. Permeable paving generally does not have the same load-bearing capacity as conventional paving, so this BMP may have limited applications depending on the underlying soil strength and paving use. Permeable paving should not be used in general traffic lanes due to the possible variety of vehicles weights and heavy volumes of traffic.

The soil report should also provide the depth of the water table to determine if permeable pavers are an appropriate application for the site. Pervious pavement typically requires a 4-foot or more separation from the water table or bedrock to properly infiltrate stormwater. Pervious pavement is not recommended over new or compacted fill.

Because permeable pavement is damaged by sediment deposits, it should be carefully placed in the landscape so as to avoid run-on, especially from sediment-laden sources such as landscaped areas.

Pavement used for sidewalks and pedestrian paths should be ADA compliant, especially smooth, and not exceed a 2 percent slope or have gaps wider than 0.25 inches. In general, tripping hazards should be avoided.

Maintenance and installation. Proper construction and installation of permeable pavement is vital to its success. To ensure that the paving system functions properly, subbase preparation and stormwater pollution prevention measures should be performed appropriately during installation.

Construction considerations include:

- Scarifying soils so that they remain porous
- Avoiding compaction of soils
- Preventing run-on and sedimentation during construction

Maintenance of permeable pavement systems is essential to their continued functionality. Regular vacuuming street sweeping and other updated techniques should be performed to remove sediment from the pavement surface. The bedding and base material should be tested to ensure sufficient infiltration rates on a regular basis. Additionally, base material may need to be removed and replaced every several years based upon the material manufacturer's specifications.

Delivery and Conveyance

Water conveyance measures in the hardscape may support the treatment BMPs outlined above. By daylighting stormwater flow, these measures draw attention to water movement and can in turn highlight bioretention and detention BMPs. Delivery and conveyance measures do not treat stormwater for quality and do not reduce water volume. They are therefore only recommended as supporting infrastructure, a preferable alternative to traditional piped flow.

Channels, runnels, trench drains, and constructed swales are conventional methods of conveying moderate amounts of stormwater from buildings and impervious surfaces to other drainage collection systems, streets, or planters. They are hardscape features constructed from impermeable materials.

Typically, these structures work well where there is a need for water redirection and space is limited. These hardscape methods may serve to move stormwater from the street to landscaped areas. Channels and constructed swales are not used for stormwater treatment but serve as day-lighted, visible conveyance features in lieu of closed pipe systems. They provide opportunities to acknowledge natural drainage processes with artistic design features along the drainage path.

A variety of materials can be used for channels, runnels, and constructed swales: stone, brick, pebbles, pavers, and concrete. Rock swales can be created by arranging stones loosely and mortaring them in place. When a closed top is required, grates can be constructed; proprietary products in standard sizes are readily available. Decorative grates are aesthetic and help illustrate water flow processes.

Because these structures are gravity fed, they require slopes to function properly. On slopes greater than 6 percent, check dams or other velocity reduction devices should be provided.
These conveyance features may direct sheet flow to bioretention or infiltration features or simply serve as an alternative to piped flow in conventional drainage systems. Dimensions should be determined based on the design storm.

Channels. Channels have vertical sides and provide a drainage path to a downstream stormwater management feature. Channels vary in depth depending on the amount of flow they are designed to carry, have a sloped bottom, and can be covered or open. In some cases, channels can be constructed with pervious bottoms. Channels can be placed in plazas, driveways, and other hardscapes where conveyance is needed. Channels may be used in some situations where swales or pipes would be too costly or impossible due to site constraints. In broad landscape contexts, channels can be large and constructed to carry large volumes of water.

Runnels. Runnels are shallower than channels, typically only a couple of inches deep, and are designed to carry small flows of stormwater. Runnels may have an open top but must be covered if they cross pedestrian walkways. Most often runnels are used to convey runoff from hardscapes to adjacent stormwater treatment landscapes. Runnels may be very useful in pedestrian hardscape areas where artistic construction is highly visible. The location and design of runnels should be carefully selected so that they do not pose tripping hazards.

Trench drains. Trench drains are a type of conveyance system similar to runnels. Trench drains differ from runnels in that they are usually smaller and have a grated top. They also have solid sides and bottoms. Trench drains are available in standard sizes and dimensions from a variety of manufacturers.

Constructed swales. Swales are similar to the swales discussed earlier but are constructed from impervious materials. They typically are long narrow depressions used to convey water. The size of a swale should be determined by the design storm and landscape features.

GUIDELINES
Access*.* All conveyance structures, both open and covered, need to meet accessibility guidelines when in the path of travel. Boardwalks can cover large swales, or decorative grates can be used over smaller widths.

Design. Channels, runnels, and constructed swales should be designed to meet the local agency design storm requirements. Overflow features may be required in some areas and should drain to the nearest gutter or other drainage feature, always draining away from adjacent properties. These features should be designed to allow debris to move through them and account for stoppages that could limit the drainage capacity.

Maintenance. Maintaining a clear conduit is essential for the proper functioning of conveyance structures. These features should be cleaned before the rainy season and checked before and after storm events. Trash, cigarette butts, soil sediment, and leaf litter all can contribute to failure and decrease the function of these features.

STORM DRAIN INLET PROTECTION: RETROFITTING EXISTING STORM DRAINS

Existing storm drain systems may be retrofitted to improve stormwater quality without costly capital improvements. The BMPs described below can be used with existing conventional piped storm drain systems to address water quality but not water volume concerns. The measures described below are designed to prevent particulates, debris, metals, and petroleum-based materials conveyed by stormwater from entering the storm drain system. All storm drain protection units should have an overflow system that allows the storm drain to remain functional if the filtration system becomes clogged during rainstorms.

Maintenance. Typical maintenance of catch basins includes scheduled trash removal if a screen or other debris capturing device is used. Street sweeping should be performed by vacuum sweepers with occasional weed and large debris removal. Maintenance should include keeping a log of the amount of sediment and amount and types of debris collected. Some local jurisdictions have incorporated the use of GIS systems to track sediment collection and to optimize future catch basin cleaning efforts. Bulb-outs should be designed with two return curves with a radius of over 10 feet to allow street sweepers to clean the corners.

All inlet tools located in the pedestrian access route should conform to ADA requirements.

STORM DRAIN INLET SCREENS

Design. Inlet screens are designed to prevent large litter and trash from entering the storm drain system while allowing smaller particles to pass through. The screens function as the first preventive measure in removing pollutants from the storm water system. Storm drain inlet screens can be designed and fabricated on an as-needed basis; proprietary screens are readily available for standard size inlets.

Placement. Inlet screens are external units mounted on existing curb side storm drain catch basins. The unit captures bigger particles and allows the storm water and small particles to pass through. The screen can be mounted on hinges to create a bypass if the screen is clogged during a storm.

A wide range of storm drain inlet screens is available. The city's street sweeping department should be consulted to ensure compliance with local specifications and to schedule regular maintenance. Annual inspection of the screen is recommended to ensure functionality.

The inlet protection should be designed to protect curbside catch basins or inlets within the travel way. Inlet inserts contain filter cartridges that can be easily replaced. Inlet inserts should be sized to capture all debris and should therefore be selected to match the specific size and shape of each catch basin and inlet.

The inlet protection can be installed on the existing wall of the catch basin. It can be placed on the curb side wall of catch basins so that during storm events water can overflow around the unit.

Maintenance should be taken into account—systems with lower maintenance requirements are preferred.

STORM DRAIN PIPE FILTER

Design. The storm drain outlet pipe protection or filter is designed to be installed on an existing outlet pipe or at the bottom of an existing catch basin with an overflow. This filter removes debris, particulates, and other pollutants from stormwater as it leaves the storm drain system. This BMP is less desirable than a protection system that prevents debris from entering the storm drain system because the system may become clogged with debris.

Placement. Outlet pipe filters can be placed on existing curbside catch basins and flush grate openings. Regular maintenance is required and inspection should be performed rigorously. Because this filter is located at the outlet of a storm drain system, clogging with debris is not as apparent as with filters at street level. This BMP may be used as a supplemental filter with an inlet screen or inlet insert unit.

URBAN FORESTRY

The urban forest includes all trees, shrubs, and other understory plantings on both public and private lands. Street trees and landscaping are essential parts of the urban forest, as they contribute positively to the urban environment—to climate control, stormwater collection, removal of quantities of ozone and particulate matter and the comfort and safety of people who live or travel along the street. A street, lined with trees and other plantings, looks and feels narrower and more enclosed, which encourages drivers to slow down and to pay more attention to their surroundings. Trees provide a physical and a psychological barrier between pedestrians and motorized traffic, increasing safety as well as making walking more enjoyable.

A healthy urban forest is also a powerful stormwater management tool. Leaves and branches catch and slow rain as it falls, helping it to soak into the ground. The plants themselves take up and store large quantities of water that would otherwise contribute to surface runoff. Part of this moisture is then returned to the air through evaporation to further cool the city.

As an important element along sidewalks, street trees must be provided with conditions that allow them to thrive, including adequate uncompacted soil, water, and air. This section provides guidance for appropriate conditions and selecting, planting, and caring for street trees, as well as for other landscaping along streets.

Street Trees

Goals and Benefits. The goal of adding street trees is to increase the canopy cover of the street, the percentage of its surface either covered by or shaded by vegetation, not simply to increase the overall number of trees. The selection, placement, and management of all elements in the street should enhance the longevity of a city's street trees and healthy, mature plantings should be retained and protected whenever possible. To achieve such, it is important to engage the horticultural expertise from the initial stages of planning, as opposed to considering landscape last as an 'add-on'.

Street trees purify and cool the air, reduce stormwater runoff, and conserve energy. Additional related benefits of street trees include increased property values, neighborhood beautification, and enhanced human health and well-being. According to www.rootfortrees.org, street tree benefits are directly related to tree size. The environmental benefits of trees arise from respiration and transpiration, which are the biological processes by which trees breathe and absorb water from the environment. Because these processes involve interactions between a tree's leaves, the environment, and the atmosphere, the benefits increase as trees grow in size.

A large tree will yield $48 to $62 in average annual net benefits over 40 years with costs factored in (McPherson, G. et al*, "*Tree Guidelines for San Joaquin Valley Communities," Western Center for Urban Forest Research and Education, USDA Forest Service, 1999). Adding street trees provides the following benefits:

- Creates shade to lower temperatures in a city, reduces energy use, and makes the street a more pleasant place in which to walk and spend time
- Slows and captures rainwater, helping it soak into the ground to restore local hydrologic functions and aquifers
- Improves air quality by cooling air, producing oxygen, and absorbing and storing carbon in woody plant tissues
- Increases property values and sales revenues for existing businesses
- Enhances local neighborhood and cultural identity through specific plant forms and materials, the act of planting and sharing food crops, or by creating sheltering spaces for social interaction
- Enhances safety and personal security on a street by calming traffic and by fostering a denser and more consistent human presence, also referred to as eyes on the street
- Provides cover, food, and nesting sites for indigenous wildlife as well as facilitates habitat connectivity

Principles. The following principles influence the selection of street trees and landscaping design:

- Seek out and reclaim space for trees. Streets have a surprising number of residual or left-over spaces between areas required for travel lanes and parking, once they are examined from this perspective. Traffic circles, medians, channelization islands, and curb extensions can provide space for trees and landscaping.
- Create optimum conditions for growth. Space for roots and above ground growth is the main constraint to the urban forest achieving its highest potential. Typically, a 6 to 8-foot wide, continuous sidewalk furniture zone must be provided, with uncompacted soil to a minimum of a 3-foot depth. If space for trees is constrained, provisions should be made to connect these smaller areas below the surface to form larger effective areas for the movement of air, root systems, and water through the soil.
- Select the right tree for the space. In choosing a street tree, consider what canopy, form, and height will maximize benefits over the course of its life. Provide necessary clearances below overhead high-intensity electrical transmission lines and prevent limbs from overhanging potentially sensitive structures such as flat roofs. In commercial areas where the visibility of façade-mounted signs is a concern, choose species whose mature canopy allows for visibility. Require detailed, multi-year pruning and shape-training plan to achieve and maintain a lowest branch height of at least 12’-14’above ground. Select trees with non-aggressive root systems to avoid damaging paving and sidewalks.
- Start with good nursery stock and train it well. When installing plant material, choose plants that have complete single leaders and are in good "form," and check that boxed

trees are not root bound. Proper watering and pruning every three to four years will allow trees to mature and thrive for many years of service.
- Do not subject plants to concentrated levels of pollutants. Trees and other plants should be integrated within streetwater management practices whenever possible, but filtering of pollutants from "first flush" rain falls and street runoff will extend the life of trees and prevent toxic buildup of street pollutants in tree wells.

Climate and Soil. Selecting trees that are adapted to a site's climate and local rain cycles can create a more sustainable urban forest. The urban environment is harsh for many plants. Often plants native to an area are best adapted to that area's climate. Select plants that can tolerate the environmental elements, such as radiant heat from the sidewalk or street surface or 50 to 60 mph winds from passing traffic.

Urban soils have become highly compacted through construction activities and the passage of vehicle and even foot traffic. Compaction reduces the soil's capacity to hold and absorb water. Plants need healthy soil, air, and water to thrive.

Using planters in the urban forest can increase the biomass and canopy cover, but these plants and trees are still compromised and confined. At its bottom and sides a barrier will exist as the prepared area meets the surrounding compacted soils. Covering the soil surface with some form of mulch can help as the shade, cooling, and retained moisture that mulch provides help support the biological activities close to the soil's surface. These activities open the pore structure of the soil over time, help keep it open, and cushion the impact of foot traffic. This process works better if the mulch material is organic, as opposed to stones. If planters have limited resources for soil preparation they should have an extensive covering of mulch.

The generalized soil types map for a city can be used as a starting point when planning projects, but then the basic soil classifications should be identified on-site, especially when confronted by planting sites at the extreme ends of the spectrum: very fast-draining, nutrient-poor sands and dense, often nutrient-rich but oxygen-starved poorly drained clays.

Planting Sites. Traditionally, trees have been squeezed into whatever limited space is easily found, but this does not work well for either the tree or the street. The following guidelines provide recommended planting areas:

City of Coral Gables, Florida

- Establish and maintain 6 to 8-foot wide sidewalk furniture zones where possible. Many large trees need up to 12 feet in width, and are not suitable for placement in narrower furniture zones. In residential areas, sidewalk furniture zones within the root zone should be unpaved and planted/surfaced with low groundcover, mulch, or stabilized decomposed granite where these can be maintained. Where maintenance of such extensive sidewalk furniture zones is not feasible, provide 12-foot long tree wells with true permeable pavers (standard interlocking pavers are not permeable).
- If the above conditions are not feasible, provide for the tree's root system an adequate volume of uncompacted soil or structural or gap-graded soil (angular rock with soil-filled gaps) to a depth of 3 feet under the entire sidewalk (in the furniture, frontage, and pedestrian sidewalk zones).
- Spacing between trees will vary with species and site conditions. The spacing should be 10 percent less than the mature canopy spread. Closer spacing of large canopy trees is encouraged to create a lacing of canopy, as trees in groups or groves can create a more favorable microclimate for tree growth and better withstand violent storms than is experienced by isolated trees exposed to heat and wind desiccation from all sides. On residential streets where lots are 40 or 50 feet wide, plant one tree minimum per lot between driveways. Where constraints prevent an even spacing of trees, it is preferable to place a tree slightly off the desired rhythm than to leave a gap in the pattern.

- Planting sites should be graded, but not overly compact, so that the soil surface slopes downward toward the center, forming a shallow swale to collect water. The crown of the tree should remain 2 inches above finished grade and not be in the center of a swale, but off to the side. The finished soil elevation after planting is held below that of the surrounding paving so 2 to 3 inches of mulch can be added. The mulch layer must be replenished as needed to maintain a nearly continuous level surface adjacent to paving.
- Generally, tree grates and guards are best used along streets with heavy pedestrian traffic. Along streets without heavy foot traffic and in less urban environments, use mulch in lieu of tree grates.

Species Selection. The following are guidelines for selection:

- Select trees with non-aggressive root systems to avoid damaging paving and sidewalks.
- In general, street trees should be a type that will achieve a height and spread of 50 feet on residential streets and 40 feet on commercial streets within 10 years of planting to provide reasonable benefits. Typically, trees on commercial streets will not achieve the same scale as they will on residential streets where greater effective root zone volumes may be achieved. On commercial streets with existing multi-story buildings and narrow sidewalks, select trees with a narrower canopy than can be accommodated on the limited sidewalk width.
- Local jurisdictions should establish a list of recommended tree species for use in the public street rights-of-way. In City of Fort Myers, drought-tolerant native trees with large canopies should be utilized where possible. Coordination with the University of Florida Institute of Food and Agricultural Sciences (IFAS) Extension Service (UF-IFAS Lee County Extension Office) should be conducted. For example, large trees may include palms, live oaks, gumbo limbo, mahogany, and paradise tree. Medium trees may include satin leaf, pigeon plum, bay cedar, Geiger, and red maple. (Note that dry weather runoff should not be directed to oaks and other trees that are not tolerant of dry season irrigation.) On commercial streets with ground-floor retail, deciduous trees with a strong central leader are desirable as they grow rapidly above the ground floor business signs. A city's list of recommended tree species should specify minimum planting site widths for each and which trees may be planted below utility lines. Where there are overhead power lines that are less than 50 feet above grade, braided insulated electrical wire should be used so that trees do not have to be pruned to avoid the electrical lines. If braided insulated electrical wire cannot be provided, appropriate trees that will not grow tall enough to reach the power lines should be specified and planted.
- Trees that are part of stormwater management practices must be species that respond well to the extremes of periodic inundation and dry conditions found in water catchment areas. Design of all planting areas should include provisions for improved stormwater detention and infiltration.

- Consistent use of a single species helps reinforce the character of a street or district, but a diversity of species may help the urban canopy resist disease or insect infestations. New plantings added to streets with existing trees should be selected with the aim of meeting the same watering requirements and creating visual harmony with existing trees and plantings. Native species should be considered for inclusion whenever possible, but consideration should be first given to a species' adaptability to urban conditions.
- Consider deciduous species where their ability to allow sunlight to penetrate into otherwise shaded areas (such as south facing windows of adjoining buildings) during the winter months will be a plus.

Tree Spacing and Other Considerations. See Chapter 4, "Travel Way Design," for an understanding of how to take intersection sight distance into account when designing intersections. Many jurisdictions have tree spacing requirements at intersections, which typically vary from 30 to 45 feet, to provide visibility at corners. But as discussed in Chapter 4, this distance can often be reduced with no compromise in safety in slow speed environments.

The following should be considered when providing trees in an urban setting:

- Most jurisdictions have spacing requirements between trees and street lights (typically about 30 feet high), which typically vary from 10 to 20 feet. The smaller setback provides greater flexibility in tree spacing and allows for a more complete tree canopy.
- Pedestrian lights, which are about 12 feet tall, generally do not conflict with the tree canopy, so spacing is less rigid. Some jurisdictions still require wide clearance for their convenience in maintaining the lights, but this wide spacing greatly reduces tree canopy and is therefore discouraged. Spacing of 10 feet away from trees is generally adequate.
- An 8-foot minimum clearance must be maintained between accessible parking spaces and trees.
- Trees may be planted as close as 6 feet from bus shelters, where they provide welcoming shade at transit stops.
- Adequate clear space should be provided between trees and awnings, canopies, balconies, and signs so they will not come into conflict through normal growth or require excessive pruning to remediate such conflicts.
- Trees may be planted in medians that are 4 feet or wider, but must have an adequate clear height between the surface of the median and the lowest branches so that pedestrians can be seen. Where trees hang over the street, the clear height should be 14 feet.

Understory Landscaping

Understory landscaping refers to landscape elements beneath the tree canopy in areas within the public right-of-way not required for vehicular or pedestrian movement, including medians, curb extensions, furniture, and frontage zones

Benefits. Understory landscaping:

- Complements and supports street trees, in particular by providing uncompacted, permeable areas that accommodate roots and provide air, water, and nutrients.
- Reduces impervious area and surface runoff.
- Treats stormwater, improving water quality.
- Provides infiltration and groundwater recharge.
- Provides habitat.
- Reduces the perceived width of the street by breaking up wide expanses of paving, particularly when the understory is in medians and sidewalk furniture zones.
- Contributes to traffic calming.
- Provides a buffer between the walkway zone and the street, contributing to pedestrian comfort.
- Improves the curb appeal of properties along the street, potentially increasing their value.
- Enhances the visual quality of the community.

Principles. The following are the principles of understory landscaping:

- Trees take precedence. The understory landscape should support them. It should not compete with them.
- Only pave where necessary. Keep as much of the right-of-way unpaved and planted as possible to maximize benefits.
- Design understory areas to infiltrate water.
- The entire understory area does not have to be covered with plants. Composted mulch is a good groundcover; top of mulch should be below adjoining hardscape so that runoff will flow into planning areas.
- Make the understory sustainable: use drought-tolerant plants.
- Replenish the soil with compost.
- Design the understory to contribute to the sense of place.

Soil. Provide good quality, uncompacted, permeable soil. Soil analyses should address the concentration of elements that may affect plant growth, such as pH, salinity, infiltration rate, etc. Remove and replace or amend soil as needed. Good preparation saves money in the long run because it reduces the need to replace plants, lowers water consumption, and reduces fertilizer applications.

Plants. Plant with species that:

- Do not require mowing/trimming more frequently than once every few months
- Are drought tolerant and can survive with minimal irrigation upon establishment
- Do not exceed a height of 2 feet within 5 feet of a driveway/curb cut and within 20 feet of a crosswalk, and, excluding trees, 3 feet elsewhere
- Do not have thorns or sharp edges adjacent to any walkway or curb
- Are located at least 4 feet from any tree trunk

Design. Generally, understory landscaped areas should be as wide as possible where there are trees: when feasible, at least 6 to 9 feet wide for parkways and 8 to 12 feet wide for medians. However, many existing parkways and medians are less wide. Narrower parkways can support understory plants and some tree species. A path or multiple paths should be added as needed across a parkway as a means of access from the curb to the sidewalk. For example, where there are striped curbside parking spaces, a path across the parkway should be provided at every one or two parking spaces.

STREET FURNISHINGS

Street furnishings in the street environment add vitality to the pedestrian experience and recognize the importance of the pedestrian to the fabric of a vibrant urban environment. Street furnishings encourage use of the street by pedestrians and provide a more comfortable environment for non-motorized travel. They provide a functional service to the user and provide uniformity to the urban design. Street furnishings include benches and seating, bollards, flower stands, kiosks, news racks, public art, sidewalk restrooms, signs, refuse receptacles, parking meters, and other elements.

Street furnishings achieve improved vitality in many ways:

- They make walking, bicycling, and public transit more inviting.
- They improve the street economy and common city prosperity.
- They enhance public space and create a place for social interaction.

Placement. Placement of street furnishings should be provided where pedestrians may gather or linger and enjoy the public space, such as on streets with pedestrian-oriented destinations and places of concentration of pedestrian activity, (nodes, gathering areas).

Site furnishing placement should follow these criteria :

- Street furnishings are secondary to the layout of street trees and light standards as street trees and light standards develop a street rhythm and pattern. Site furnishing should be placed in relation to these elements sensitive to the vehicular flow and pedestrian use of these elements. Careful consideration to the placement provides ease of recognition and use.
- In addition to the guidelines provided for each element, placement should adhere to the minimum spacing**.**

Table 11.2 Site Furnishing Minimum Setbacks

Location	Setback
Face of Curb	18”
Driveway	2’
Wheelchair Ramp	2’
Ramp Landing	2’
Fire Hydrant	2’
Stand Pipe	2’
Transit Shelter	4’

- All site furnishing must be accessible per Public Rights-of-Way Accessibility Guidelines (PROWAG) and other city regulations.
- Local jurisdictions should strive to include sustainable materials for street furnishings.

Benches and Seating

Public seating provides a comfortable, utilitarian, and active environment where people can rest, socialize, or read in a public space. The proper placement

First Street Bench- (Credit: Henry Bley)

Seating arrangements should be located and configured according to the following guidelines:

- Seating should be located in a shaded area under trees.
- Seating should be oriented toward points of interest; this can be the adjacent building, an open space, or the street itself if it's lively. Where sidewalk width permits, seating can also be oriented perpendicular to the curb.
- Informal seating opportunities, incorporated into the adjacent building architecture, may be used as an alternative to free-standing benches. Low planter walls can be used as informal seating areas.

Benches and seating should be made of durable high-quality materials. Seating opportunities should be integrated with other streetscape elements, and the seating design should complement and visually reinforce the design of the streetscape.

BOLLARDS

Bollards are primarily safety elements to separate pedestrians or other non-motorized traffic from vehicles. Thoughtful design and/or location of bollards can add interest, visually strengthen street character, and define pedestrian spaces.

Edwards Drive Parking Bollard, (Credit: Henry Bley)

Bollards are used to prevent vehicle access on sidewalks, or on other areas closed to motor vehicles. Removable bollards should be placed at entrances to permanent or temporary street closures. Care must be used in placing bollards so as not unintentionally impose dangers to cyclists.

Bollards range in size from 4 to 10 inches in diameter. Bollards should have articulated sides and tops to provide distinct design details. The details should be coordinated with other street elements of similar architectural character.

Removable bollards should be designed with a sturdy pipe projecting from the bottom of the exposed bollard. Removable bollards should appear permanent. Electrically controlled mechanisms retract the bollard into a void below the surrounding finish surface. This allows emergency vehicle access to closed streets.

Street Vendor Stands

Street vendor stands, such as flower, magazine, and food vendor stands, rely on regular pedestrian traffic to sustain their business. To maximize efficiency, the stands operate during daytime work hours and cater to those commuting to/from employment areas. In areas with a vibrant evening environment, stands may have evening hours to benefit from the extended period of exposure to pedestrian traffic.

Centennial Park Market Street Vendor Sign,
(Credit: Henry Bley)

Generally, street vendor stands should either be located outside the street right-of-way or in the sidewalk, furniture,

The design of the street vendor stands should have details and features coordinated with other street elements. These details should be of a similar architectural character. The stands should allow a minimum of 6 feet of clear pedestrian passage between the edge of the display area and other elements.

INFORMATIONAL KIOSKS

Kiosks in public areas provide valuable information, such as maps, bulletin boards, and community announcements. Kiosks can often be combined with gateway signs and are an attractive and useful street feature.

De Leon Information Fountain- (Credit: Henry Bley)

Placement. Kiosks may be located in any of the following areas:

- The sidewalk, furniture, or frontage zones
- Curb extensions
- Where parking is not allowed
- Close to, but not within transit stops

Kiosks should not block scenic views but should enhance the area as a street feature.

Design. Kiosks should be designed to the following guidelines:

- Kiosks should include bulletin boards or an enclosed case for display of information.
- As a gateway element, the kiosk should include the neighborhood, commercial district, street, or park name; a map; or other information.
- Kiosks should have details and features coordinated with other street elements and should have a similar architectural character.

News Racks

News rack placement is subject to municipal guidelines. In addition, the following guidelines should be considered:

- News racks located within the furniture or frontage zones should not reduce the minimum width of the sidewalk pedestrian zone with news rack doors open.

- News racks should be placed no closer than 2 feet from adjacent street signs and 4 feet from bike racks.

News racks should visually blend with their surroundings and complement the architectural character. Multiple news racks should be consolidated into a standard decorative stand.

Parking Meters

Parking meters can be either traditional single-space meters or consolidated multi-space meters (parking stations).

Multi-space meters are preferred over single-space meters. Multi-space meters should be placed every 8 to 10 parking spaces and spaced approximately 150 to 200 feet apart. Signs should clearly direct patrons to the meter. The signs should be spaced at approximately 100 feet on-center.

Parking Meter
(Credit: Henry Bley)

Parking meters should be placed in the sidewalk furniture zone. Single-space meters should be placed at the front end of the individual stalls.

Municipalities should encourage the conversion of single-space meters to multi-space units to reduce visual clutter from the urban landscape. The multispace units should be selected to minimize their impact on the pedestrian zone.

Signs

Streetscape signs provide information specific to direction, destination, or location. The sign plans should be developed individually for each neighborhood or district. Streetscape signs are most appropriate for downtown, commercial, or tourist-oriented locations or around large institutions.
Streetscape signs include parking, directional, and wayfinding signs.

Street Sign- (Credit: Henry Bley)

Streetscape signs should be kept to a minimum and placed strategically. They should align with the existing street furnishings and be placed in the sidewalk furniture zone.

The sign design should be attractively clean and simple and complement the architectural character of other street furnishings.

Refuse Receptacles

Refuse receptacles should accept both trash and recyclables. Where there is a demand, different receptacles should be provided for different recyclable materials.

Refuse receptacle- (Credit: Henry Bley)

Refuse receptacles should be located:

- Near high activity generators such as major civic and commercial destinations
- At transit stops
- Near street corners but outside of the sidewalk pedestrian zone

There should be a maximum of one refuse receptacle every 200 feet along commercial streets and a maximum of four refuse receptacles at an intersection (one per corner).

PUBLIC ART

On a large scale, public art can unify a district with a theme or identify a neighborhood gateway. At a pedestrian scale, public art adds visual interest to the street experience.

Location. Public art can be situated in a variety of areas and locations, including streets, public spaces with concentrations of pedestrians, or areas of little pedestrian traffic, to create a unique space for discovery.

Edwards Drive-Park Art "Uncommon Friends," (Credit :Henry Bley)

Design. Public art should be considered during the planning and design phase of development to more closely integrate art with other streetscape elements, taking into account the following:

- Public art is a pedestrian amenity and should be presented in an area suited for pedestrian viewing. The piece should be placed as a focal element in a park or plaza, or situated along a pedestrian path and discovered by the traveler.
- Public art can be incorporated into standard street elements (light standards, benches, trash receptacles, utility boxes).
- Public art can provide information such as maps, and signs or educational information with history and culture. All installations do not need to have an educational mission; art can be playful.
- Public art should be accessible to persons with disabilities and placement must not compromise the sidewalk pedestrian zone.

Sidewalk Dining

Outdoor café and restaurant seating adjacent to the sidewalk activates the street environment and encourages economic development.

First Street – Outdoor café seating: Ford's Garage, (Credit: Henry Bley)

Location. Tables and chairs are to be placed on the sidewalk directly at the front of the restaurant and allowed in the frontage zone or furniture zone of the sidewalk where sufficient width is available.

Design. Placement of tables and chairs must include diverters (barriers) at the end of the dining area to guide pedestrians away from the accepted area of sidewalk. Since the public purpose of allowing restaurants to have dining on the sidewalk is to stimulate activity on the street, municipalities should prohibit restaurants from fully enclosing the dining area.

OTHER STREETSCAPE FEATURES

Other features that enhance the pedestrian experience include clocks, towers, and fountains, which strengthen the sense of place and invite pedestrians to come enjoy.

Patio De Leon- Streetscape Fixtures (Credit: Henry Bley)

UTILITIES

The location of underground and aboveground utilities must be considered when planning new landscaped areas in the right-of-way. Each jurisdiction should establish guidelines to organize and standardize utility location and to minimize conflicts between landscaping and utilities based on input from all affected departments and agencies.

The majority of underground utilities, including sanitary sewers and storm drains, and water, gas, and electrical mains, are typically located under the roadway. Sanitary sewers are often in the center of the street directly under the potential location of a landscaped median. They are usually relatively deep. In general, if they have at least 4 or 5 feet of cover, they should not be affected by the introduction of a landscaped median. The other utilities within the roadway are typically located closer to the curbs.

Telecommunications, street lighting conduit, traffic signal conduit, and fiber optic conduit are often located under the sidewalk. Lateral lines extend from the utility mains in the public rights-of-way to serve adjacent properties.

GUIDELINES

Benefits of well-organized utility design/placement include:

- Reduced clutter in the streetscape;
- Increased opportunity for planting areas and for soil volume to support tree growth and stormwater infiltration;
- Reduced maintenance conflicts; and,
- Improved pedestrian safety and visual quality.

Location. Utilities should be placed to minimize disruption to pedestrian travel and to avoid ideal locations for directing stormwater, planting trees and other vegetation, and siting street furniture, while maintaining necessary access to the utilities for maintenance and emergencies.

Utilities within 10 feet of where a landscaped median may be located should have at least 5 feet of cover.

Placement. Utility main lines that run laterally under the sidewalk should be located in a predetermined zone to minimize conflicts with tree roots and planting areas. The ideal location to minimize conflicts with trees would be under the pedestrian or frontage zones, although the more practical location is often under the furniture zone. Stacking dry utilities (telephone, CATV, electric, etc.) in the pedestrian or frontage zones will further reduce conflicts with the landscaped area.

ROADWAY/PARKING LANE

Large utility vaults and conduits running the length of a city block may be located in the roadway or parking lane where access requirements allow. Vaults in the parking lane may be located in short-term parking zones or in front of driveways to facilitate access.

Each jurisdiction typically has specific design standards for vaults and utilities based on expected use and vehicle type. They can also be placed in midblock curb extensions.

FURNITURE ZONE

Small utility vaults, such as residential water vaults, residential water meters, gas valves, gas vaults, or street lighting access, should be located in the sidewalk furniture zone at the back of the curb wherever possible to minimize conflicts with existing or potential tree locations and landscaped areas. Vaults should be aligned or clustered wherever possible.

Generally, utility boxes are sited in the direction of the pipe. Utility boxes that are parallel with the curb should be located in the sidewalk furniture zone when possible. Vaults perpendicular to the curb should be located between existing or potential street trees or sidewalk landscape locations (for example, in walkways through the sidewalk furniture zone to parked cars.)

Utility laterals should not run directly under landscaped areas in the furniture zone, but instead under driveways and walkways wherever possible.

SIDEWALK PEDESTRIAN ZONE

Flush utility vaults and conduits running the length of the city block may be located in the pedestrian zone. Vaults in the pedestrian zone should have slip-resistant covers. Large flush utility vaults should be placed at least 3 feet from the building and 4 feet from the curb where sidewalk widths allow.

Surface-mounted utilities should not be located in the pedestrian zone.

SIDEWALK FRONTAGE ZONE

Utility vaults and valves may be placed in the frontage zone. Placement of utility structures in this zone is preferred only when incorporating utility vaults into the furniture zone is not feasible.

Utility vaults in the frontage zone should not be located directly in front of building entrances. Existing vaults located in the center accessible portion of a ramp should be moved or modified to meet accessibility requirements, as feasible, as part of utility upgrades.

Catch basins and surface flow lines associated with storm drainage systems should be located away from the crosswalk or between curb ramps. Catch basins should be located upstream of curb ramps to prevent ponding at the bottom of the ramp.

CONSOLIDATION

Utilities should be consolidated for efficiencies and to minimize disruption to the streetscape. Dry utility lines and conduits, (telephone, CATV, electric, gas, etc.), should be initially aligned, rearranged, or vertically stacked to minimize utility zones.

Wherever possible, utility conduits, valves, and vaults (e.g., electrical, street lighting, and traffic signals) should be consolidated if multiple lines exist within a single street or sidewalk section. Dry utilities (gas, telephone, CATV, primary and secondary electric, streetlights) may use shared vaults wherever possible. San Francisco has proposed shared vaults with predetermined color coded conduits per predetermined city standards.

Street lighting, traffic signal, and light rail or streetcar catenary poles should share poles wherever possible. When retrofitting existing streets or creating new streets, pursue opportunities to combine these poles.

OTHER DESIGN GUIDELINES

Street design and new development should consider the overall pattern of plantings, lighting, and furnishings when placing new utilities in the street, and locate utility lines so as to minimize disruption to the prevailing streetscape rhythms.

Utilities should be located underground wherever possible, as opposed to overhead or surface-mounted. New utility installations should employ the latest sensor technologies to limit future digging. Overhead utilities should be located in alleys where possible. New utilities should use durable pipe materials that are resistant to damage by tree roots and have minimal joints. Trenchless technologies, such as moling and tunneling, should be used wherever possible to avoid excavation and disruption of streetscape elements.

New infrastructure projects should use resource-efficient utility materials. Re-used or recyclable materials should be incorporated wherever possible.

Tree removal or truncation of tree roots within the canopy zone should be avoided and minimized during the routing of large-scale utility undergrounding projects. Any utility-related roadway or sidewalk work should replace paving material in kind (e.g., brick for brick) where removed during maintenance, or replace with new upgraded paving materials.

Utility boxes may be painted as part of a public art program.

NEW DEVELOPMENT AND MAJOR REDEVELOPMENT

Alleys for vehicle, utility, and service access should be incorporated to enable a more consistent streetscape and minimize above-ground utilities. New utilities should be located to minimize disruption to streetscape elements per guidelines in this section.

ABANDONMENT

Currently abandoned dry conduits should be reused or consolidated if duplicate lines are discovered during street improvement projects. Utilities should be contacted for rerouting or consolidation. Where it is not possible to reuse abandoned mains, conduits, manholes, laterals, valves, etc., they should be removed per agency recommendations when possible to minimize future conflicts.

Abandoned water and sewer lines may be retrofitted as dry utility conduits where available or if possible to minimize the need for future conduit installations.

PROCESS

Utility installation and repair should be coordinated with planned street reconstruction or major streetscape improvements. New development should submit utility plans with initial development proposals so that utilities may be sited to minimize interference with potential locations for streetscape elements. Utility work also offers opportunities to make other changes to the street after the work is completed and should be coordinated with planned improvements to avoid duplication of efforts or making new cuts in new pavement. Examples of improvements to streets that can be done at low cost after utility work include restriping for bike lanes if utility work requires total street repaving, as well as building sidewalks in conjunction with utility work occurring outside the traveled way.

LIGHTING

Lighting provides essential nighttime illumination to support pedestrian activity and safety as well as vehicle safety. Well-designed street lighting enhances the public realm while providing safety and security on roadways, bike paths, and lanes as well as pedestrian paths including sidewalks, paths, alleys, and stairways.

Historically significant street light poles and fixtures should be maintained and upgraded where appropriate.

Dean Street- Street Lighting

LIGHT POLES AND FIXTURES

Pedestrian lighting should be coordinated with building and property owners to provide lighting attached to buildings for sidewalks, alleys, pedestrian paths, and stairways where separate lighting poles are not feasible or appropriate.

The design should relate and be coordinated with the design per the City of Fort Myers *Standard Details and Specifications.*

ADDITIONAL SELECT RESOURCES

Lancaster, B. Rainwater Harvesting for Drylands and Beyond,
http://www.harvestingrainwater.com/

Landscape Architecture Foundation's Landscape Performance Series,
www.lafoundation.org/lps

12. RE-PLACING STREETS: PUTTING THE PLACE BACK IN STREETS

INTRODUCTION

Most American cities have come to view streets primarily as conduits for moving vehicles from one place to another; from point A to point B is the common expression. While moving vehicles is one of their purposes, streets are spaces, even destinations in and of themselves; as such, they need to convey all modes of transportation in a safe and comfortable manner. Conceiving of a street as a public space and establishing design guidelines that serve multiple social functions involves several fundamental steps. Behind them all is a redefinition of whom streets ought to serve. By approaching streets as public spaces, local jurisdictions redirect their attention from creating traffic conduits to designing a place for the people who use the street.

People put the *place* back in streets.

City of Fort Myers, Downtown

This chapter focuses on three main ways for local jurisdictions to:

1. "Re-place" their streets, *or make streets into Places***,**
2. Refocus their purpose on the people who use them, and
3. Strategize to re-place streets and maintain them.

PUBLIC SPACE AND THE NEED TO *RE-PLACE* STREETS TO MAKE THEM COMPLETE

Public spaces are the stages for our public lives. They are the places shared by all members of a community, of any size and all abilities. Quality public spaces are places where things happen and where people want to be, vital places that highlight local assets, spur rejuvenation, and serve common needs.

City of Fort Myers, Downtown

Streets comprise a large portion of publicly owned land in cities and towns, and they are a vast part of any community's public space network. Historically, streets served as meeting places, playgrounds for children, marketplaces, and hubs for activities. As populations spread out from city centers, streets lost many of those functions. Streets were instead designed and planned for one use: *mobility*. At best, streets conceived as Complete Streets address the mobility needs of all street users including pedestrians, cyclists, drivers, and transit riders. During the last century, however, automobiles have been prioritized over people as users of our streets.

As part of the public realm, successful streets have a variety of functions beyond allowing automobiles to travel rapidly. For this reason, "placemaking," or the process of creating high-quality destinations, must be at the core of the planning and design of our urban streets to meet the following challenges:

- **Population growth and urbanization**. People moving back into cities will need to be accommodated in limited space, putting greater demands on existing streets. If streets continue to largely function to move people traveling in motor vehicles, they will not be able to accommodate this growth adequately. Streets will need to enable people to do more while traveling less in motor vehicles and to travel in more efficient ways.
- **The need to maximize social and economic exchange.** Streets will need to serve the highest and best use for the land they are on, and mobility is only one among many possible uses. Streets need to be designed to maximize social value, which also spurs healthy economic exchange. In this way, streets become arteries distributing prosperity. Streets that invite social interaction are more likely to ensure healthy growth.
- **The need to reduce energy consumption and induce sustainable growth.** Streets that are places promote locality. They enable people to travel comfortably by non-motorized modes, which in turn shortens travel distance demand. With growing concerns regarding fuel resources and climate change, this shift will be critical. Because re-placed streets spur locality-serving commerce and social venues, they also set the stage for and enable healthy and environmentally sustainable practices in the surrounding built environment.
- **A desire to create public space.** Beyond being the frames for other development, streets can be public spaces themselves. Access to public space is critical to safe, healthy, and successful communities. When streets are designed as great spaces for people, they reinforce a sense of belonging and build on the strengths of the communities they host.

City of Fort Myers

PLACEMAKING FOR STREETS

In order to be *places*, streets must:

- Augment and complement surrounding destinations, including other public spaces such as parks and plazas;
- Reflect a community's identity;
- Invite physical activity through allowing and encouraging active transportation and recreation;
- Support social connectivity;
- Promote social and economic equity;
- Be as pleasant and accessible for staying as for going;
- Prioritize the slowest users over the fastest;
- And balance mobility/public space functions.

City of Fort Myers

So that people can:

- Walk and stroll in comfort;
- Sit down in nice, comfortable places, sheltered from the elements;
- Meet and talk—by chance and by design;
- Look at attractive things along the way;
- See places that are interesting;
- Feel safe in a public environment;
- Enjoy other people around them;
- And get where they need to go.

Re-placed streets must be slow streets that are inviting and filled with human activity. This is the most important distinction between streets designed for maximal car throughput and re-placed streets; it requires the necessary adjustment from car to people-focused street planning. Streets designed for fast and far movement favor people moving by motor vehicles, not people moving under their own power. Human energy limits people to slow and local movement.

Because *people*, not motors, are essential to long-term growth in places of all kinds, human-scaled streets are an inducement to healthy lifestyles and economic resilience.

New Development must meet a total Complete Streets view and image. To rework an existing street in the City under a Capital improvement project, there is the understanding that:

a. Right-of-way can be acquired at minimal cost.
b. Proper funding can be found.

Design Techniques and Goals for Re-Placed Streets

A re-placed street balances the moving and staying needs of its users and has multiple, people-serving purposes. The design techniques and goals detailed below describe how to create re-placed streets using the existing road right of way width.

As outlined in previous chapters, a total Complete Street has the following elements listed below:

1.) Wide sidewalks to accommodate multiple activities;
2.) Lighting;
3.) Design for the access of mass transit such as LEETRAN;

City of Fort Myers

4.) Opened streets to multiple activities;
5.) Encouraged active ground floor uses in adjacent buildings;

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6.) Cluster activities and amenities;
7.) Designed street elements and adjacent buildings for the human scale;
8.) Connection of both sides of the street;
9.) Shortened crossing distance;
10.) Utilization of on-site and local resources where possible,
11.) Surface area used for energy capture,

12.) Use of effective storm-water management techniques including bioswales, and rain gardens (Chapter 11),

13.) A buffer maintained between pedestrians and vehicles when there is fast moving traffic using planters, bollards, parked cars, kiosks, newsstands, public toilets, and/or lampposts, 14.) A buffer maintained between pedestrians and vehicles when there is fast moving traffic, (planters, bollards, parked cars, kiosks, newsstands, public toilets, and lampposts), Chapter 11.

15.) Use open space for community food gardens.

16.) Traffic slowed to a comfortable speed to mix with other travel modes through low speed design elements, traffic calming techniques, and shared space.

STRATEGIES TO RE-PLACE STREETS

Re-placing streets requires building streets around the existing road rights-of-way under the City's capital improvement system without acquiring additional road rights-of-way. The design under the Engineering Department of the City's Public Works Division will review and design the re-placed streets for the City.

A re-placed street will use as many features as described in this guideline as can fit in the existing rights-of-way and still function and provide proper life safety and maintainability by the City.

Establish a Maintenance and Management Plan

Great streets are well-loved and well-used. Maintenance and management is critical, because streets are not stagnant; they change daily, weekly, and seasonally. Therefore, streets must adapt and be flexible to this change. As a result, public space management will be required.

To sustain a quality street environment, the community must commit to long-term investment in the re-placed street this may mean an increase to taxes or other revenue source for the provision of extra services.

13. DESIGNING LAND USE ALONG LIVING STREETS

INTRODUCTION

Streets provide access to buildings and support the myriad land uses that comprise a community's socioeconomic environment. As discussed in Chapter 12, "Re-Placing Streets," "*placemaking"* is the practice of first, designing streets and other public spaces as an interconnected network of human-scale, "public living rooms" in which the safety and comfort of pedestrians and bicyclists are prioritized over the sole function of automobile access, and second, coordinating the character and design of neighborhoods so as to create a desired type of living environment, or "place."

Complementary land-use and street design (Credit: Dan Burden)

Successful and sustainable communities include a wide range of distinct places, or environments, from the quiet, shady residential streets to the busy neighborhood centers, and from the noisier, mixed-use "bright lights" of downtowns to the larger, single-purpose industrial centers of employment hubs. While the type of land use in such communities is an important characteristic in the design of private developments, so too are site design and building architecture to ensure that safe, functional, and esteemed places result.

This chapter provides a discussion of the ways in which the planning and designing of properties contribute to rational placemaking. The discussion includes placemaking principles that are applicable to common and unique places, design techniques applicable to basic placemaking principles, and implementation strategies for community adoption via local policies and regulations.

ESSENTIAL PRINCIPLES FOR BALANCED STREET ENVIRONMENTS

The following recommendations comprise the basic design principles applicable to street environment design:

- Urban patterns in livable, sustainable places of enduring value should generally be based on compactness, connectivity, completeness, and continuity versus the outmoded values of sprawling, disconnected, and single-use development.

- Streets are the "public living rooms" of their neighborhoods; as such, their structural framework should be designed to accommodate people in a safe, comfortable, and navigable environment.
- Streets, as mobility venues for communities, i should provide safety, convenience, and comfort for pedestrians and bicyclists.
- Streets, parks, plazas, squares, and other community places make up the network of public spaces in downtown districts; as such, their design should embrace opportunities for community members to appreciate on a daily basis, regardless of their age, income, or physical abilities.
- Street networks designed with pedestrians in mind, as described in Chapter 3, "Street Networks and Classifications," naturally form small to medium-sized blocks that allow pedestrians to comfortably walk to a range of amenities, as a pleasant and practical alternative to driving. In existing environments where such a network exists, it should be preserved, and in areas where large parcels are proposed for redeveloped, such a network should be created.
- The distribution of land uses should be designed to allow everyday destinations (e.g., schools, parks, and retail shops) to be located within a comfortable walking distance of most residences.
- Buildings should contribute to the architectural character of the streetscape, face the street with attractive entrances that welcome pedestrians, and have windows that overlook the street to create a sense of security.
- On-street parking reinforces a pattern in which visitors enter buildings from the street, and can provide an important buffer between pedestrians and moving traffic.
- The setback between buildings and the sidewalk should be designed to enhance the pedestrian experience, whether setbacks are attractive landscaped yards that provide privacy for building occupants or shopfronts at the sidewalk that display merchandise to passing pedestrians. In no cases should cars, parked or moving, be placed between the sidewalk and the buildings.


Good building setback (Credit: Ryan Snyder)

- Off-street parking and service access and their driveways should be designed to disrupt the pedestrian experience as little as possible. Whenever possible, access should be from

an alley or shared driveway off a side street and parking and garages should be located behind or beside buildings, not between the sidewalk and the building. When a driveway to the front of the lot cannot be avoided, it should be as narrow as possible.
- Off-street parking, especially surface parking, is a non-productive use, and the amount required should be reduced to the extent possible by utilizing on-street parking and by sharing off-street parking among adjacent uses. Off-street parking requires about twice the surface area per parked car of on-street parking, due to the driveways required to access the lot and aisles needed for maneuvering within the lot. This non-productive space creates dead zones and increases the distances between destinations, further reducing the attractiveness of walking.
- Whenever possible, the mix and intensity of land uses should be designed to support, and be supported by, efficient transit systems..

STREETSCAPE ENVIRONMENT TYPES

Cities, towns, neighborhoods and districts are unique. This uniqueness creates a sense of place. There are a few general types of places that repeat from community to community, within which the idealized relationship of street to adjacent land uses follows certain general guidelines. The following descriptions of archetypical environments detail concepts and strategies, not finite design solutions. Designs should be based on the best of the local and regional architectural and landscape heritage.

NEIGHBORHOODS

Neighborhoods are the main component of cities, the places where most residents live. Many of the concepts below reflect the best characteristics of neighborhoods, , based on the following concepts:

- The various residential designations within a community constitute the predominance of interconnected neighborhood land uses that should be served by convenient walking and bicycling facilities that connect other neighborhood-serving land uses, such as retail, small businesses, elementary schools, parks, and playgrounds.
- The basic neighborhood design principles for dwellings composed primarily of single family homes are the same as for neighborhoods comprised of multifamily homes.
- Neighborhood streets are the “living rooms” and “play rooms” of the community; as such, they should be designed to accommodate safety and enjoyment for pedestrians, particularly with respect to children and the elderly who are the most vulnerable pedestrians.
- Landscaping is a critical component of neighborhoods. Typically, downtown environments include sidewalks flanked by shade trees on the public side and front yards

composed of special landscape treatments on the private side. This creates a distinctive streetscape character that contrasts between public neighborhood centers and other private, mixed-use environments.

- On-street parking serves visitors and residents alike, while providing a valuable buffer between pedestrians, children at play, and passing traffic.
- Buildings should front streets with gracious front doors, overlooking the streets, with windows that provide "eyes," thereby conveying a sense of security for the street.
- Front yard designs should create spaces that promote an interact action between adult activities and children at play, and conducive of agriculture.

Streets and buildings working together create attractive neighborhoods
(Credit: Ryan Snyder)

- Home entrances should be located closer to the street than are garages, so as to emphasize the home "environment" over car storage functions, and to bring the "eyes" of the home environment closer to the street.
- Automobiles should minimize disruption of the pedestrian environment, primarily sidewalks,. Along urban corridors, this can be accomplished by providing access to parking and garages via alleys and driveways from side streets, so as to access garages located behind or beside, not in front of, the residences. When side access is not possible, access from the fronts of lots should be provided via driveways.

NEIGHBORHOOD CENTERS

Neighborhood centers take many forms and occur at varying scales, from a convenience store at a main intersection in a local neighborhood, to a busy little "Main Street" environment in a larger town or city, to a high intensity, transit-oriented center at a neighborhood edge along a major urban corridor. Regardless of the scale and character of the neighborhood center, the following set of basic design concepts can define centers that are convenient to pedestrians from adjoining neighborhoods:

Neighborhood Center (Credit: Ryan Snyder)

- Neighborhood centers, the name notwithstanding, are generally at the edges or corners of neighborhoods, facing a major street or streets that carry traffic volumes capable of supporting the businesses. An ideal arrangement is a "Main Street" that is located at the conjunction of two or more neighborhoods, making the edges of the neighborhoods into the center of the larger community, and providing a range of amenities and resources within easy walking and biking distance to the residents.
- Neighborhood centers are ideally mixed-use, providing an array of goods, services, employment, and residential options that can function both as an extension of the adjoining neighborhoods and as a convenient destination for people passing through.
- The buildings of these centers should face the primary street, creating a busy pedestrian environment that causes drivers to slow down and see what the center has to offer.
- The ground floor uses in neighborhood centers are generally commercial, providing convenient goods and services to customers; the upper floors can be residential, office, or a mix of both.
- The streetscape in neighborhood centers is usually quite formal: street trees are normally located in small planters within the sidewalk, surrounded by tree grates or very small landscaped areas, providing space for pedestrians to comfortably stroll, and for people to get in and out of cars parked curbside.
- There are many options for the design of setback areas in neighborhood centers, including courtyards with sidewalk dining, narrow landscaped zones that soften the streetscape while allowing views of the shops, and simple shopfronts built right to the sidewalk.
- Neighborhood centers can also include purely residential buildings, as long as the design of the ground floor street interface provides a degree of privacy for the residents, either by setting the building back behind a landscaped yard or raising the ground floor above the sidewalk level, or both.
- Except for the smallest centers, which might just be one corner store, neighborhood centers generally require off-street parking, which should be located behind or alongside

the buildings whenever possible, not between the sidewalk and the buildings.

- In larger neighborhood centers that require large off-street parking lots, the size of the lots can be reduced if they are shared by uses with peak parking demands in the daytime (offices) and uses with peak operations at night (e.g., dinner restaurants and residences). Reducing parking demands saves cost, creates a healthier environment, and improves the urban character of the neighborhood.

Public pavilion in a plaza overlooking the beach at a street end: Lauderdale-Bv-The-Sea

- Plazas can create vibrant urban centers. Their design should focus on proper size and scale, active uses, doors and windows fronting the plaza, trees, landscaping, public art, fountains, etc. Stages, bandstands, play fountains, and other aesthetic features liven the atmosphere of plazas.

Corridors

This section focuses on major street corridors that connect across an urban area. Corridors can have many different characters and occur at varying scales, from a rural main street stop along a highway, to a main avenue within a town, or a high intensity urban corridor in a large city. Many planning and design concepts are common to corridors at all these scales.

Mixed-use building
(Credit: Luisa Fernanda Arbelaez)

Many major street corridors began as rural roads, evolved into automobile thoroughfares lined with a range of commercial uses, however, recently have lost much of their commercial value, as retail and office uses have migrated to larger-format retail centers and business parks. Many such corridors now present a significant opportunity for communities to provide infill housing mixed with modest amounts of commercial uses within walking distance of adjoining neighborhoods. The repositioning of these often blighted "commercial strips" as more valuable mixed-use places requires a coordinated redesign of the streets and careful planning of the infill development along the corridor.

The street design principles and practices described in this manual will help create streets that do more than move cars. By using these principles and practices, undifferentiated miles of monotonous corridors can be restructured to provide the aforementioned types of neighborhood centers, interspersed with residential or office uses along the street. The core placemaking strategies found in this manual - lowing cars, planning for people, landscaping streets, providing on-street parking, and designing property setbacks to modulate privacy for residences and visibility for businesses - can transform miles of monotony into a sequence of useful places.

Below are some of the core design concepts and principles that can help to integrate land uses with such streets, and make them more coherent, human-scale places:

Blank walls and inactive uses on the ground floor make for poor pedestrian environments, (Credit: Ryan Snyder)

- The entire length of a corridor should be lined with active uses. These can include the neighborhood centers described above at appropriate nodes, multifamily housing of various types, and even single-family housing if appropriately buffered with landscaped setbacks or a multi-way boulevard. Sound walls, berms, and other forms of "pure buffer" are an admission of urban design failure, disconnecting the city rather than connecting it, and should be employed only as a last resort.
- Through a community visioning process integrated with transit planning processes and retail capacity studies, the location and size of neighborhood centers (active, mixed-use, and often transit-oriented nodes) should be established.
- Long corridors should be analyzed to define the existing or emerging character by segment, then potential nodes, centers, or destinations with more focused pedestrian activity, can be identified.
- A mix of land uses can be provided to encourage people to make trips by means other

than cars in those locations, and a network of streets to assure connections between uses, should be available.

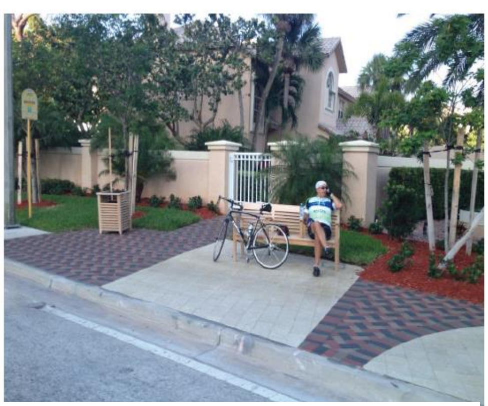
- Design standards, or guidelines for development within the segments that will remain auto-oriented, should be created so these segments can be made as pedestrian and bicycle-friendly as possible (e.g., minimizing the number of curb cut locations and widths that interrupt the sidewalk, buffering street-frontage parking so the sidewalk environment is not compromised, providing setbacks for landscaping and transit amenities wherever possible to encourage transit use).
- In close consultation with the residents of adjoining neighborhoods, the vision and standards for the design and massing of buildings in each segment of the corridor should be developed.

Urban Centers

Urban center: Vancouver, BC (Credit: Dan Burden)

Urban centers are typically the economic and social hearts of cities or towns. They can be village-scale centers in small towns, low to mid-rise downtowns in most cities, or high intensity urban centers with high-rise buildings in larger cities, where unique regional destinations are often located.

Ideally, the urban center environment is a very compact mix of a wide range of land uses, creating high land values as well as a high potential for transportation congestion. Accordingly, it is vitally important that in addition to a balanced street network for pedestrians, bikes, and cars, such places be provided with high levels of transit service. Important design concepts for urban centers include the following:

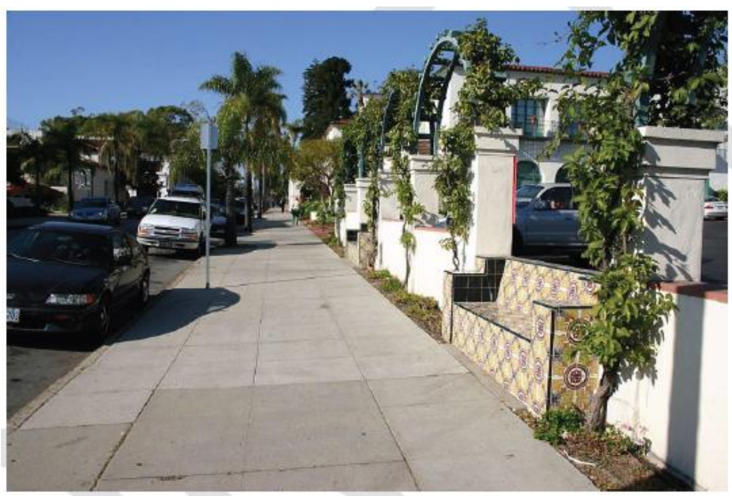


Connect surrounding land use to transit stops with attractive gates (Credit: Kimley-Horn and Associates, Inc.)

- Urban centers are usually organized around an established network of major boulevards and urban streets that support the businesses and major public institutions. Because networks that are scaled and designed for pedestrians are finite in their traffic carrying capacity, it is critical that transit plays a major role in moving people.
- Urban centers are mixed in use, providing an array of goods, services, employment, and residential options

along with important public and cultural institutions. Buildings in urban centers should face the primary street, which can often be more than one side of a block, and support an active pedestrian environment.

- Buildings in large urban centers should form a consistent, but not unidimensional street wall following a consistent pattern of setback and height; the street wall is typically at the back of a wide sidewalk and appropriate to the character of the street it fronts.
- Along streets with purely residential buildings, the design of the ground floor-street interface should provide a degree of privacy for the residents, with residences normally set back from, and raised above the sidewalk.
- Commercial uses generally front the sidewalk with large, transparent shopfronts, but some institutional and office uses commonly connect to the sidewalk environment with lobbies and foyers instead. In such cases, it is important that windows from the offices and other interior spaces overlook the street to support an environment that feels safe. For hotels and office buildings that require porte-cochere, or drop-off areas for residents or guests, these should ideally be designed to occur at the street edge, along the curb zone, and should not impose large curb cuts and circular driveways that interrupt the sidewalk. When such off-street vehicular access must be provided, it should be integrated into a forecourt or entry plaza that is designed, first as a public space for people, and incidentally allows vehicular access that does not disrupt the pedestrian environment. The width of the pedestrian zone should be maintained throughout; the furniture and/or frontage zones can be reduced. Parking in urban centers should include on-street parking to buffer pedestrians from faster moving traffic, and shared, aggregated parking that is located underground wherever possible.
- Above-grade, structured parking should be lined with ground floor active uses that front the streets, not exposed or hidden with blank walls. This also applies to upper floors, where stacking exposed parking levels above the street-level commercial uses, should be avoided.



Well screened surface parking: Santa Barbara, CA (Credit: Paul Zykofsky)

- Where surface parking lots are unavoidable, they should be located behind a building that fronts the sidewalk and public street, or, at a minimum, screened with attractive landscaping or public art to provide a comfortable street edge for passing pedestrians.

Vendor kiosks or "slim stores" can also be used for this purpose.

- The key to district parking strategies is creating a supply of available parking that is shared by many uses, whose peak parking demands will be at different times of the day and the week. This approach, together with a strong transit component and an attractive walking and biking environment, will reduce the required amounts of parking, which in turn will save cost, increase real estate utilization, improve environmental performance, and improve the urban environment for people.

Special Use Districts

Special use districts are areas dominated by a single type of land use. One example of this is industrial districts, where manufacturing, production, and distribution of goods are the primary activities. Other examples are employment centers that primarily provide high concentrations of commercial offices, medical centers, and large education campuses. Such districts benefit from a location that provides easy access to regional roads and highways. The sizes of their buildings, the volumes of truck traffic, and the hours of operation make them generally unsuitable for residential uses.

It is important to note that even within special use districts, there are many opportunities to mix in useful amenities and strong reasons to ensure that all the streets are walkable, bikeable, and served by transit. In industrial, office-dominated, educational, or medical campus districts, this enables restaurants, copy centers, and other support businesses to do well while reducing workers' need to drive out of the district for basic services. These local-serving commercial uses can thrive if the environment supports their patronage, and housing can be integrated as well. Some key principles for the design of such districts include the following:

- Districts can foster a critical mass of related businesses that function well in close proximity to each other (like industrial suppliers and manufacturers, or medical offices and a hospital).
- It is important that special use districts be organized around a balanced street network, with development standards to ensure that the urban design does not exclude pedestrians and bicyclists. Many employees and visitors arrive

Adjacent outdoor seating livens the street: (Credit: Kimley-Horn and Associates, Inc.)

to their jobs by transit or bicycle, so accommodating pedestrians should be as important as moving goods and vehicles between businesses. Many employees who drive or take transit to work, walk or bike to local destinations during their lunch breaks.

- Where other uses (e.g., restaurants, cafes, and small convenience stores) are interspersed within the dominant land use, they should provide a pedestrian-friendly street frontage to encourage employees or visitors to arrive from nearby businesses on foot.
- Major corridors entering special use districts typically carry heavier traffic and trucks, but also need to safely accommodate bicycles and pedestrians.
- The street network should assure that truck freight traffic has clear paths of travel that do not encroach on sidewalks.
- Buildings in special use districts should provide a *good public face* along the streets, with noxious or unattractive uses located behind buildings or attractive fences with landscaping.
- For special use districts like medical centers, the building frontage, and its entrances onto the campus and its individual buildings from the sidewalk, should be pedestrian friendly and accommodate the mobility impaired. Services open to the public, such as cafés and gift shops, should face the street.
- Campuses, which are generally composed of larger areas without public streets, should have a clear network of pedestrian paths and streets that encourage walking and biking, not driving, and allow neighboring pedestrians and bicyclists to cut through the campus.
- Setbacks in special use districts will vary based on the street and sidewalk character that the buildings front; landscaping should be provided along public sidewalks and shade trees should be provided to reduce the effects of urban heat islands, which are common in highly paved industrial districts.
- Parking in special use districts may include on-street parking to buffer pedestrians from faster moving traffic, and where parking is provided onsite, lots should be connected to clear, safe pedestrian pathways.
- Loading docks and service functions should be designed to not conflict with pedestrian entrances from sidewalks into the facility.

Urban Design

Urban design is the design of urban environments, whether in small villages, neighborhoods, town centers, or major urban districts. While sometimes used to describe just the selection of sidewalk patterns, benches, and streetlights, the term “urban design” is used here in its broadest and simplest sense: *the design of environments in which people live, work, shop, and play.*
“Land use” is commonly used as a rough synonym for urban design, and often as a substitute for words such as “building,” “business,” “parking lot,” or anything else that is located on a parcel of private property. In this manual, the term is used to refer to *the “use” of the “land” in question.*

Urban design encompasses site design and street design along with the allowed uses within a certain block or district of a city, and defines the nature of people's experience of that place. The design and use of private development—collectively the "private realm" of the city—work in tandem with and shape the public realm of the city, defining the overall character of the place. When the design of the private and public realm works well together, the places they make are often experienced as "great streets" or "great places," and desirable destinations.

Urban design considers the relationship of site and building to the street, creates spaces for people, and can define the overall streetscape character (Credit: Lisa Padilla)

Once the community decides on the desired character of the urban environment and the range of allowed land uses is determined, zoning regulations and development standards are prepared to support the desired type of place and street, so that the buildings that are developed, or redeveloped, on each parcel play the appropriate supporting role in "completing the street."

The "public room of the street" is an important public space primarily shaped by the land uses and buildings that enclose it. (Credit: Cityworks Design and Michele Weisbart)

Creating great streets with good private realm design starts at the initial phase of laying out a project on a site, including the location and design of the building(s) and the design of the access, parking, and landscape. The following principles are general and are written based on practices that support livable and healthy communities through (i) thoughtful site design, (ii) appropriate building forms, and (iii) good relationships between the building and the sidewalk and street that it fronts.

Thoughtful Site Design

The orientation of every building affects that building's relationship to people on the street. Each component of building demands careful site design. The following provide site design guidance:

Thoughtful site design includes breaking up long blocks with attractive pedestrian paseos
(Credit: Kimley-Horn and Associates, Inc.)

- New projects or buildings developed on large parcels should form new blocks and streets that create a comfortable and walkable block size to help complete the network of streets (see Chapter 3, "Street Networks and Classifications").
- Buildings should be sited to support good connectivity to the community center or neighborhood destinations that are nearby.
- Buildings should be oriented to the street to promote sidewalk activity and provide eyes on the street for the safety and comfort of pedestrians.
- The design of the site should minimize disruptions of pedestrian ways, whether sidewalks or mid-block passageways (typically by limiting the number and width of driveways).
- All buildings should be sited with their primary entries and fronts along the sidewalk, to encourage access from the sidewalk and on-street parking on foot.
- The number of driveways should be limited and consolidated. They should be no wider than necessary and designed to allow motorists to see pedestrians on the sidewalk.

- Parking lots and service entrances should be located toward the rear of the lot, accommodating automobiles but making it comfortable for people to access the buildings on foot.
- Wherever buildings are not built immediately adjacent to the public sidewalk, a coherent network of pedestrian routes should extend into the property so that pedestrians approaching from the street can access each building without walking through vehicular drives and parking lots.
- In all cases, the building pattern within a block should be designed to form comfortable, habitable, outdoor spaces that promote a "sense of place" and a unique local character. Each building belongs to an individual or a business—the "community" is what happens between the buildings.
- The impacts of a building's form and site design on the larger neighborhood or district environment should be taken into consideration. For example, storm water can be managed on private property to reduce demands on the street infrastructure (collection and percolation), poorly functioning irrigation systems can be corrected (to minimize water waste and unnecessary run-off to the street), and building forms can be designed to provide access to fresh air and sunlight for their occupants and passersby on the sidewalk.

Building's Relationship to Sidewalk

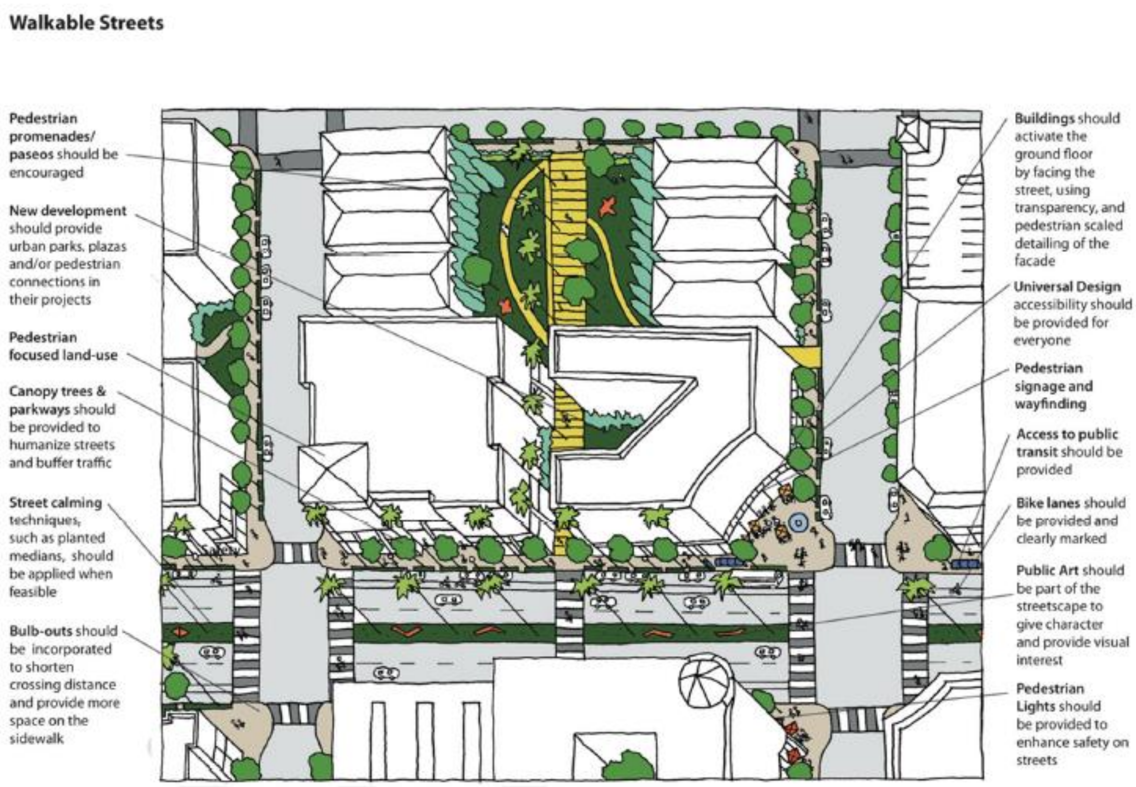
Each building directly interacts with the adjacent sidewalk on a micro level. The following provides guidance for designing buildings with sidewalks in mind:

- Buildings contribute to the overall character of the street by providing well-designed frontages and clear entry points from the sidewalk.
- For active mixed-use and commercial streets, building frontages should be mostly transparent with "active storefronts" that allow pedestrians to see into shops, restaurants, and public spaces.
- Along residential streets, building frontages should include windows overlooking the street with a layering of landscape, porch, patio, or semi-public space that buffers appropriately (setbacks will vary based on street typology and scale of the buildings).
- The primary building face should be located on the most active street frontage with an attractive and welcoming facade that includes entry doors, windows, signs, and other character-defining elements.
- The secondary building face that exists along a mid-block passage or side street should also include openings overlooking the public space.
- The tertiary (back) side of the building is located along a back alley or service drive, where pedestrian movement is secondary to service, with loading docks, service entries, trash storage receptacles, and other unattractive functions as may be required.
- Blank walls should be limited to the rear, and very limited along the secondary face.

- Lighting should be integrated into the building design to indirectly illuminate the sidewalk at night, first by light filtering through storefront windows, and second, by architectural night lighting that highlights the building itself and enriches the street environment during nighttime.

APPROPRIATE BUILDING FORMS

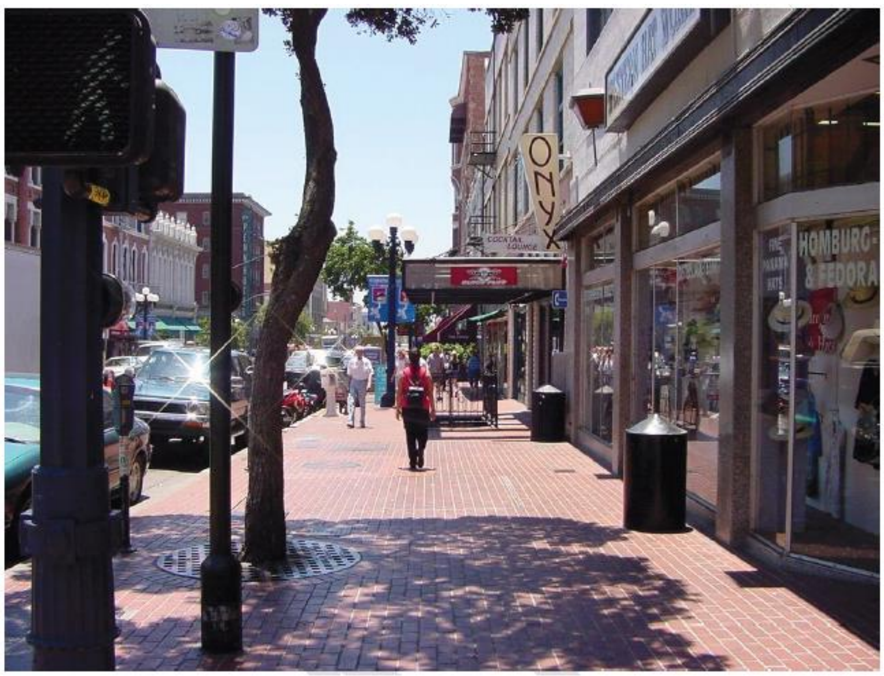
Every building interacts with the street, so the details of key aspects of its form need careful consideration. The following provides building form design guidance:



Everything from the block size to the design of buildings and open spaces contributes to making walkable streets. (Credit: Cityworks Design.)

- Building height, density, and setbacks are planned and designed to create a specific type of place that has a certain scale and character closely coordinated with the street typology.
- Building design standards should be developed to support a healthy street environment for pedestrians: for example, designing buildings to take into account how they interact with strong winds to create wind tunnels or unnecessarily restrict flows of natural light and air.

- On active, mixed-use, and commercial streets, the design of the lower 3 to 4 floors should have an appropriate level of detail and transparency as appropriate to support a great sidewalk environment for pedestrians.
- Buildings of 1 to 3 stories should be designed entirely at a pedestrian-oriented neighborhood scale, with features that can be appreciated by people walking or bicycling.
- Mid-height buildings of 4 to 6 stories should be designed at a pedestrian-oriented scale at the lower 2 to 3 floors and integrate windows, balconies, and other features that provide opportunities for occupants to overlook the street from upper floors.
- Taller buildings (over 6 stories) should generally have a base of lower floors designed similarly to those of mid-height buildings, and may benefit by stepping back from the frontage above this level to provide a street character that is not overwhelming to the pedestrian.
- In most mixed-use districts and neighborhood centers, it is more important to provide a relatively steady “street wall” to define a simple “street as an outdoor room” than to provide varied setback and step-backs to “break up the mass,” (see preceding section on streetscape environment types). In suburban environments, where buildings often are free-standing within the landscape, the desire to articulate the building form is understandable, but in urban districts and centers, the primary placemaking role of buildings is to calmly define the space of the place rather than to “express themselves” as unique objects.



Active Ground Floor Uses, (Credit: Ryan Snyder)

- Towers in very dense districts, such as an urban center, should be slender and mostly transparent, with a low to mid-rise base that provides pedestrian-oriented features. Towers should be designed to appear attractive and approachable from the street and sidewalk, not just to be an icon in the skyline.

- Parking should be integrated into the site and building design. Ideally, parking would be beneath the building, tucked behind the building fronting the sidewalk and accessible from an alley or side street, or sited internally to the project or block so buildings "wrap it" to the greatest degree possible.
- Buildings should be designed by applying universal access principles, (like locating stairs in prominent locations to encourage people to use them), making naturally legible paths through good design and an integrated site and building design approach.

POTENTIAL IMPLEMENTATION STRATEGIES

Tools available to help implement good urban and architectural design that support the creation of good streets and great places include the following:

- Community-based vision plans, which are critical agreements or road maps that articulate how communities see their streets, neighborhoods, districts, and future growth
- Zoning standards that allow, encourage, and require a diverse mix of land uses that support the creation of sustainable, valuable places
- Standards and guidelines associated with this type of zoning that shape and coordinate development with street design to ultimately deliver residents and stakeholders a fully realized vision that is authentic and unique to their community, and that supports a healthy, pedestrian-centered lifestyle

HEALTH AND LAND USE

Good land use planning and urban design can help create healthy neighborhoods with great streets and innovative and sustainable buildings. Some planning principles that should be considered include the following:

- Create a variety of places where people choose to walk and feel safe doing so—walking is an important form of daily exercise than can easily be integrated into the design of communities.
- Provide opportunities and incentives to create social environments in which all generations mix. These could include

public or private facilities that accommodate both youth and senior activities, or planning development where adjacent uses allow different generations of the community to interact on a regular basis. By contrast, environments in which one must drive from one daily activity to the next systematically exclude the very young and the very old, who cannot drive and therefore become "involuntary pedestrians" in environments designed for cars.

- Assure access to healthy foods and grocery stores; limit fast food establishments and allow drive-through service only in places where it is in the community's best interests to have passersby shopping without turning off their engines.
- Capture opportunities for Farmers' Markets – ideally on streets or within public spaces that are central and part of the local neighborhood street network.
- Look for underutilized public spaces to provide community gardens within neighborhoods, which will encourage gardening and social interaction while providing access to fresh produce.
- Integrate exercise routes and equipment into the network of streets, or even within underutilized roadway space (for instance, expanding neighborhood parkways where parking can be sacrificed, or a could be adopted for use by people).

Outdoor sidewalk social environment with activities for all ages: Venice, CA (Credit: Dan Burden)

- Promote sustainable planning practices and building design that help to preserve the environment through energy efficient design - allowing residents and visitors to access the buildings without driving is the foundation of energy efficient design.
- Ensure complete bicycle networks and provide amenities within new projects to promote bicycling as appropriate to the scale of the project (bike racks, bike lockers, showers, or even a bicycle station).

New development should be planned to promote sustainable design and integrate gardens and open spaces that can be enjoyed by residents, or by pedestrians walking by.
(Credit: Bridge Housing, David Baker Architects)

BENCHMARKS

Good land use planning and urban and architectural design are best measured by how they complete the community's vision for the specific place, and how they enhance the daily lives of their residents and users. Other qualitative and quantitative metrics that could be used to evaluate their effectiveness include the following:

- Jobs within a 15-minute commute by public transportation, bicycle, or walking;
- Convenience shopping within comfortable walking or biking distance;
- A school or park that a child can walk to/from home;
- Useful transit within a 10-minute walk from home and/or work;
- Clear zoning standards or design guidelines that help assure planning and design will be implemented as envisioned by the community;
- Increased land values coming from the effective melding of transit, land use, and design; and,
- The creation of great streets or places that people want to spend time in or live near.

Proximity of amenities in walkable neighborhood
(Credit: Cityworks Design)

14. RETROFITTING SUBURBIA

INTRODUCTION

Much of suburbia will have to change in order to thrive and meet the health, environmental, and economic challenges of the coming decades. Because of their form, widely separated land uses, and disconnected street networks, most suburban areas lack walkability and require that people travel by car for most of their needs. This has serious environmental consequences (poor air quality, climate change, and high energy consumption) as well as health consequences as suburbanites live in environments that discourage active transportation and favor or even require driving to maintain access to daily needs.

(Ariel picture of the City of Fort Myers)

Residents in these neighborhoods tend to become isolated due to the lack of walkable streets and walkable destinations. The costs of owning and operating more automobiles, even with stable fuel costs, can pinch both family budgets and local economies as people have less discretionary income. Changing demographics also presents challenges. Suburban homes have been built to accommodate young families with children, but fewer households now fit that profile. More and more households are comprised of empty nesters, young singles, divorced adults, and other non-nuclear families, and this trend is expected to grow in the future.

As fuel prices continue to rise, and as residents age, suburbs will need to serve more of their residents' needs closer to home, and serve those needs in places that can be reached other than by driving. Suburban areas will need retrofitting to accommodate a new reality that rewards places located close to people and are reachable in many ways.

Pedestrian on a suburban boulevard sidewalk in City of Fort Myers

This chapter describes how streets can support retrofitting suburbia, provides strategies for retrofitting streets, and recommends priorities and phasing. All of the changes recommended in this chapter will improve safety. The first priority for a local jurisdiction beginning to retrofit itself for the future should be to find and fix the unsafe places. This underscores the importance of robust community input and 'ground truthing' inventory processes.

MARKET FORCES IN THE HISTORY OF URBAN LAND DEVELOPMENT

Understanding the history of land development and its relationship to transportation facilities is important because buildings and streets are durable. Today's infrastructure influences decisions about investment that determines what the future will look like. Trends in urban land development over time, including the rise of suburbia, can be largely explained from economic forces at work during the period in which the trend initiated.

The following brief history of changes in land development over time is based on *The Transportation/Land Use Connection*, American Planning Association (APA) Report Number 546/547, June 2007:

- Cities formed and grew as businesses clustered near sources of raw materials, markets, or ports. A key reason that civilizations developed cities is to economize on the transportation costs associated with conducting the activities essential for daily life.
- Before cars, trucks, and highways, most cities developed around a single high-density employment center near the port or freight-rail depot.
- Land prices were cheaper farther away from the high-density center to compensate for higher transportation costs. Development densities were sparser with increasing distance from the high-density center in response to lower land prices. Therefore, transportation costs influenced land prices, which in turn influenced density.
- Improvements in transportation and building methods allowed monocentric cities to grow.
- The development of cars, trucks, and highways broke the strong link to the traditional monocentric, high-density city center.
- Trucks and buses created the demand for land development policies in the early twentieth century that were aimed at keeping employment-based land uses and multi-family residential land uses out of single-family areas. These land development regulations contributed to the development of suburban areas where all land uses are segregated by type and are connected only by auto-centric highways.
- Auto travel allows well-located cities to grow until traffic congestion, energy prices, air pollution, or land constraints counteract their locational advantage.

Because of these constraints and a changing demographic, generational expectations are now motivating a return, at least in urbanized areas, to a more compact development pattern with lower transportation costs. In Southwest Florida, this motivation is leading to a polycentric land development pattern where clusters of density are taking shape in many areas. There are cost advantages to clustering that seem to outweigh the cost disadvantages of suburbia. Although some aspects of sprawl over the last fifty years have produced positive results, decentralization may well have gone too far from an economic perspective.

SMART GROWTH, NEW URBANISM, AND FORM-BASED CODES

Smart growth, as a comprehensive development concept, will play a vital role in helping to retrofit suburbia to be more sustainable. The Congress for New Urbanism, an organization with Florida origins, promotes the restoration of existing urban centers and towns with the coherent reconfiguration of sprawling suburbs into communities of real neighborhoods and diverse districts, connected via safe and accessible multimodal transportation. Form-based codes, Compact Community codes and Smart codes all support compact growth, mixed use, and multimodal development patterns for new and retrofit development.

These planning trends represent a comprehensive approach to development used in many cities across the nation and incorporate the following principles.

- **Enhance Quality of Life.** Smart Growth communities are designed to attract a diverse population of residents and businesses – then keep them there, with pedestrian-oriented, walkable neighborhoods, diverse housing, and an array of local businesses and services. Nearby resources minimize car trips and maximize walking, bicycling, and person-to-person interaction. Its compact land-use planning at its best, including commercial, office, public, and recreational uses.
- **Promote Economic Development.** Attract businesses and jobs to locations near housing, infrastructure, and transportation options. Promote economic development in industry clusters. Expand access to education, training, and entrepreneurial opportunities. Support the growth of local businesses, including sustainable natural resource-based businesses, such as agriculture, forestry, clean energy technology, and fisheries.
- **Create Livable Communities.** Support the revitalization of city and town centers and neighborhoods by promoting development that is compact, conserves land, protects historic resources, and integrates uses. Encourage remediation and reuse of existing sites, structures, and infrastructure rather than new construction in undeveloped areas. Create pedestrian-friendly districts and neighborhoods that mix commercial, civic, cultural, educational, and recreational activities with open spaces and homes.
- **Promote Alternative Transportation.** Maintain and expand transportation options that maximize mobility, reduce congestion, conserve fuel, and improve air quality. Prioritize rail, bus, boat, rapid and surface transit, shared-vehicle and shared-ride services, bicycling, and walking. Invest strategically in existing and new passenger and freight transportation infrastructure that supports sound economic development consistent with Smart Growth objectives.
- **Create a Range of Housing Opportunities.** Support the construction and rehabilitation of homes to meet the needs of people of all abilities, income levels, and household types. Build homes near jobs, transit, and where services are available. Foster the development of housing, particularly multifamily and smaller single-family homes, in a way that is compatible with a community's character and vision and with providing new housing choices for people of all means.
- **Preserve Open Space, Natural Resources, and the Environment.** Protect and restore environmentally sensitive lands, natural resources, agricultural lands, critical habitats, wetlands and water resources, and cultural and historic

landscapes. Increase the quantity, quality, and accessibility of open spaces and recreational opportunities

Smart growth principles have been advocated to help South Florida meet the needs of our current and future families by revitalizing neighborhoods, preserving natural areas, stimulating economic development, and providing transportation alternatives to the car.

LIVABLE AND SUSTAINABLE COMMUNITIES

Streets planned, designed, and operated to be safe and accessible to all regardless of age, income or ability are an essential part of a functional multimodal transportation system as well as a critical component of Livable and Sustainable Communities. Many national organizations support and promote the concepts of Livable Communities or Sustainable Communities, which are those that support a healthy, active, affordable, economically and socially viable, yet, resource-wise lifestyle. The concept of livability is focused on creating ways to increase the economic prosperity of neighborhoods, reduce commute times to work and recreational activities, and also reduce pollution. These community patterns are supported by the AARP, FTA, FHWA, HUD, USDOT, National Association of Area Agencies on Aging and the National Association of Realtors.

TRANSFORMING SUBURBAN STREETS TO COMPLETE STREETS

Streets play an enormous role in determining a place's quality of life. Everywhere in the country, people prefer a certain kind of street, ("*Redefining Charlotte's Streets*," Urban Street Design Guidelines, Charlotte, North Carolina, 10/22/2007). People's favorite streets include streets with:

- An abundant tree canopy and other streetscape features;
- Sidewalks and buffer zones from traffic;
- Moderate traffic speeds; and,
- Multi-usage, (walking, cycling, driving, and enjoying the lawns or sidewalks and patios on either side).

People need not know the term "Complete Street" to recognize and enjoy one.

The least favorite streets are those where driveways, parking lots, and utility poles are more abundant than trees, bicycles, and people. They often consist of wide expanses of pavement for moving traffic, and make little or no provision for any other users. In particular, there is little opportunity to cross the street.

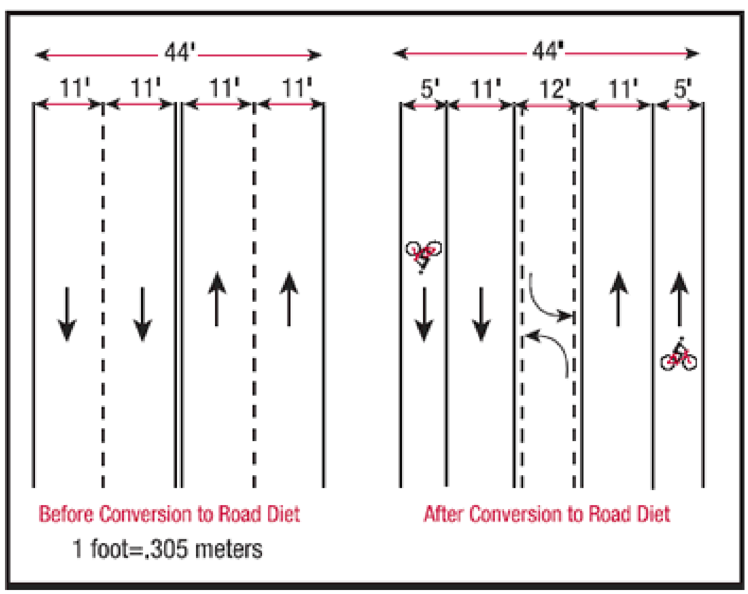
The challenge for local governments with too many least-favorite streets, is to transform them into most-favorite Complete Streets.

Changing Streets without Changing the Right-of-Way

By definition, a retrofit occurs on an existing street. This manual gives design guidance for all streets, existing and new. The following section recommends how to accommodate those design recommendations on *existing* streets. Many aspects of complete streets actually take *less* space than typical suburban design.

To create a Complete Street in the right-of-way of an existing street, the street needs to be assessed to see if it can be retro-fitted by the Engineering Division. Options to achieve this are:

- **Narrow travel lanes.** Ten or 11-foot lanes are acceptable for most urban boulevards. They are just as safe as 12-foot lanes for posted speeds of 35 mph or less.[1] Narrowing travel lanes to create Complete Streets elements is consistent with the Florida Department of Transportation (FDOT) Plans Preparation Manual (PPM), Chapters 8, 21, and 25, which references narrowing travel lanes for the purpose of creating bike lanes. Furthermore, an FDOT Central Office study found that narrowing inside travel lanes to provide more space for bicyclists on the outside of the roadway produced positive safety benefits including reduced conflicts and greater passing separation afforded by motorists when performing an overtaking maneuver. [1](Dumbaugh, E., "*Safe Streets, Livable Streets*," Journal of the American Planning Association 71[3] 283-300)
- **Seek opportunities to put streets on a 'road diet.'** This involves eliminating superfluous travel lanes or narrowing existing lanes. Common scenarios include the following:
    1. Convert a four-lane undivided road to a three-lane road with a two-way, left-turn center lane, two motor vehicle travel lanes, and two bike lanes. This configuration can handle up to 18,000 ADT and improves safety and access to adjacent destinations; the two-way left-turn center lane can be



Example of a 4-lane to 3-lane road diet with bike lanes replaced with short sections of medians and pedestrian crossing islands in selected locations. On-street parking can be substituted for bike lanes where the context and conditions warrant.

2. Remove a travel lane from three-lane and four-lane, one-way streets. Two-lane, one-way streets can handle around 21,000 ADT. Three-lane, one-way streets can handle around 32,000 ADT.
3. Reduce six-lane boulevards to four lanes for ADT's of up to 35,000.
4. Tighten corner curb radii to the minimum needed to provide a usable turning radius for an appropriately selected design vehicle. Occasional encroachment by larger vehicles into other travel lanes is acceptable; intersections should not be designed for the largest occasional vehicle.

- Eliminate unnecessary turn lanes at intersections. An example is a right-turn lane with very few right turning vehicles (fewer than 100 per hour). Free-flow right-turn lanes**,** including freeway entry and exit ramp connections to surface streets, should be replaced with yield control.
- Replace painted channelization islands at intersections with raised islands. This gives pedestrians a true refuge and breaks up a long crossing of many lanes into smaller discrete steps.

Simulation of Positive results of a 4-lane to 2-lane road Fort Myers

All of these changes can free up space, which can be used for additional elements. To improve street quality, incorporate the following elements and other related elements included in other chapters of this manual:

- Colored pavement bike lanes,
- Add or widen sidewalks,
- Add raised medians, which visually narrow the roadway and provide a median refuge for midblock crossings,
- Provide median, parkway and sidewalk landscaping, which further visually narrows the roadway and provides a calming effect,
- Add or retain curb parking, which improves community access, calms traffic, and buffers pedestrians, and,
- Add bulb-outs, which shorten pedestrian crossing distances and improve sight lines.

Non-Physical Changes

In addition to physical retrofits, further adaptions to existing street management and operations include:

- Adjusting signal timings for slower speeds and to ensure comfortable crossing times for appropriate populations. In areas with aging populations, for example, crossing times may need to be lengthened. The Institute of Transportation Engineers (ITE) Recommended Practice, *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach*, recommends using 2.8 feet per second in areas with aging populations.

- Working with transit agencies to improve bus operations.
- Working with schools to develop a Safe Routes to School Program.
- Reexamining the parking codes (for example, off-street parking requirements may be reduced, especially in coordination with additional on-street parking).

Street Crossings

A connected sidewalk network includes street crossings. See Chapter 5, "Intersection Design," and Chapter 7, "Pedestrian Crossings," for design details. To improve street crossings, jurisdictions can consider the following:

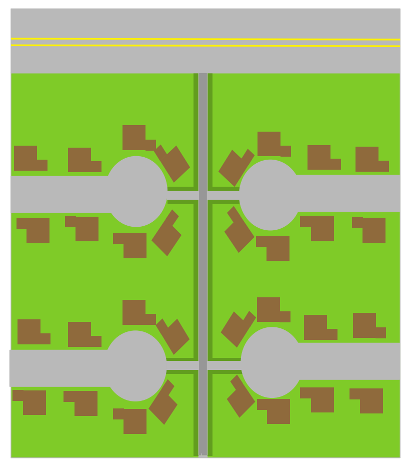
Marked Pedestrian Crossing, The City of Fort Myers

- Make pedestrian crossing locations safe, comfortable, and more frequent (LaPlante, J., "Retrofitting Urban Arterials into Complete Streets," 3rd Urban Street Symposium, June 24-27, 2007 Seattle, Washington).
- Allow crossings at every corner of an intersection.
- On streets with bus routes, make provisions for pedestrians to cross the street at all bus stops. Bus riders need to cross the street either coming or going.
- Provide mid-block crossings; pedestrians should not be expected to travel to the closest intersection to cross the street. Signalized intersections in suburban areas are often spaced ¼ mile, ½ mile, or even further apart. It is unreasonable to expect people to walk that far to cross the street, nor do signalized intersections offer safety benefits to pedestrians, due to the many added turning conflicts at large suburban intersections.

Many of these changes can be made through spot improvement programs. Many are relatively inexpensive; it is not necessary to wait for a reconstruction to create a Complete Street. More substantial retrofits may require reconstruction (see the Model Project section at the end of this chapter). A planned surface repaving project is an excellent time to retrofit the corridor to add comfort, convenience, safety, aesthetics, and economic value.

RE-ESTABLISHING STREET NETWORKS

Chapter 3, "Street Networks and Classifications," details the need for interconnected street networks with short blocks. Much of today's suburban landscape was built in isolated pods: residential subdivisions, business parks, shopping centers, and schools that are poorly connected to neighboring properties. These pods create barriers to getting around, other than in a car, because they create long distances between destinations and because the pods are often surrounded by sound walls, fences or berms, literally blocking potential bicycle and walking routes. These pods don't work well for auto traffic either, since they force all traffic onto busy streets rather than allowing connection and local circulation through local streets.



Connecting cul-de-sacs
(Credit: Marty Bruinsma)

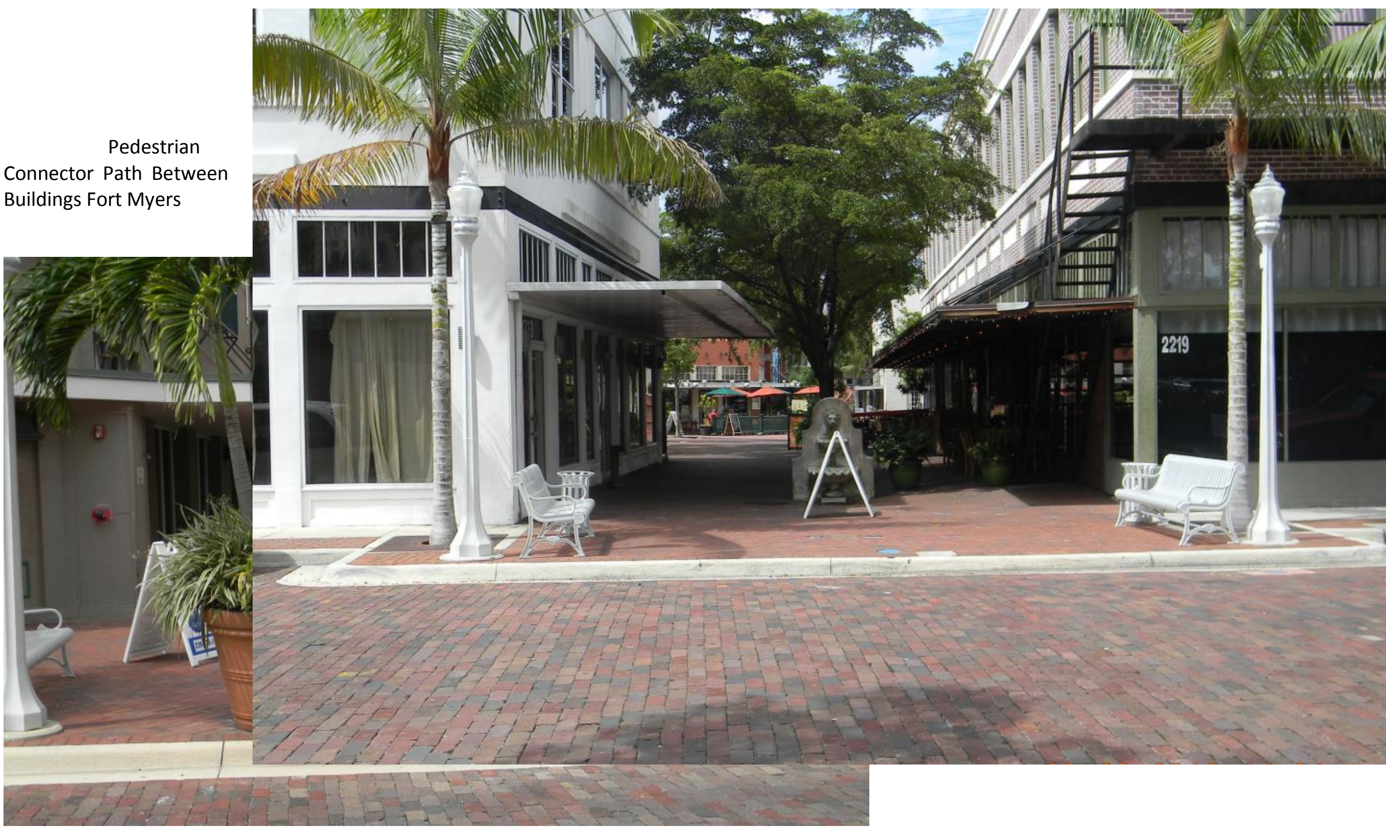
To create a vibrant suburb that will thrive in new conditions, direct connections must be created or re-created to enable efficient, direct travel by everyone. That means establishing or re-establishing street and sidewalk networks.

Re-establishing a street network can be more challenging, particularly when right-of-way has not been preserved. Some local governments have purchased homes at the end of cul-de-sacs, put the connectors in, and then sold the homes. This is often far less expensive than purchasing great lengths of ROW to widen roads for capacity increases. In cases where a local government is still developing suburbs, it should make connectivity a fundamental priority by following the principles in Chapter 3, "Street Networks and Classifications."

Cul-de-sacs break up connections.
(Credit: PB Americas, EWA Connection Study, May 2009)

Pedestrian networks can be re-established by opening noise walls and connecting new sidewalks. (Credit: PB Americas, EWA Connection Study, May 2009)

Pedestrian Connector Path Between Buildings Fort Myers



Pedestrian Connector Path Between Buildings Fort Myers

SECOND-GENERATION LAND USE ALONG TRANSFORMED STREETS

Not only streets will need to change in suburbia; many land uses are obsolete and/or no longer economically viable, however, street improvements generally should come before land use change in suburban retrofitting. This is because *high-quality land uses come to high-quality streets.* Very rarely will high-quality land uses come to low-quality streets.

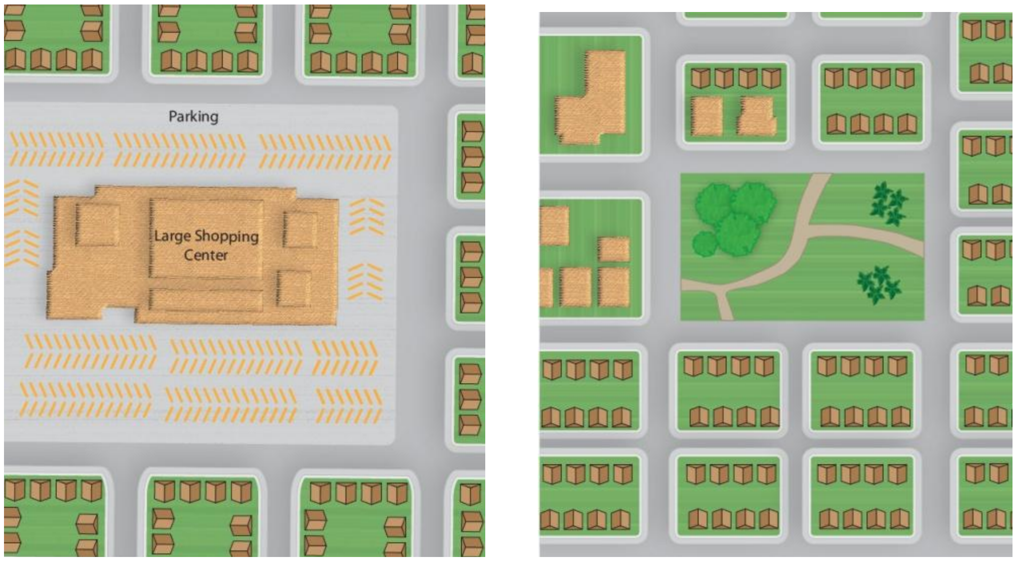
The street and the land use work together and determine whether a place is attractive and draws people and investment. To that end, communities retrofitting older suburban areas would do well to implement the following three principles:

- Focus new investment in nodes on streets. Identify and focus investment at individual nodes. In most of suburbia, there will not be enough investment all at once to transform whole corridors.

- Focus revitalization efforts on creating genuine places in those nodes: compact, mixed-use, transit-oriented, and at least internally walkable. Plan for and enable neighborhood-serving commercial districts where necessary, rezone from automobile-oriented commercial sites (gas stations, convenience stores, and fast food outlets). These car plazas are designed for, and are dependent on vehicular access and offer no relationships with the nearby residential areas. They absorb retail potential and will tend to discourage development of neighborhood-serving commercial districts.

- Carefully detail the desired outcomes. It is vital that retrofit efforts pay attention to the details described in the individual chapters of this manual.. Adopting well-intentioned policy goals is not enough. There must be follow through by incorporating the vision's details in the design and construction of the project. Desired outcomes may include reduced vehicle miles traveled (VMT), reduced greenhouse gas emissions (GHG), increased transit ridership, and development consistent with established smart growth principles.

Infill development between nodes that follows the principles of this document will help to connect the nodes into livable neighborhoods.



Conversion of shopping center to a neighborhood
(Credit: Michele Weisbart)

SETTING PRIORITIES AND PHASING

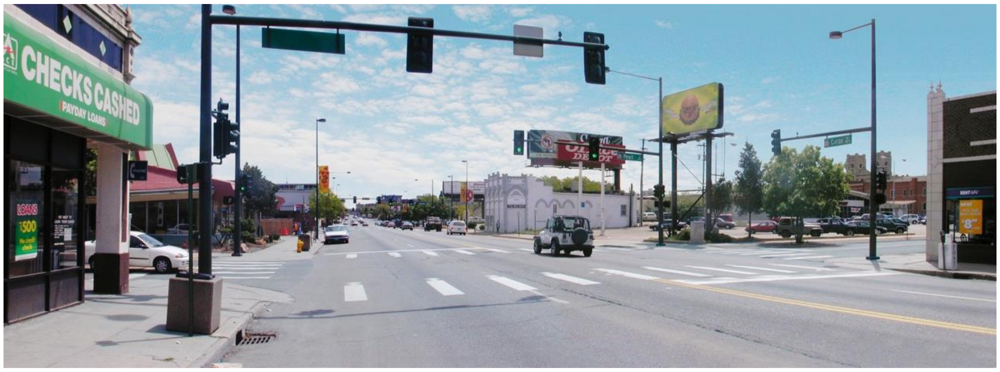
The primary challenge in retrofitting suburbia is less about fixing the infrastructure and more about creating economically sustainable places, with the emphasis on *place*.

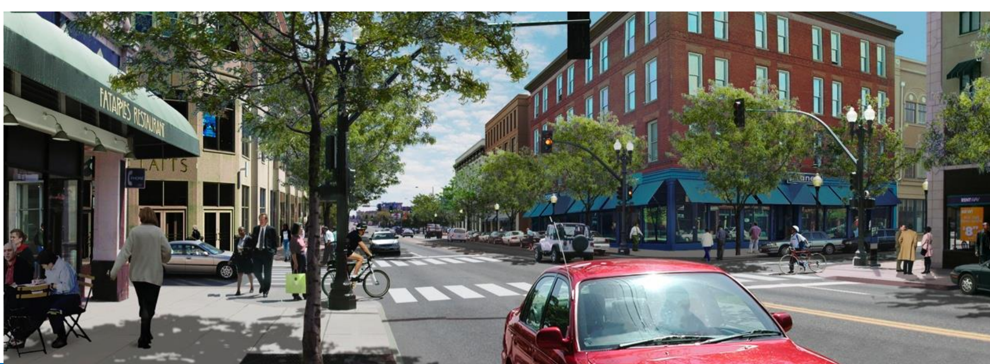
As suggested above, the priority should be to begin by creating vibrant nodes. Local jurisdictions should not allow themselves to be daunted by the scale of the retrofit challenge.

Take advantage of opportunities. Only a small sample of current opportunities are listed below:

- The growing popularity of smart growth and place-making as development concepts.
- The need to accommodate ‘Aging in Place.’
- Increased interest for in-town living.
- Public/private partnerships.
- Transit-oriented development (TOD).

As with street retrofits, creating places can be done incrementally. The images on the next page show such an incremental process that can be achieved.





Example of a transformed suburban street with increased public usage (Credit: Urban Advantage, Inc.)

MODEL PROJECT: Dean Park

Dean Park is an example of where the City has already tried to adopt a Complete Streets theme within the existing road way system.

Picture of Dean Park, City of Fort Myers

The City shows that a Complete Street can be achieved in an urban area and still remain functional.