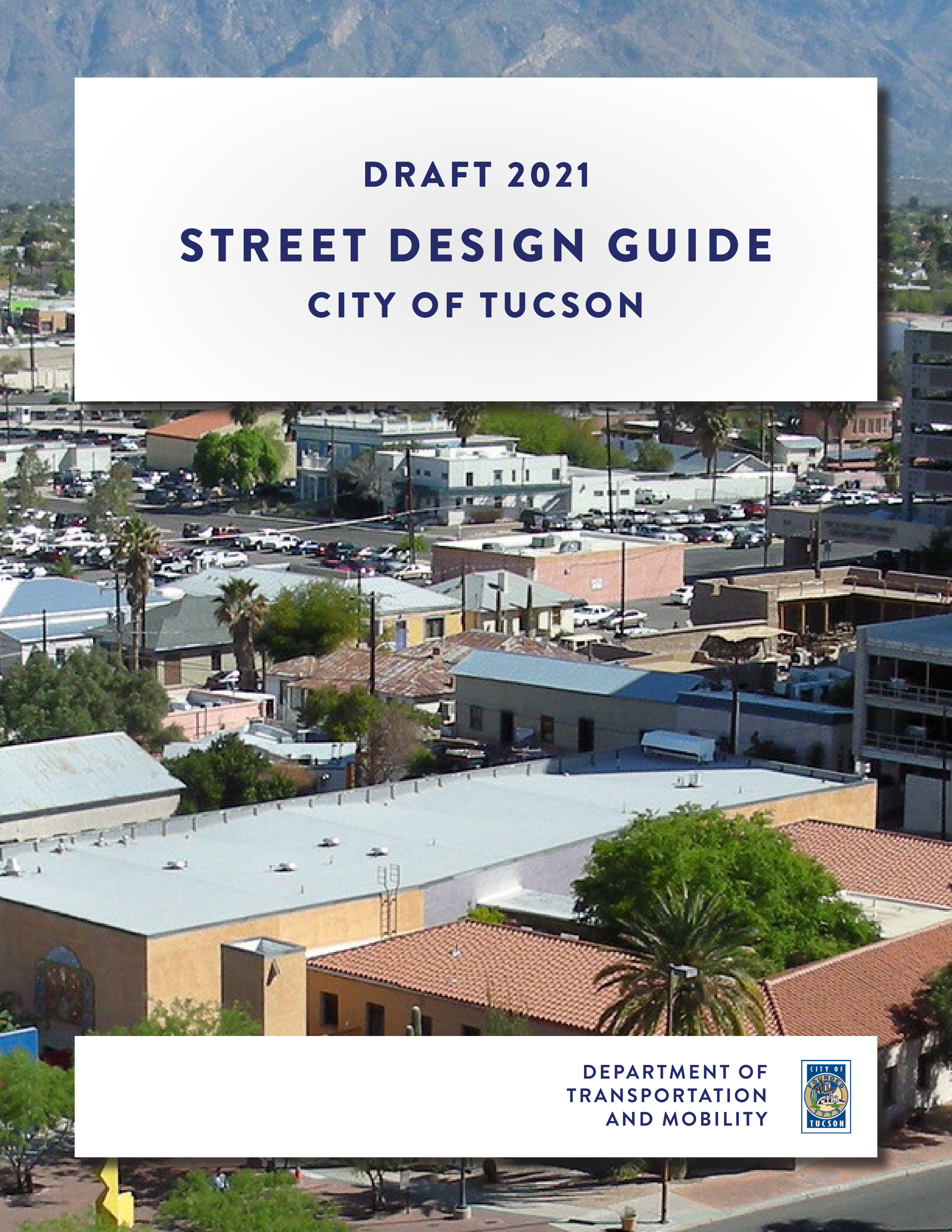

DRAFT 2021

STREET DESIGN GUIDE

CITY OF TUCSON

DEPARTMENT OF
TRANSPORTATION
AND MOBILITY

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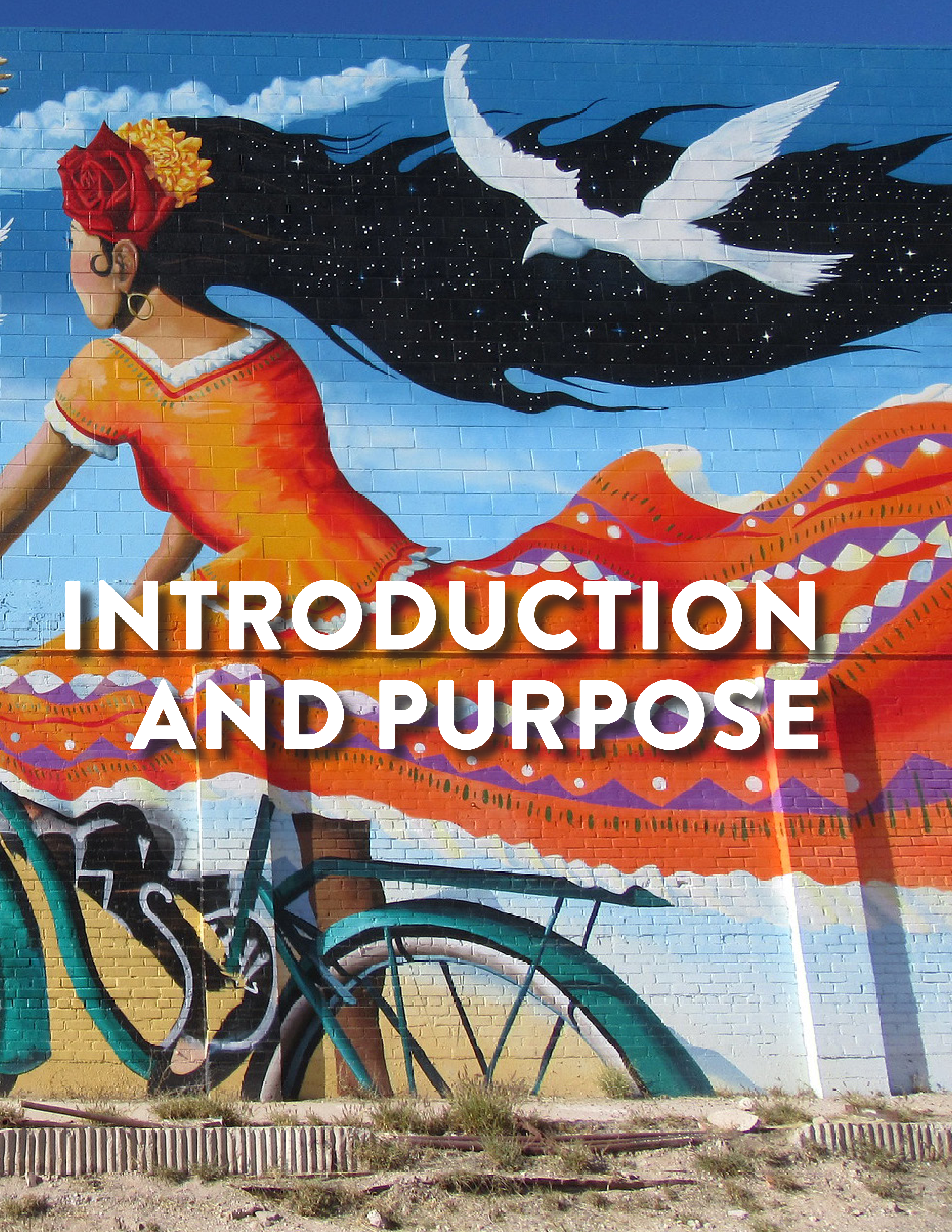
INTRODUCTION AND PURPOSE



INTRODUCTION AND PURPOSE

The Street Design Guide 2020 was prepared by the City of Tucson Department of Transportation and Mobility (DTM) to provide guidance on incorporating a Complete Streets design approach in all transportation projects in the city.

Vision for Tucson's Streets

Streets are the City of Tucson's largest public space, providing connections by multiple modes of travel to destinations across the community for residents, regional commuters, and visitors alike.

Because streets are so central to how people experience the city, the City of Tucson views all transportation improvements as opportunities to foster a vibrant, healthy, equitable, interconnected, accessible, environmentally sustainable, and more livable city where everyone can move about safely, comfortably, and with dignity.

With the passage of its Complete Streets Policy in February 2019, the City has made explicit its commitment to ensuring that Tucson's transportation system promotes enhanced mobility for people of all ages and abilities in a connected and equitable manner including, but not limited to, meeting the needs of people walking, biking, using wheelchairs or other mobility devices, taking transit, or driving (in both private and commercial vehicles).

What are Complete Streets?

"Complete Streets" is an approach to transportation planning and design that guides the development of a safe, connected, and equitable transportation network for everyone—regardless of who they are, where they live, or how they get around.

A Complete Streets approach goes beyond simply looking at how the roadway performs between the curbs; and instead considers the entire right-of-way to ensure that all user needs are being met.

While the Complete Streets approach looks to achieve universal goals—including improving transportation safety, accessibility, and comfort—the application of Complete Streets design will vary by context and street function: what makes sense as a transportation priority in a mixed-use downtown setting, such as wide sidewalks, outdoor dining, and narrow streets, may not be appropriate on a suburban commercial thoroughfare, and vice-versa.

[Previous two-page spread]
Section of a mural by Joe Pagac near downtown Tucson on North Stone Avenue near East Sixth Street. Source: "IMG_3019" by Kai.Bates under license CC BY-NC 2.0

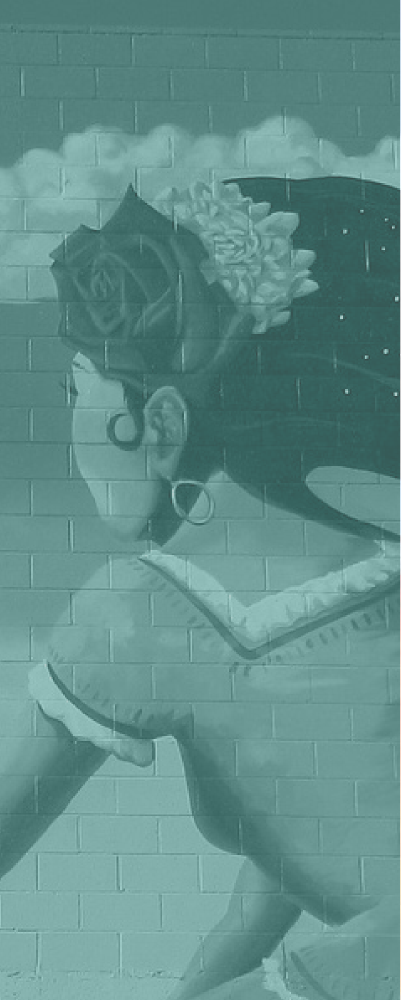
Common elements of Complete Streets applicable across contexts include:

- Safe, accessible, visible, and comfortable pedestrian walkways;
- Safe and comfortable bikeways and crossings;
- Appropriately sized and designed travel lanes and roadways;
- Accommodations for commercial vehicles and deliveries;
- Attractive, inviting, and welcoming public spaces.

Benefits of Complete Streets

Instituting a Complete Streets approach in the planning, design, and operation of the transportation system has numerous benefits. It expands the emphasis of transportation improvements from primarily serving motor vehicles to a philosophy that allows engineers, planners, designers, and stakeholders to refocus on a wider variety of transportation goals. The benefits of this approach are to:

- Improve safety for all system users;
- Provide more connected and comfortable bicycle, pedestrian and transit facilities;
- Ensure access and mobility for people of all ages and abilities;
- Encourage biking, walking, and transit ridership;
- Provide more opportunities to be outside, in the community, and physically active;
- Improve air quality;
- Increase shade by adding more urban greenery;
- Manage and improve stormwater quality through green infrastructure investments;
- Improve the quality of place.



City of Tucson Complete Streets Policy

The adoption of the City of Tucson's Complete Streets Policy was the culmination of more than two years of work. The initial effort was guided by Living Streets Alliance (LSA), a local non-profit organization that advocates for engaging the community to improve streets and other public spaces. LSA worked with the City to engage the public and build support for the Complete Streets concept, establishing important partnerships, and bringing in national and international experts in Complete Streets to provide training and inspiration. This effort led to the creation of a 30+ member community Task Force, charged with crafting the final Policy document for consideration and adoption by Tucson's Mayor and Council. The development of the Policy was a community-driven effort that saw effective collaboration between the Task Force, LSA, and the City, a model that can be replicated and extended into other areas of the Complete Streets program.

Guiding Principles

The Policy is built upon six Guiding Principles (Table 1.1), which provide the foundation for all elements of how the Complete Streets approach will be integrated into the practices and programs of the Tucson Department of Transportation and Mobility (DTM).

Table 1.1
Complete Streets Guiding Principles

GUIDING PRINCIPLE	DESCRIPTION
Safety	*Complete Streets provide a safe travel experience to all and designing Complete Streets is a safety strategy to eliminate preventable traffic fatalities.*
Accessibility	*Complete Streets serve people of all ages and abilities.*
Equity, Diversity, and Inclusivity	*Complete Streets provide a safe travel experience to all and designing Complete Streets is a safety strategy to eliminate preventable traffic fatalities.*
Land Use	*Complete Streets incorporate context-sensitive, flexible design approaches and consider the surrounding community's current and expected land use and transportation needs in an interconnected manner.*
Environment and Health	*Complete Streets support the health and well-being of Tucson's residents and environment by enhancing sustainable transportation options, providing opportunities for physical activity through active transportation (such as walking and biking), improving air quality, through reduced vehicle emissions, mitigating urban heat island effect, utilizing stormwater runoff and decreasing stormwater pollutants, and maximizing shade trees and vegetation.*
Economic Vitality	*Complete Streets help spur economic development by supporting business and job creation and fostering a more resilient workforce that has greater access to employment opportunities through improved travel options.*

The Policy sets the City up for successful implementation by establishing a clear direction for how the Complete Streets initiative is to be instituted. The Policy includes a 14-item implementation chart that includes tasks such as creating a robust and meaningful community engagement plan; reviewing and updating relevant city procedures, plans, regulations, and processes; developing a project prioritization tool; and creating this Guide.

Implementation Committees

The Policy established two City committees to oversee and bring accountability to the Complete Streets initiative. The first, called the **Technical Review Committee** (TRC), is responsible for overseeing internal operations and ensuring inter-departmental coordination. The TRC is composed of the following representatives:

- Transportation Director
- Transit System General Manager
- Director of Planning and Development Services
- Director of Parks and Recreation
- A City Manager's Office Representative
- Housing and Community Development Director
- Tucson Fire Department Chief
- Tucson Water Department
- Tucson Police Department Chief
- Director of Environmental and General Services Department
- A representative of the Complete Streets Coordinating Council
- External issue area experts

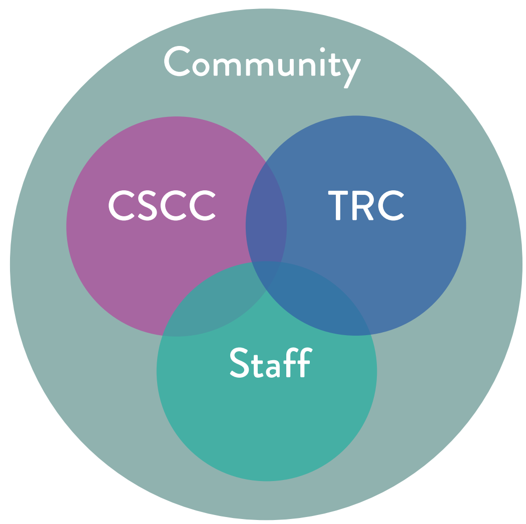


Figure 1.1
Complete Streets Implementing Bodies

The second committee is known as the **Complete Streets Coordinating Council** (CSCC). The CSCC is composed of 20 members of the public who represent the geographic, demographic, and economic diversity of the Tucson community, with members demonstrating a background and/or experience in the Policy's Guiding Principles.

The TRC and CSCC work collaboratively with Transportation Department staff on all areas of the Complete Streets program, including reviewing and providing input on the development of the Street Design Guide. Figure 1.1 shows a conceptual rendering for the working relationship between Transportation Staff, the TRC, and the CSCC.

Tucson's Transportation System

The largest challenge to implementing Complete Streets—and developing a complete network of streets—is correcting the city's historic transportation practices. Tucson, like many Sun Belt cities, grew up around the automobile. This history is demonstrated in the city's urban form, which is largely defined by a grid of high-speed, multi-lane roadways. These facilities serve both as the city's major traffic arteries and as attractors of traffic due to the concentration of many of the city's commercial and other destinations. As a result, many roadways must accommodate a mix of users, who make different, and often competing, demands for space. For example,

- people driving longer distances desire to travel quickly across the city with limited delay;
- businesses want to maximize access and visibility for potential customers;
- customers arriving by car look for available parking and easy commercial access;
- people bicycling want safe biking routes, secure bicycle parking, and business access;
- people walking need complete sidewalks, frequent, safe crossing opportunities, comfortable walking environments, and well-managed driveway access;
- transit riders want comfortable stops, reliable service, and safe crossings;
- Utility companies have franchise agreements with the City to locate overhead and underground utilities within the public right-of-way.

The challenges on the network are compounded by the fact that Tucson, unlike many Sun Belt cities, has a limited freeway system, which puts added pressure on surface streets to serve the needs of regional and crosstown travel. In fact, within the Tucson metropolitan region, nearly 75 percent of travel occurs on surface streets, which is unique for a community of its size.

Historically, vehicular mobility was prioritized in transportation investments, resulting in the construction of wide roads and large intersections. Investment in comfortable and accessible pedestrian, bicycle, and transit facilities was often limited, if made at all. Many of Tucson's residential streets and major roadways still lack basic or accessible pedestrian facilities.

In more recent years, however, progress has been made in addressing some of the city's historic transportation deficiencies. For example,

- many Complete Streets concepts have already been incorporated into recent corridor projects;
- an extensive on-street bicycle network has been installed on the city's streets;
- development and implementation of innovative bicycle and pedestrian crossings like HAWKS and Bicycle HAWKS;
- many miles of sidewalks have been constructed as standalone projects and as part of broader corridor improvements;
- green infrastructure and landscaping have been integrated into many roadways;
- and the Sun Link Streetcar began operations, spurring significant development in Tucson's downtown core and around the University of Arizona.

But much still remains to be done.

Purpose of the Street Design Guide

While it will take decades to address the legacy of Tucson's historic transportation practices, the development of the City of Tucson Street Design Guide is an important step in the effort, building on recent progress to ensure that Tucson's streets meet the needs of all users. The purpose of this document is to take the concepts described in the Complete Street Policy and apply them to specific contexts and elements of city street design. The Guide, in combination with the Policy, institutionalizes the Complete Streets approach within City agencies to make it a routine part of the decision-making process.

The Guide provides direction to policymakers, City agencies, private-sector engineering firms, developers, and community members about where, when, and how to incorporate best practices in Complete Streets design. The Guide promotes higher-quality street designs that will ultimately, as each project is completed, result in a network of roadways stretching across the city that is safe, attractive, comfortable, and welcoming for all.

The Guide is meant to supplement, not replace, existing City of Tucson engineering practices in order to meet the goals of the Complete Streets Policy. It is general in application—providing design guidance on the preferred use of the right-of-way in a way that is consistent with tenets of Complete Streets—without being overly prescriptive.

However, where there may be direct conflicts or inconsistencies between the guidance provided in this document and existing City of Tucson transportation guidelines, standards, details, or policies (such as recommended travel lane widths), practitioners should look to the Street Design Guide for direction. Though, in all cases, engineering judgment should be used.

The Tucson Department of Transportation and Mobility (DTM) will revise conflicting policy or design direction following the adoption of the *Street Design Guide* to ensure future consistency.

Move Tucson

The *Street Design Guide* was developed in coordination with a new City of Tucson long-range transportation plan, known as *Move Tucson*. The two documents are companion pieces, with the *Guide* establishing a new Tucson street typology (Chapter 2) and describing preferred street design elements, while *Move Tucson* assigns the street types established in the *Guide* to the transportation network. and sets priorities for where design improvements will be made in a constrained funding environment. *Move Tucson's* focus is on building a complete and connected network, recognizing that not all streets can serve all users at the same level.
Both the *Guide* and *Move Tucson* are intended to be living documents, meaning that as conditions change, transportation practices evolve, and new priorities emerge (such as with the introduction of newer transportation technologies), one or both documents will be updated to reflect new realities.

Using the Guide

The *Guide* should be used early in the project development process. This ensures that the concepts presented herein are incorporated at the outset of project design, not as an afterthought. The default for all transportation projects should be that they are Complete Streets projects: the *Guide* sets expectations for what that means in the Tucson context. Using the *Guide* to communicate what Tucson expects of its transportation system provides a common point of reference and establishes foundational design principles to allow project teams and stakeholders to identify acceptable trade-offs and work through competing priorities.

Figure 2 shows a simplified representation of the project development process and how the Complete Streets Guide should be used in the project development process. **The Guide will be most applicable during the Corridor Planning and Conceptual Design stages of the development project** (highlighted in teal in Figure 1.2).

It is important to note, though not specified in Figure 2, that the public is involved in every stage of transportation decision making, from informing network priorities and performance targets in the planning stage to engaging in the development of conceptual corridor designs and providing input at the different levels of design.

The project development process and level of involvement will vary based on the size and complexity of projects. Some smaller-scale projects may go directly from project identification to 60 percent or 90 percent design, while larger, multi-year projects, may require very involved corridor planning processes, resulting in multiple iterations of conceptual designs with plan submittals at more frequent intervals.

Figure 1.2
Complete Streets Incorporation in the Transportation Project Development Process

NETWORK PLANNING	CORRIDOR PLANNING	CONCEPTUAL DESIGN	ENGINEERING DESIGN
Phase Elements • Transportation goals and performance targets • Existing conditions review • Network deficiencies and performance issues screening • Investments prioritization and project identification	**Phase Elements** • Study area boundaries • Project goals and scope • Corridor needs assessment and deficiencies • Initial design approach • Preliminary cost estimate	**Phase Elements** • Alternatives development and selection • Preliminary design elements and dimensions • Baseline alignment adoption • Refined cost estimate • Preliminary cost estimate • Corridor needs assessment • Up to 30% design	**Phase Elements** • Design reviews and refinements • Utility conflicts identified and addressed • Acquisitions, relocations, and demolitions • Cultural clearances • Final construction estimate • 60% plan to final design • Construction scheduling and phasing
Street Design Guide Use the Guide as reference in the network planning phase to determine where current streets are not designed consistent with the recommendations of this document.	**Street Design Guide** The Guide should inform the initial corridor needs assessment and be used as a key reference in developing an initial design approach based on the street type of the project location.	**Street Design Guide** The Guide is most applicable in conceptual project design. The Guide's recommendations should be used to determine street design elements, allocation of space in the right-of-way, and preliminary dimensions of roadway elements.	**Street Design Guide** The Guide should be used in the review of design submittals to ensure design refinements are still consistent with the guidance of this document.

Critically, since the Street Design Guide is communicating the broad objectives of aligning City street design with a Complete Streets approach, it does not address every element of street design. Practitioners must continue to refer to existing guidelines, standards, details, and policies to develop a safe and accessible transportation system. Figure 1.3 below lists the many resources that may be considered in planning and designing transportation projects in the City of Tucson. It is not exhaustive. The documents range from long-range planning documents to engineering standards.

Figure 1.3
Relevant Standards and Manuals by Phase

NETWORK PLANNING	CORRIDOR PLANNING	CONCEPTUAL DESIGN	ENGINEERING DESIGN
• Move Tucson • PAG Regional Mobility and Accessibility Plan (RMAP) • Regional Transportation Authority Plan (RTA) • Modal Plans: - Bicycle Boulevard Master Plan - Regional Freight Plan - Pedestrian Safety Action Plan - Etc. • Plan Tucson • Tucson Major Streets and Routes Plan **• Tucson Street Design Guide**	**• Tucson Street Design Guide** • Move Tucson, RMAP, RTA • Tucson Major Streets and Routes Plan • NACTO Guidelines • Tucson Access Management Guidelines • Transportation Research Board Highway Capacity Manual	**• Tucson Street Design Guide** • Tucson Technical Standards Manual • NACTO Guidelines • AASHTO A Policy on Geometric Design of Highways and Streets • Tucson Access Management Guidelines • District specific (4th Ave/Downtown) design guidelines • International Fire Code (with Tucson Amendments) • Tucson City Code Chapters 25/26 • Tucson Major Streets and Routes Plan • Landscape Design and Green Streets Active Practice Guidelines	• AASHTO A Policy on Geometric Design of Highways and Streets • MUTCD • PAG Standard Specifications and Details for Public Improvements • Pima County/City of Tucson Signing and Pavement Marking Manual • TDOT Active Practice Guidelines • TDOT Departmental Policies and Procedures • Tucson Technical Standards Manual • Standard Manual for Drainage Design and Floodplain Management in Tucson, Arizona • Tucson City Code Chapters 25/26 • Tucson Water Standards Specifications and Details **• Tucson Street Design Guide**

USERS

The Street Design Guide is intended to serve a variety of users in different ways.

- For City departments, the Guide serves as a key reference to ensure all transportation projects are designed in accordance with Complete Street principles.
- Engineering firms should consult the Guide when developing design concepts for corridor improvements.
- Private developers can use the Guide to proactively integrate relevant Complete Streets elements into their projects.
- Elected officials may refer to the Guide when proposing public improvements in the city.
- Community groups and residents can employ the Guide to review transportation projects and to advocate for improvements in their neighborhoods.

General Guidance

The Street Design Guide is structured around two primary sections.

1) The first section (Chapter 2) establishes new Complete Streets road typologies and includes cross-sections and design dimensions for the various street elements.

2) The second section (encompassing Chapters 2 – 6) is a design toolkit that discusses Complete Streets design elements in more detail, providing an overview of each element, its application and use, design and operation, and other considerations.

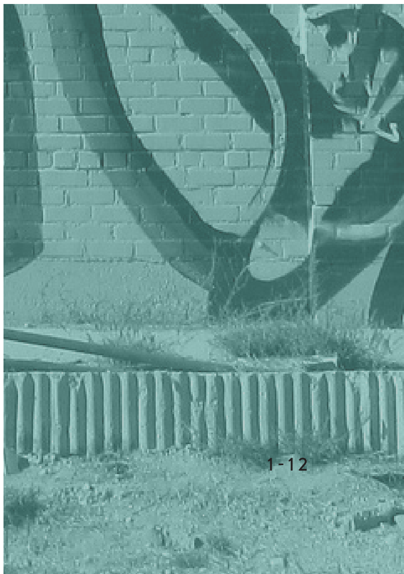
DIMENSIONS

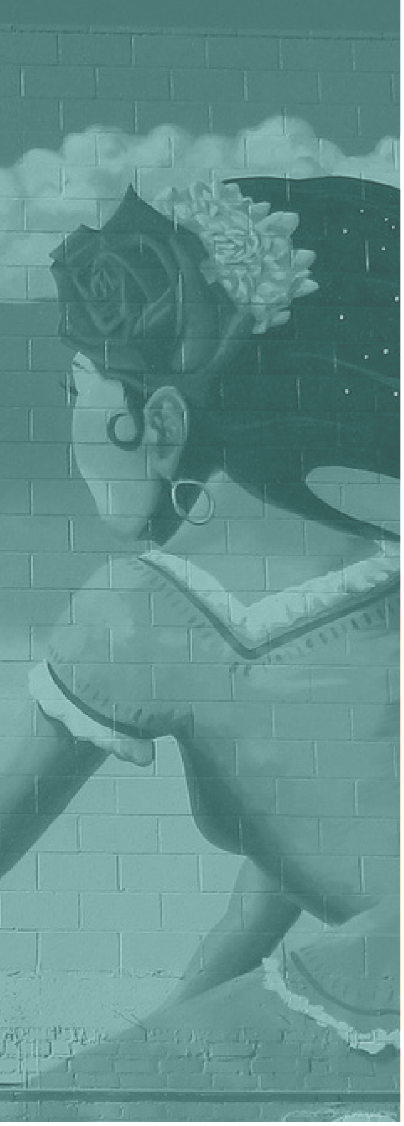
Street geometries presented in the Guide's first section include *minimum, maximum,* and *preferred dimensions*[1-1]. **The preferred dimension should be the starting point for roadway design.** In the second section (the toolkit), the Guide provides recommendations and considerations but does not require or restrict usage, except where specified.

[1-1] See tables 2.4 and 2.5 in Chapter 2 for street dimensions and priorities in constrained rights-of-way.

DESIGN FLEXIBILITY

While the Guide includes preferred roadway dimensions and recommendations for design treatments, design flexibility is still a key element of the project development process. It is understood that transportation improvements in Tucson's urban area are complex, requiring project teams to account for narrow and/or irregular rights-of-way, stormwater management, cultural and historic resources, established vegetation, and utilities, among others.





As such, the Guide is intended to be supportive of, not a replacement for, the professional judgment of practitioners, with each transportation improvement requiring close coordination between design professionals, stakeholders, and other partners to address unique project challenges.

Where designing to the preferred roadway dimensions is not possible (or, in some cases, not advisable), the team should use professional judgment to assemble roadway elements within the minimum/maximum ranges, whilst adhering to Complete Streets principles. **Any proposed roadway design that deviates from the minimum and maximum dimensions will require the approval of the City Engineer** (see Figure 4).

Designs that do not meet the intent of the Complete Street Policy, such as those that do not provide accommodation for all roadway users, will need to apply for a Policy exception, discussed in more detail later in this chapter.

OUTSIDE-IN DESIGN

Where rights-of-way are narrow, or other conflicts make it difficult to fully design to the preferred dimensions, project teams are encouraged to use an "outside-in" design approach. The "outside-in" approach, as described in the Institute of Transportation Engineers' (ITE) Implementing Context Sensitive Design on Multimodal Thoroughfares, is one in which the project's designer works from the outside of the roadway to the inside to ensure that the "needs of pedestrians, bicyclists, transit riders, and freight loading and unloading, etc." are considered first in the design process.[1-2]

The "outside-in" approach may require that motor vehicle capacity is treated as a secondary consideration (depending on project goals), potentially resulting in the acceptance of increased vehicle delay as a reasonable trade-off for improved safety and accommodation of other roadway users.

APPLICABILTY

The Guide should be applied to improvements on City-owned streets, including where private development makes improvements to the public right-of-way. Privately constructed streets should be built to the standards of the City of Tucson Unified Development Code.

[1-2] Institute of Transportation Engineers. Implementing Context Sensitive Design on Multimodal Thoroughfares: A Practitioners Handbook. (2017) Pg. 25.

DESIGN EXCEPTIONS

In cases where the development team judges that accommodation cannot, or should not, be made for one or more user group, the Complete Streets Policy states that exceptions may be granted.

Exceptions can be granted upon review and approval under the circumstances shown in Table 1.2.

Table 1.2
Complete Streets Policy Exceptions.

#	EXCEPTION
1	*Accommodation is not necessary on roadways where specific users are prohibited, such as bicycles on interstate freeways.*
2	*The cost of accommodating the needs of a particular user group for the transportation project would be disproportionately high relative to the current or future need or probable use of the facilities by the particular user group. This determination should be made with due consideration to future users, latent demand, and the social and economic value of providing a safer and more convenient transportation system for all users.*
3	*There is a documented absence of current and future need.*
4	*Funding source is restricted in terms of how it can be used.*
5	*Project is in final design or construction as of the effective date of this Policy.*
6	*Project involves emergency repairs that require immediate, rapid response (such as a water main leak). Temporary accommodations for all modes shall still be made whenever feasible. Depending on severity and/or length of time required to complete the repairs, opportunities to improve multimodal access shall still be considered where possible as funding allows.*
7	*Project involves routine maintenance that does not change the roadway geometry or operations, such as mowing, sweeping, or spot repair.*

Any request for exceptions within categories 1–5 above shall be reviewed by the TRC in consultation with the CSCC.

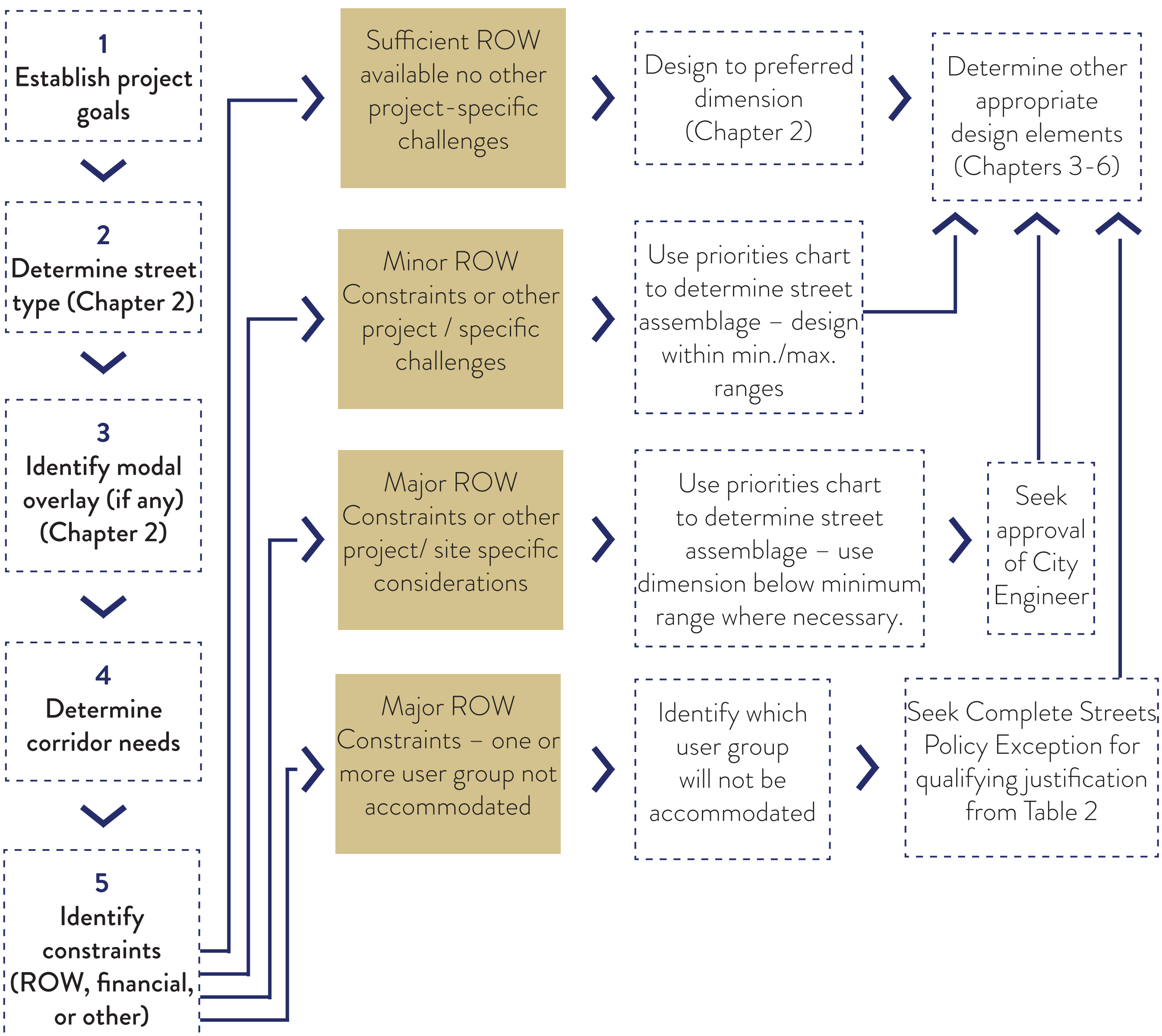
City staff or private developers shall put into writing a request for an exception and provide supporting documentation on how the project fits into one of the aforementioned exception categories. The request shall be made publicly available.

The Tucson Department of Transportation and Mobility Director shall provide the final ruling on whether or not to grant the exception after receiving comments from the TRC and the CSCC. The decision shall be documented with supporting data that indicates the basis for the decision, and all documents shall be made publicly available.

Categories 6 – 7 do not require the exceptions review process as outlined above.

Figure 1.4 provides a summary of project conditions and when to apply flexible approaches to design or seek exceptions.

Figure 1.4
Relevant Application of Exceptions and Flexibility in Project Design



CONSISTENCY

The Street Design Guide is consistent with and incorporates design elements from the following national transportation design manuals.

- **National Association of City Transportation Officials (NACTO),** *Urban Street Design Guide*
- **NACTO,** *Urban Bikeway Design Guide*
- **NACTO,** *Transit Street Design Guide*
- **Institute of Transportation Engineers (ITE),** *Implementing Context Sensitive Design on Multimodal Corridors: A Practitioners Handbook*
- **ITE,** *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach*
- **The American Association of State Highway Transportation Officials (AASHTO),** *A Policy on Geometric Design of Highways and Streets (also known as The Green Book)*
- **The Federal Highway Administration (FHWA),** *Manual of Uniform Traffic Control Devices for Roads and Streets (MUTCD)*
- **FHWA,** *Proven Safety Countermeasures*
- **FHWA,** *Pedbikesafe.org*
- **United States Access Board,** *Americans with Disabilities Act Accessibility Guidelines (ADAAG)*
- **U.S. Access Board,** *Public Rights-of-Way Accessibility Guidelines (PROWAG)*

Using the listed manuals and guidance ensures that the Street Design Guide is consistent with existing federal standards while promoting more innovative and flexible design approaches appropriate for the Tucson area.

OTHER CONSIDERATIONS

The Guide forwards several policies from Plan Tucson, the City of Tucson's General and Sustainability Plan. Among these are:

- **LT11 –** Adjust future right-of-way widths of major roadways considering their expected function for all modes of transportation and foreseen improvements.
- **LT12 –** Design and retrofit streets and other rights-of-way to include green infrastructure and water harvesting, complement the surrounding context, and offer multi-modal transportation choices that are convenient, attractive, safe, and healthy.
- **LT13 –** Continue to explore and monitor opportunities to increase the use of transit, walking, and bicycles as choices for transportation on a regular basis.

- **LT14 –** Create pedestrian and bicycle networks that are continuous and provide safe and convenient alternatives within neighborhoods for getting to school, work, parks, shopping, services, and other destinations on a regular basis.
- **LT22 –** Participate in efforts to develop a coordinated regional, multi-modal transportation system that improves the efficiency, safety, and reliability of transporting people and goods within the region and to destinations outside of the region.

Additionally, the Guide is consistent with direction provided by Pima Association of Governments (PAG), who in 2015 passed a resolution encouraging member jurisdictions to "develop locally appropriate Complete Streets guidance".[1-3]

[1-3] Pima Association of Governments. Resolution by the Regional Council of Pima Association of Governments Supporting Complete Streets. (2015).

Contents

The Street Design Guide is organized into seven chapters.

Chapter 1. Introduction and Purpose
This chapter summarizes the Policy foundation for the Guide and provides general guidance on usage of the document in project development.

Chapter 2. Street Types
This chapter establishes new street typology and provides example cross-sections of preferred road dimensions.

Chapter 3. Pedestrian Area Design Elements
This chapter provides a toolkit of pedestrian walkway and roadside design treatments.

Chapter 4. Roadway Design Elements
This chapter provides a toolkit for in-the- road design enhancements, including bike facilities, transit accommodations, travel lanes, and traffic calming.

Chapter 5. Intersections and Crossings Design Elements
This chapter provides guidance on designing safe intersections and crossing opportunities.

Chapter 6. Green Streets
This chapter discusses how to incorporate landscaping, street trees, and green infrastructure into the roadway.

Chapter 7. Implementation
This chapter discusses opportunities for the implementation of Complete Streets design.

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STREET TYPES

STREET TYPES

Overview

As discussed in Chapter 1, a key concept in Complete Streets road design is taking into account a roadway's context -the area surrounding a roadway. To take the roadway's context into account the *Street Design Guide* uses a new street typology.

A street typology classifies streets based on sets of similar characteristics such as elements of roadway function, location, and adjacent development patterns. This new street typology will emphasize the transportation and land use connection to make design decisions that are appropriate in each community context, which is different than the traditional FHWA functional classification system.

Design guidance is made with the new street types in mind.

This chapter describes Tucson's street types in broad terms. It covers general principles of design and discusses modal priorities.
This chapter also provides guidance on the preferred dimensions of the different roadway zones for each street type, including the sidewalk zone, landscaping strip/amenity zone, bikeways, transit ways, and travel lanes, illustrated with sample cross-sections.

Importantly, the *Guide* does not assign the new street types to Tucson's road network, other than providing illustrative examples. Street types, as stated previously, are assigned to Tucson's road network in Move Tucson.

Federal Functional Classification System

Tucson's Complete Streets typology is intended to supplement and enhance the existing federal functional classification system.

The functional classification system is general in nature so as to be applicable to all public roads in the United States. It uses a hierarchy to group classes of streets based on the relative emphasis of vehicular mobility versus property access. Its purpose is to serve as a framework for identifying the particular role of a roadway in moving vehicles through a network of highways.

[Previous two-page spread]
A street in Downtown Tucson.
Source: "Hotel Congress" by Paul Sableman under license CC BY 2.0

The following functional classes are those that are most relevant to this Guide:

- Other Principal Arterial (non-interstate or expressway)
- Minor Arterial
- Collector (major and minor)
- Local Road

Connecting the federal functional classification system to Tucson's street typology is important to facilitate coordination with regional partners, who use functional classification, for reporting transportation performance data, and ensuring eligibility for federal transportation funding, which is distributed through the Federal-aid Highway Program.

Tucson's Street Types

Tucson's streets are classified into the following nine types:

- Downtown / University District
- Neighborhood Commercial
- Urban Thoroughfare
- Urban Connector
- Suburban Thoroughfare
- Suburban Connector
- Neighborhood Street
- Shared Street
- Industrial Street

The nine street types offer a balance between functional classification, adjacent land uses, and the competing needs of all transportation modes. Each street type prioritizes various design elements and the allocation of right-of-way based on the context and character of the neighborhood and street.

The types are further refined through a network of modal priorities. These are:

- Frequent Transit Network
- Regionally Significant Corridor
- Freight Corridor
- Bicycle Priority Streets
- Bicycle Boulevard

The street types are not intended to be applied continuously across the length of any given corridor; a single street may change type as the surrounding land uses or functions of the road change. For example, a street may transition from an Urban Connector to a Neighborhood Commercial street and then back again depending on the context. Additionally, more than one modal priority may co-exist with the underlying street type. For example, a Regionally Significant Corridor may also be identified as a Freight Corridor, and both can be located on an Urban Thoroughfare.

Description

The following pages describe the nine street types and five modal priorities in more detail. **The street types are based on current conditions of roadway function and context. Modal priorities were identified through separate City or regional planning processes.** The descriptions provided are a general guide that should be used to assign road types in Move Tucson using the dominant characteristics of the roadway. Not all roads will perfectly align with all listed characteristics, so the characteristics should be looked at in their totality.

Street Type	DOWNTOWN / UNIVERSITY DISTRICT

Description

Destination streets typical of Downtown Tucson and surrounding the University of Arizona. Characterized by active street life; multi-story, mixed-use buildings; heavy bike and pedestrian usage; on-street parking; and slower travel speeds.

Typical Roadway Characteristics

AADT	Below 20,000
Lanes	2 – 4
Curb-to-Curb Width	35 – 60 ft.
Roadway Connectivity	High
Flow	1 or 2-way
Speed	Low
Driveways	Minimal

Typical Development Characteristics

Land Use	Mix of multifamily residential, office, and ground floor service.
Building Height	Multi-story (2-20 stories+)
Development Intensity	High
Building Setback	Minimal / Built to sidewalk
Building Lot Coverage	High
Building Orientation	Street
Parking	Garage, shared surface lot, or on-street

Examples

Congress St. (Church St. to 4th Ave.)
University Blvd.
6th Ave. (12th St. to Toole Ave.)
N. Park Ave. (north of 6th St.)

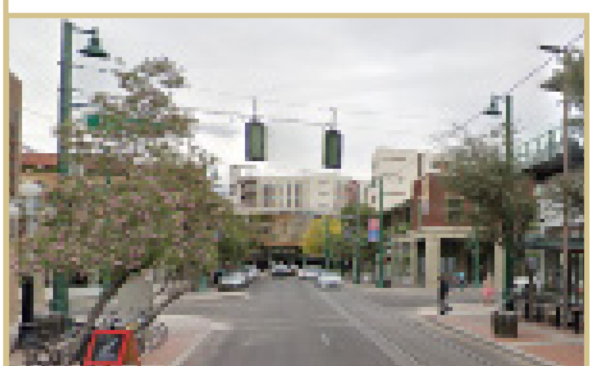


Image 2.1
Congress St.

Street Type NEIGHBORHOOD COMMERCIAL DISTRICT

Description

An emerging street type that acts as a walkable destination/activity center but without the height or density of the downtown. Characterized by 1-3 story mixed-use buildings built to the sidewalk; pedestrian-scale design; ground-floor retail/restaurants; active street life; on-street parking; and slower travel speeds.

Typical Roadway Characteristics

AADT	Below 15,000
Lanes	2 – 3
Curb-to-Curb Width	35 – 55 ft.
Roadway Connectivity	High
Flow	2-way
Speed	Low (25 mph)
Driveways	Minimal

Typical Development Characteristics

Land Use	Primarily retail, dining, and entertainment. Some residential above ground floor.
Building Height	1 – 3 stories
Development Intensity	Moderate-to-High
Building Setback	Minimal / Built to sidewalk
Building Lot Coverage	High
Building Orientation	Street
Parking	Garage, small shared surface lot, or on-street

Examples

E. 6th St. near Tucson Blvd.

Image 2.2
6th St.

Street Type	URBAN THOROUGHFARE

Description

Large roadways located in central Tucson. The thoroughfare primarily serves local and regional vehicle travel, freight, and transit, with some pedestrian and bike activity. Characterized by high traffic volumes and moderate-to-high speeds. Land use is a mix of small strip commercial, commercial centers, with some residential (multi and single family). Buildings are primarily 1-3 stories, though taller multi-story buildings can also be found, with a growing number being constructed recently.

Typical Roadway Characteristics

AADT	25,000+
Lanes	4 – 6
Curb-to-Curb Width	60+ ft.
Roadway Connectivity	Moderate-to-High
Flow	2-way
Speed	Moderate-to-High (30 – 40 mph)
Driveways	Frequent

Typical Development Characteristics

Land Use	Mainly single use strip commercial and office. Some multi/single-family detached residential.
Building Height	1 – 3 stories, with some taller buildings closer to downtown and the University of AZ
Development Intensity	Moderate
Building Setback	20 – 75 ft. from curb
Building Lot Coverage	Moderate
Building Orientation	Street
Parking	Small surface lots on front side of buildings

Examples

Grant Rd. (Campbell to Country Club)
Irvington Rd. (12th Ave. to 6th Ave.
1st Ave. (Grant to Ft. Lowell)

Image 2.3
Speedway Blvd. and Campbell Ave.

Description

Moderately sized roadways in central Tucson. The street serves a mix of vehicular travel, bike and pedestrian travel, and transit. Characterized by low-to-moderate volumes, low-to-moderate speeds, and moderate dimensions. Land use is a mix of smaller-scale commercial developments and residential (multi and single family). Buildings are mainly 1- 3 stories, though multi-story buildings can also be found.

Typical Roadway Characteristics

AADT	3,000 – 25,000
Lanes	2 – 5
Curb-to-Curb Width	35 – 60 ft.
Roadway Connectivity	Moderate-to-High
Flow	2-way
Speed	Low-to-Moderate (25 – 35 mph)
Driveways	Frequent

Typical Development Characteristics

Land Use	Single-family detached residential. Some multi-family residential and strip commercial.
Building Height	1 – 3 stories, with occasional locations with taller buildings, particularly closer to downtown and the University of Arizona
Development Intensity	Moderate
Building Setback	15 – 40 ft. from curb
Building Lot Coverage	Moderate
Building Orientation	Mix of street and away from street
Parking	Small surface lots, individual driveways, and sometimes on-street parking

Examples

Glenn St.
Park Ave. (north of Speedway Blvd.)
S. 6th Ave. (Irvington Rd. to Ajo Way)

Image 2.4
Glenn St.

Street Type	SUBURBAN THOROUGHFARE

Description

Large roadways located in lower-density areas. The Thoroughfare primarily serves local and regional vehicle travel, freight, and transit. Characterized by high traffic volumes, moderate-to-high speeds, and wide dimensions. Land use is a mix of large commercial centers with some smaller strip developments and residential. Buildings tend to be set further back from the sidewalk than the Urban Thoroughfare and occupy less of the lot due to larger surface parking.

Typical Roadway Characteristics

AADT	25,000+
Lanes	4 – 6
Curb-to-Curb Width	60+ ft.
Roadway Connectivity	Low-to-Moderate
Flow	2-way
Speed	Moderate-to-High (35 – 40 mph)
Driveways	Infrequent

Typical Development Characteristics

Land Use	Commercial centers, small strip commercial and office, and residential developments.
Building Height	1 – 2 stories, occasional taller buildings
Development Intensity	Low-to-Moderate
Building Setback	60+ ft. from curb
Building Lot Coverage	Low-to-Moderate
Building Orientation	Largely oriented away from the street
Parking	Large surface parking lots

Examples

Broadway Blvd. (East of Wilmot Rd.)
Wetmore Rd. (Oracle Rd. to 1st Ave.)
Valencia Rd. (I-19 to Mission Rd.)

Image 2.5
E. Broadway Blvd.

Street Type	SUBURBAN CONNECTOR

Description

Moderately sized roadways located in lower-density areas. The streets serve a mix of vehicular travel, bike and pedestrian travel, and transit. Characterized by low-to-moderate volumes, low-to-moderate speeds, and moderate dimensions. Land use is primarily residential with some small-scale commercial. Buildings tend to be set further back from the sidewalk than the Urban Connector and development intensity is lower, even rural in some cases.

Typical Roadway Characteristics

AADT	3,000 – 25,000
Lanes	2 – 5
Curb-to-Curb Width	35 – 60 ft.
Roadway Connectivity	Low-to-Moderate
Flow	2-way
Speed	Moderate (30 – 35 mph)
Driveways	Infrequent

Typical Development Characteristics

Land Use	Residential developments, small strip commercial and office.
Building Height	1 to 2 stories, occasional taller buildings
Development Intensity	Low-to-Moderate
Building Setback	40+ ft. from curb
Building Lot Coverage	Low-to-Moderate
Building Orientation	Largely oriented away from the street
Parking	Large surface parking lots, individual driveways

Examples

Limberlost Dr. (Oracle Rd. to Campbell Ave.)
Escalante Rd. (Kolb Rd. to Camino Seco)
Greasewood Rd. (Ironwood Hill Dr. to Speedway Blvd.)

Image 2.6
Escalante Road

Street Type	NEIGHBORHOOD STREET

Description

Local residential streets located across the city. The streets provide access to residences and are often a safer, more comfortable option for walking and biking. Characterized by slow travel speeds, narrower dimensions, and low traffic volumes. Land use is almost exclusively residential.

Typical Roadway Characteristics

AADT	Below 3,000
Lanes	2 (unmarked)
Curb-to-Curb Width	27 – 40 ft.
Roadway Connectivity	Varies by location
Flow	2-way
Speed	Low (25 mph)
Driveways	Frequent

Typical Development Characteristics

Land Use	Primarily single-family residential. Some multi-family, some small-scale commercial.
Building Height	1 – 2 stories
Development Intensity	Varies by location
Building Setback	20 – 40 ft. from curb
Building Lot Coverage	Low-to-Moderate
Building Orientation	Oriented to the street
Parking	Individual driveways, some shared driveways

Examples

N. Fair Oaks Ave.
E. Allen Rd
W. Alaska St.

Image 2.7
Exeter Street

Street Type — SHARED STREET

Description

The narrowest of residential streets, these are typically less than 27 ft. wide. They are called shared streets because they serve pedestrians, bikes, and vehicles together in the street. Some of these streets almost act like alleys. The narrow streets encourage very low travel speeds making them a safe environment for all users.

Typical Roadway Characteristics

AADT	Below 3,000
Lanes	2 (unmarked)
Curb-to-Curb Width	18 – 27 ft.
Roadway Connectivity	Varies by location
Flow	2-way
Speed	Very Low (below 25 mph)
Driveways	Frequent

Typical Development Characteristics

Land Use	Primarily single-family residential.
Building Height	1 – 2 stories
Development Intensity	Varies by location
Building Setback	10 – 20 ft. from curb
Building Lot Coverage	Moderate-to-High
Building Orientation	Mix of street and away from street
Parking	On-street or residential driveways

Examples

S. Meyer Ave.
E. Cerulean Way
S. Railroad Ave.

Image 2.8
Cerulean Way

Street Type	**INDUSTRIAL STREET**

Description

Streets in industrial areas that provide access to manufacturing plants and warehouses. Characterized by a high share of freight traffic and industrial land uses. Traffic volumes and speeds tend to be lower than on Connectors or Thoroughfares.

Typical Roadway Characteristics

AADT	Below 20,000
Lanes	2 – 4
Curb-to-Curb Width	25 – 50 ft.
Roadway Connectivity	Depends on location
Flow	2-way
Speed	Low-to-Moderate (25 – 30 mph)
Driveways	Frequent

Typical Development Characteristics

Land Use	Streets that serve industrial land uses. Manufacturing, warehousing / distribution, utilities, etc.
Building Height	1 – 2 stories
Development Intensity	Low-to-Moderate
Building Setback	60+ ft. from curb
Building Lot Coverage	Low-to-Moderate
Building Orientation	Largely oriented away from the street
Parking	Large surface parking lots

Examples

Flowing Wells Rd. (Miracle Mile to Grant Rd.)
N. Runway Dr. (Gardner Ln. to Prince Rd.)
Irvington Rd. (Contractor's Way to Swan Rd.)

Image 2.9
Flowing Wells Rd.

Street Type **FREQUENT TRANSIT NETWORK**

Description

Roadways in which there are bus routes with headways of 15 minutes or less, Monday through Friday from 6 a.m. to 6 p.m.
Source: Suntran.com/ftn and 2020 Long-Range Regional Transit Plan.

Examples

Speedway Blvd. (Euclid Ave. to Kolb Rd.)
6th Ave. (Downtown Tucson to Irvington Rd.)
22nd St. (10th Ave. to Houghton Rd.)

Image 2.10
South 6th Ave near 20th St.

Street Type **REGIONALLY SIGNIFICANT CORRIDOR**

Description

Thoroughfares serving longer vehicular trips and regional commuting, including state highways, state routes, and regional arterials.
Source: Pima Association of Governments 2013 Regionally Significant Corridors Study.

Examples

Grant Rd. (Silverbell Rd. to Kolb Rd.)
Golf Links Rd. (Alvernon Rd. to Houghton Rd.)
Kolb Rd. (Grant Rd. to I-10)

Image 2.11
Kolb Rd. near Yuma St.

Street Type	FREIGHT CORRIDOR

Description

Roadways which serve major manufacturing and warehousing concentrations or upon which a high number of multi-unit trucks travel.
Source: Pima Association of Governments 2018 Regional Freight Plan.

Examples

Valencia Rd. (Ajo Rd. to Houghton Rd.)
Grant Rd. (Silverbell Rd. to Kolb Rd.)
Alvernon Wy. (Golf Links Rd. to Aerospace Pkwy.)

Image 2.12
Park Ave at 20th St.

Street Type	BICYCLE PRIORITY STREET

Description

Bicycle Priority Streets are connector streets in which more space is allocated to bicyclists through wider bicycle lane buffers/protective elements and/or wider bicycle lanes.
Source: Move Tucson.

Examples

Mountain Ave.

Image 2.12
Mountain Ave.

Street Type **BICYCLE BOULEVARD**

Description

Bicycle boulevards are residential streets designed to prioritize bicycling and enhance conditions for walking.
Source: City of Tucson 2017 Bicycle Boulevard Master Plan.

Examples

3rd St. / University Blvd.
Fontana / 4th Ave.
Liberty / San Fernando Ave.

Image 2.13
Liberty Bicycle Boulevard

Each of the street types described above can be associated with the existing federal functional classifications system. Table 2.1 provides a conversion between Tucson's street types and the functional classes.

STREET TYPE	PRINCIPAL ARTERIAL	MINOR ARTERIAL	COLLECTOR	LOCAL
Downtown / Unversity	■	■	■	■
Neighborhood Commercial		■	■	■
Thoroughfare	■	■		
Connector		■	■	
Neighborhood Street				■
Shared Street				■
Industrial Street			■	■

Table 2.1
Conversion Chart between Tucson Street Types and Federal Functional Classification System

As stated, the street types reflect current conditions within the City of Tucson which provide a familiar and meaningful basis for classification. The description of each type should not be treated as a recommendation for, or restriction on, any particular type of development.

For example, the description for the Urban Thoroughfare and Connector indicates that one-to-three story buildings are typical. This does not mean that those are necessarily the desired building heights. Density is increasing on many urban corridors within central Tucson, which will likely lead to more walking, biking, and transit, particularly where street design is supportive of such activity. The Tucson street typology is intended to be flexible enough to accommodate these types of changes, achieved either by applying the design flexibility allowed within each street type or, if changes are significant enough, by assigning a new street type to a given road segment. As Tucson's urban form continues to evolve, the types and descriptions can be updated to better reflect community conditions.

To ensure compatibility between the street types and changing community context, the street types are checked against future growth areas identified in Plan Tucson, the City of Tucson's General and Sustainability Plan.

Every city street should be assigned with a street type to ensure that the Complete Streets approach is appropriately incorporated into all transportation improvements, from the smallest neighborhood street to the largest thoroughfare, and from suburban areas to Tucson's downtown.

The remaining sections of this chapter provide broad guidance on the desired cross-sectional dimensions for each street type. In most cases, Tucson's streets do not currently conform to these dimensions, so roadways will need to be reconfigured during improvements to transform Tucson's street network to reflect the Complete Streets model. Improvements could range from full corridor construction/reconstruction projects down to low-cost interventions with paint and posts.

Design Values

Roadway improvements should employ the following design values in a manner appropriate for the street type and project goals:

- **Prioritize safety.**
- **Ensure facilities are accessible for all users.**
- **Discourage speeds that are excessive for the roadway function and context. Do not over-rely on signage and enforcement to discourage unsafe speeds, rather design the roadway to a target speed.**
- **Take advantage of opportunities to re-allocate space, where appropriate, to support walking, biking, and transit use. Choose designs that encourage active modes.**
- **Consider multimodal performance measures. Do not let congestion and vehicle travel times be the only project considerations.**
- **Look for opportunities to address user needs and project goals through operational improvements and corridor modernization. Widening roads in the urban area should be the option of last resort.**
- **Integrate green elements, such as trees, other landscaping, and the use of green infrastructure, in roadway projects.**
- **Engage the community early and often to ensure that proposed improvements are context-appropriate and serve intended users.**
- **Use heat-reducing design elements in the public right-of-way wherever possible to mitigate the urban heat island effect and to increase resilience against climate change.**

SETTING A TARGET SPEED

There is a direct and well-documented connection between high travel speeds, increased crash risk, and injury severity (Table 2.2). Higher travel speeds increase stopping distance and narrow drivers' field of vision, which reduces awareness of potential crash risks approaching perpendicular to the direction of travel (such as pedestrians stepping into the roadway).

Table 2.2
Stopping Distance, Crash Risk, and Fatality Risk at Given Speeds.

SPEED (MPH)	STOPPING DISTANCE (FT)*	CRASH RISK (%)	FATALITY RISK (%)
10 – 15	25	5	2
20 – 25	40	15	5
30 – 35	75	55	45
40+	118+	90	85

*Stopping Distance includes perception, reaction, and braking times.

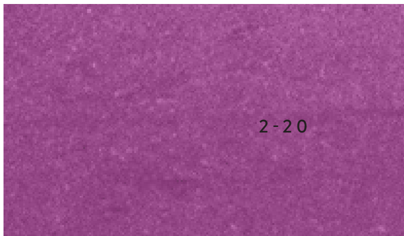
Source: Traditional Neighborhood Development: Street Design Guidelines (1999), ITE Transportation Planning Council Committee.

In areas with a high potential for walking and biking due to the underlying community characteristics, high travel speeds deter residents from choosing active modes due to increased traffic noise and a greater sense of risk. This is ultimately at odds with the intent of Tucson's *Complete Streets Policy*.

Simply lowering the speed limit does little to decrease travel speeds as drivers tend to respond to the character of the urban environment and road design when determining how fast to drive. Moreover, posting speed limits too low for the design of the roadway places a considerable enforcement burden on the police department and could pose a safety risk as the speed differential increases between those who drive at higher speeds in response to roadway design vs. those who follow the posted speed limit.

One strategy for discouraging excessive speeds, increasing safety, and making a more comfortable travel environment for non-motorists is to design roads to a "target speed." Target speed, as defined by ITE, "is the highest speed at which vehicles should operate on a thoroughfare in a specific context, consistent with the level of multimodal activity generated by adjacent land uses to provide both mobility for motor vehicles and a safe environment for pedestrians and bicyclists."[2-1] Stated simply, using a target speed means designing the roadway for how fast drivers are intended to go.

[2-1] Institute of Transportation Engineers and Congress for the New Urbanism. Designing Walkable Urban Thoroughfares: A Context Sensitive Approach. (2010). Pg. 108



This is a more proactive approach than conventional practice in which vehicle operating speeds are used to determine the design speed of the roadway, which then determines the speed limit.

PROACTIVE SPEED LIMIT APPROACH

Target Speed > Design Speed > Posted Speed

TRADITIONAL SPEED LIMIT APPROACH

Operating Speed > Design Speed > Posted Speed

This Guide recommends that project teams select a target speed at the outset of a transportation project and use it to determine the appropriate selection of design elements. Elements related to target speed could include, but are not limited to:

- Lane widths
- Curb radii
- Signal progression
- Turn lane depth
- Median design
- Deceleration distance
- On-street parking
- Curb lines
- Sight distance
- Tree canopy
- Land use and building location

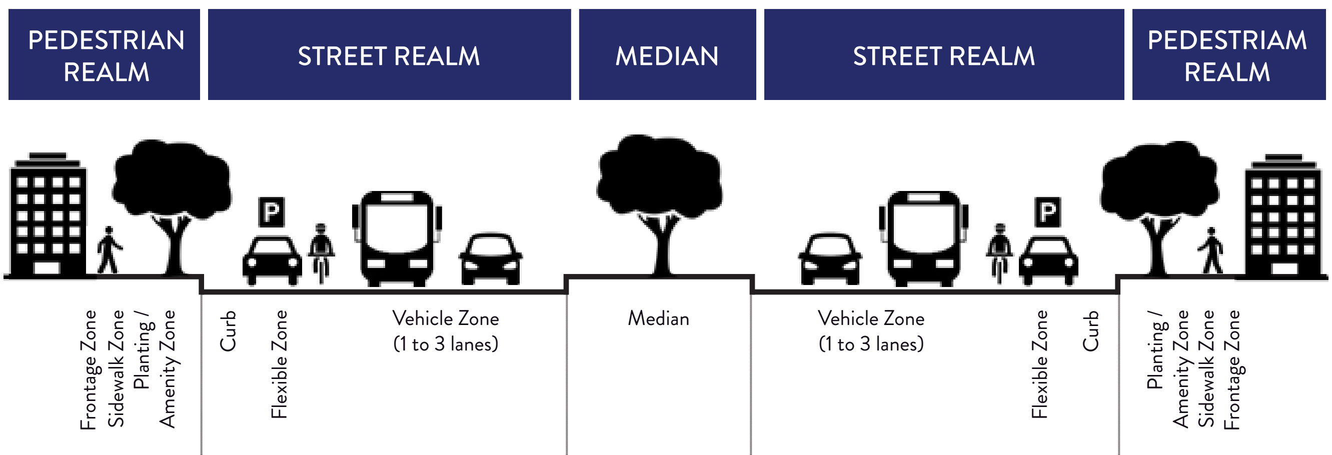
The posted speed limit should be the same as the target speed of the roadway.

THE ZONE SYSTEM

Recommendations for each street type in the Guide are organized around the zone system. The zone system is a framework that helps to determine how space can be allocated within the public right-of-way. This can be useful in helping project teams work through trade-offs. This Guide uses a three-realm system: the Pedestrian Realm, Street Realm, and Median. Each realm can include different zones.

Figure 2.3 provides a general representation of the zone system. How each zone is utilized and designed will vary by street type and location. Also, not all streets will include all of the elements presented in the figure.

Figure 2.3
Zone System with Example Street Elements (not to scale).



Frontage Zone Signs Building Front Street Furniture Bus shelter **Sidewalk Zone** Clear sidewalk **Planting / Amenity Zone** Trees Landscaping Signs Street Furniture Driveways Bus shelter Lighting	**Curb** Curb **Bicycle Zone** Bike lanes Buffers **Parking Zone** Parked cars Loading Drop-offs Shared mobility **Other** Turn lanes Curb Extensions	**Vehicle Zone** Auto lane(s) Transit lane(s)	**Median** Turn lane Landscaping Trees Pedestrian Refuge Median Island Signs	**Vehicle Zone** Auto lane(s) Transit lane(s)	**Curb** Curb **Bicycle Zone** Bike lanes Buffers **Parking Zone** Parked cars Loading Drop-offs Shared mobility **Other** Turn lanes Curb Extensions	**Frontage Zone** Signs Building Front Street Furniture Bus shelter **Sidewalk Zone** Clear sidewalk **Planting/ Amenity Zone** Trees Landscaping Signs Street Furniture Driveways Bus shelter Lighting

The Pedestrian Realm

The pedestrian realm includes the frontage zone, the sidewalk zone, and the planting/amenity zone. This is the area behind the curb that both accommodates pedestrian travel and features the elements of the right-of-way that make for a comfortable walking experience and create a sense of place. Some elements include sidewalks, street trees, benches, shared use paths, water harvesting features, signs, raised bicycle lanes, pavers, bus stops and shelters, street lights, and outdoor dining. If the design team uses an "outside-in" approach, they would start by prioritizing space in the pedestrian realm.

The Street Realm

The street realm includes both the **vehicle zone**, which accommodates transit vehicles, personal automobiles, and commercial vehicles, and the **flexible zone**. The flexible zone may include parking and bicycle facilities as well as right-turn lanes, curb extensions and/or bulb outs, water harvesting features, parklets, and other elements. Where parking and bicycle facilities are both present, bicyclists can be accommodated between the parked car and the curb, between the parked car and the travel lane, or on a two-way protected facility on a single side of the street.

The Median

The median can include a raised median, left-turn lanes, pedestrian refuges, landscaping, in-street green infrastructure, signs, lights, and other elements.

More information about the specific elements within each zone is provided in Chapters 3 – 6.

Roadway Dimensions

Complete Street design treats streets as public space, to be used by everyone, not just automobiles. How the street is used is determined by the urban context, design elements, and allocation of space.

Roadways that currently devote less than 25 percent of the right-of-way to the combined pedestrian realm and bicycle/parking zone, for example, are going to largely serve motor vehicles and transit, while roadways that devote 50 percent or more of the right-of-way to the outside zones are going to provide a more balanced environment that supports active modes as well as other public activities.

Table 2.4 provides policy guidance on preferred and acceptable roadway dimensions, which illustrates how space is to be allocated within each of the different street types. The listed dimensions are part of an effort to rebalance the use of space in the right-of-way in a way that accommodates all users but still dedicates adequate space to serve the primary functions of the street type. These are guidelines, not standards, that represent the orientation and preferences of the City of Tucson for how space should be used in the right-of-way.

Table 2.4 includes the preferred, minimum, and maximum dimensions for each zone. Project teams should use the preferred dimension as the starting place for design but should have the flexibility to work within the minimum/ maximum ranges as needed (for more information, see the Design Flexibility section in Chapter 1). Dimensions should be considered within the assemblage of the entire street, accounting for the adjacent street elements.

The elements in the table are ordered from the outside-in, but some elements can be re-ordered as needed. Also, not all elements will be present in all roadways.

The following are general instructions for using Table 2.4:

• The "–" symbol indicates no dimension has been established for the field

• "NA" indicates that a particular element is not included in the street type

• Curb lane is the outside travel lane on a roadway (i.e. the lane closest to the curb)

• Inside lanes include the center lane and the lane closest to the median

• Lane dimensions are measured from the center of the lane or edge line or center of the double lane line. Where no lane line or edge line is present and the travel lane abuts a curb, lane dimensions are measured from the face of the curb to the center of the lane line.

Table 2.4
Cross Section Dimensions for Tucson Street Types

	PEDESTRIAN REALM									CURB
	Frontage Zone			Sidewalk Zone			Planting / Amenity Zone			
Street Type	Pref.	Min.	Max.	Pref.	Min.	Max.	Pref.	Min.	Max.	–
Downtown / University District	2'+	2'	15'	8'–12'	6'	–	6'	4'	–	–
Neighborhood Commercial District	2'+	2'	15'	8'	6'	–	6'	4'	–	–
Urban Thoroughfare	2'+	2'	–	6'–8'	5'	–	8'–12'	6'	–	–
Urban Connector	2'+	2'	–	6'–8'	5'	–	6'–10'	4'	–	–
Suburban Thoroughfare	2'+	2'	–	6'	5'	–	8'–12'	6'	–	–
Suburban Connector	2'+	2'	–	6'	5'	–	6'–10'	4'	–	–
Neighborhood Street	2'+	2'	–	5'	5'	–	4'–8'	0'	–	–
Shared Street	2'+	2'	–	–	–	–	–	–	–	–
Industrial Street	2'+	2'	–	5'	5'	–	2'–4'	0'	–	–

STREET REALM												MEDIAN		
Bicycle (includes buffers / protective features)			Parking			Curb Lane			Inside Lane(s)			Left-Turn Lane		
Pref.	Min.	Max.	Pref.	Min.	Max.	Pref.	Min.	Max.	Pref.	Min.	Max.	Pref.	Min.	Max.
8'–11'	0'	–	8'	7'	9'	10'	9.5'	11'	10'	9.5'	11'	10'	9'	10'
8'–11'	0'	–	8'	7'	9'	10'	9.5'	11'	10'	9.5'	11'	10'	9'	10'
8'–11'	5'	–	NA	NA	NA	11'	10'	11'	10'	10'	11'	10'	10'	12'
8'–11'	5'	–	8'	7'	9'	10'	10'	11'	10'	10'	11'	10'	9'	11'
8'–11'	5'	–	NA	NA	NA	11'	10'	12'	11'	10'	12'	11'	10'	12'
8'–11'	5'	–	8'	7'	9'	10'	10'	11'	10'	10'	11'	10'	10'	11'
–	–	–	7'	7'	8'	7'	7'	10'	NA	NA	NA	NA	NA	NA
–	–	–	NA	NA	NA	9'	9'	10'	NA	NA	NA	NA	NA	NA
–	–	–	8'	7'	9'	12'	11'	14'	12'	11'	14'	12'	11'	14'

[2-2] The shy zone is the distance that pedestrians will "shy" from the building edge while walking.

TABLE 5 NOTES:

Frontage Zone

• The frontage zone is the area between the front of buildings and other tall structures and the sidewalk zone. The preferred dimension indicates the desire to provide at least a 2-foot "shy" distance between the sidewalk and buildings, walls, or fences.[2-2]

• In urban environments, overly large frontage zones and building setbacks should be discouraged.

Sidewalk Zone

• No maximum values are included because wider sidewalks may be appropriate in some circumstances. This Guide does not seek to restrict sidewalk width.

• No minimum value is provided for Shared Streets because on these extra narrow local streets, it is assumed pedestrian travel can be safely accommodated within the street due to low travel speeds and volumes.

• In retrofit projects, sidewalks may narrow to 4 feet for short distances at pinch points, but not for extended distances. Four-foot sidewalks should be avoided if possible.

Planting / Amenity Zone

• As with the sidewalk clear zone, the Guide does not seek to restrict the maximum width of the Planting/Amenity Zone.

• The planting/amenity strip may be composed of either hardscaped concrete pavers or landscaping and natural features. Outside of walkable commercial districts, it is preferred that the planting/amenity zone remain unpaved to reduce heat retention.

• A minimum of 2 feet in width is required for the planting/amenity strip where wedge curbs are used on low ADT neighborhood streets.

Bicycle

• Dimensions include bicycle travel area as well as buffers/protective elements. Any bicycle dimensions above 6 feet assume a buffered or protected bicycle facility. An 8-foot bicycle lane, for example, could indicate either a 5-foot bicycle lane with a 3-foot buffer, or a 6-foot bicycle lane with a 2-foot buffer.

• Bicycle lane widths greater than 6.5 feet are not desirable without painted buffers as they may be mistaken as travel lanes or parking lanes.

• Where bicycle lanes are adjacent to on-street parking in commercial areas, buffering the parking side of the bicycle lane is the priority in order to keep bicyclists out of the "door zone."

• Zero-foot minimum indicates that shared lane markings may be acceptable bicycle accommodations in some low-speed/low-volume urban environments.

• Dimensions larger than the preferred may be appropriate on Bicycle Priority overlay streets.

• Where a gutter pan is present, the gutter pan should not be included in the dimension of the bicycle lane or counted as a ridable surface. When streets are reconstructed, gutters should be removed.

Parking

• On-street parking may be allowed on some, but not all, Connector streets. Dimensions only apply for where parking is allowed.

• An 8-foot parking lane should be used next to a marked bicycle lane to reduce incursions of parked vehicles into the bicycle lane.

• When a parking lane is next to a travel lane, combined width should be no less than 18 feet on Connector Streets.

• Where a wedge curb is installed on a neighborhood street, the parking lane width is measured from the back (outside edge) of the wedge curb.

Curb Lane

• The preferred lane width for Freight Network and Frequent Transit Network streets is 11 feet.

• Curb lanes narrower than 11 feet may be used on thoroughfares without a significant share (>5%) of large vehicles or those that are adjacent to buffered/protected bicycle lanes in constrained conditions.

• An 11-foot curb lane should be used on roadways with target speeds of 40 mph and over.

• 9.5-foot lanes may only be used for through lanes in conjunction with a turn lane at an intersection.

• If a gutter pan is present, the gutter pan should not be included in the measurement of the curb lane.

Inside Lane(s)

• Where a 10-foot inside lane is adjacent to a raised median, a 1-foot offset between the median curb and the travel lane should be used. Inside lane width dimensions in the table do not include an offset.

• An 11-foot inside lane should be used on roadways with target speeds of 40 mph and over.

• Where inside lanes are directly adjacent to an opposing travel lane an 11-foot lane should be used where target speeds are 35 mph or over.

• Centerlines are not marked on local streets. Total width of the 2-way travel way should be no less than 14 feet where on-street parking is permitted.

Median

• The dimensions provided in Table 2.4 apply only to left-turn lanes.

• Where there are continuous raised medians that include openings and storage for left turns, medians can be more than 14 feet wide to accommodate opposing 10-foot turn lanes, lane offsets, and traffic separators.

CONSTRAINED PRIORITIZATION

The majority of streets in Tucson serve developed areas with already established curblines and rights-of-way. As such, the preferred dimensions listed in Table 2.4 may not be easily attainable, particularly where there are no planned corridor expansion or re-construction projects that provide the opportunity to move curblines and relocate utilities. Even in corridor-scale projects, acquisitions of private-property to accommodate some road designs is often not desirable, or budgets may be limited. In such cases, compromises will need to be made during project design.

Table 2.5 on the following page provides policy guidance for the allocation of space with limited budgets and in constrained rights-of-way. Community members and stakeholders should be engaged in setting street design priorities using the guidance in this table as a starting point during the corridor planning phase. The table should be used in conjunction with the dimensions in Table 2.4 in determining whether to use the minimum, maximum, or preferred width for each element. Acceptable design trade-offs will ultimately need to be determined on a case-by-case basis depending on project priorities, public input, engineering judgment, and the nature of project constraints.

Certain dimensions can be attained more easily, such as re-striping the street realm to narrow travel lanes and allocate more space to the bicycle zone, while others, such as allocating more space to the pedestrian realm, will likely be costlier and more complex.

In some cases, lower-priority design elements can be excluded from projects, depending on project goals. For instance, medians or two-way left-turn lanes are not essential on all streets, or additional travel lanes may not be necessary on corridor capacity projects where congestion can be effectively managed through improvements like signal upgrades and better access management. **In all cases, safety should be the highest priority in determining acceptable trade-offs.**

Table 2.5 also includes modal overlays as well as street types since the zones may be prioritized differently for modal priority type.

Table 2.5
Zone Priorities in Constrained Conditions

	Frontage Zone*	Sidewalk Zone	Planting / Amenity Zone	Bicycle Zone	Parking Zone	Vehicle Zone	Median Zone
STREET TYPES†							
Downtown / University	H	H	M	M	H	L	L
Neighborhood Commercial	H	H	M	M	H	L	L
Urban Thoroughfare	L	H	M	H	NA	M	M
Urban Connector	L	H	M	H	L	M	L
Suburban Thoroughfare	L	H	M	M	NA	H	M
Suburban Connector	L	H	M	M	L	M	M
Neighborhood Street	L	H	M	L	M	M	NA
Shared Street	L	NA	L	NA	L	L	NA
Industrial Street	L	L	L	L	M	H	L
MODAL PRIORITIES							
Frequent Transit Network	L	H	H	M	L	H	H
Regionally Significant Corridor	L	H	M	L	L	H	H
Freight Corridor	L	H	M	L	L	H	H
Bicycle Priority Street	L	H	M	H	L	L	L
Bicycle Boulevard	L	H	M	H	L	L	NA

L = Low Priority M = Medium Priority H = High Priority NA = Not Applicable

* Outside of downtown and other walkable districts, the frontage zone can be accommodated on private property though setbacks. Therefore, setting aside space for this zone is a low priority. Fences, walls, and other structures should still be set back from the sidewalk by at least 2 feet.

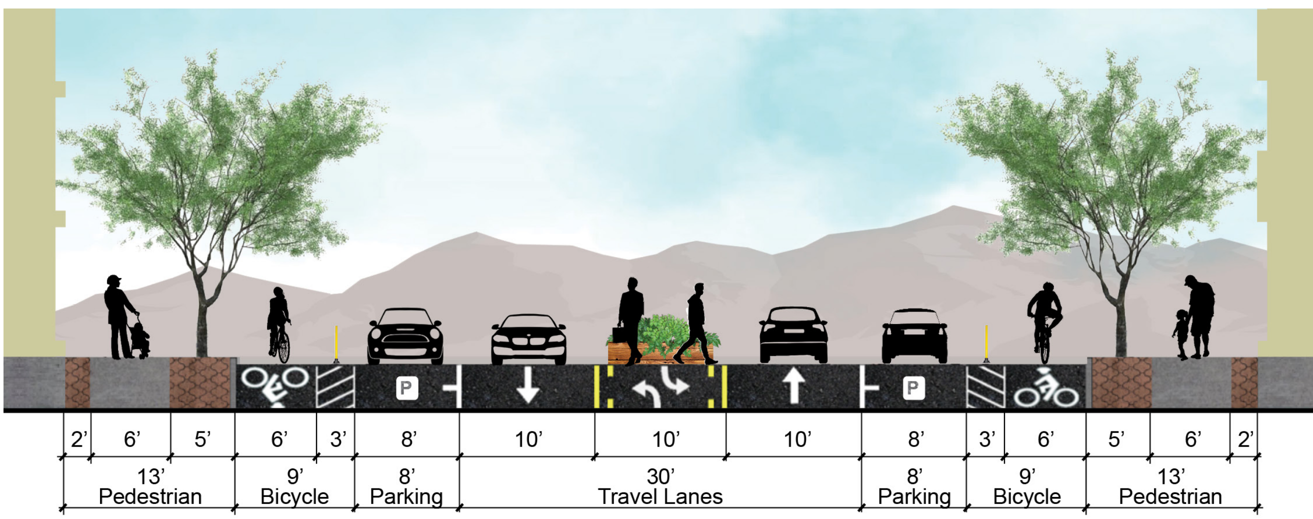
† Applies to streets with no modal overlay. Where a modal overlay is present, the priorities of the overlay control.

Sample Cross-Sections

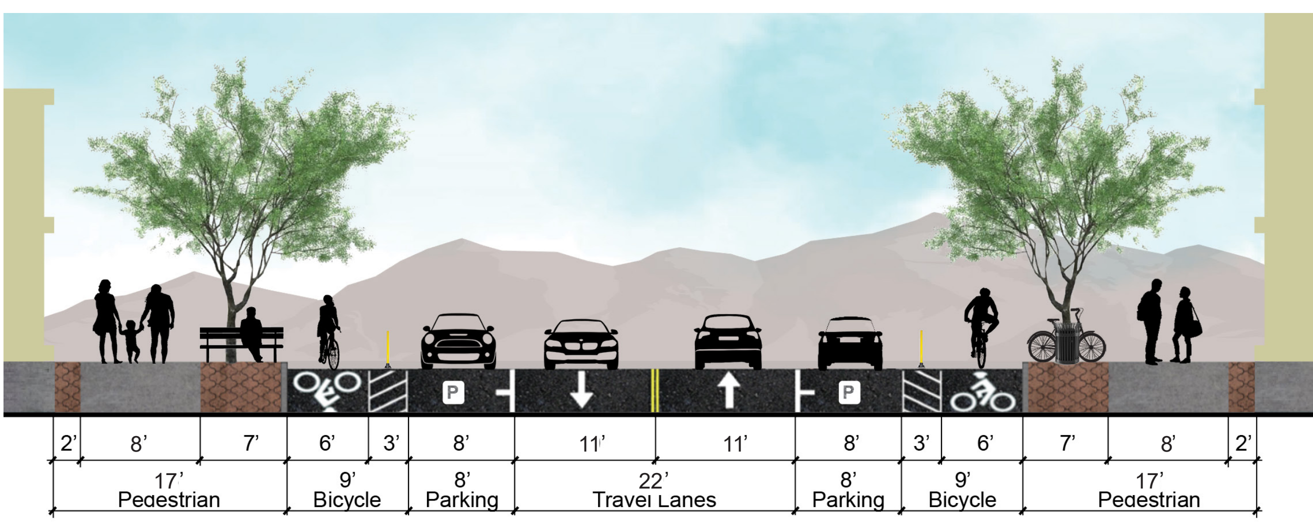
The following example cross-sections illustrate different potential mid-block configurations for each street type, using the guidance provided under Tables 2.4 and 2.5. The cross-sections do not represent specific streets or specific situations and should not be interpreted as standards. They are intended to represent the flexibility allowed within this Guide while at the same time providing different design concepts. Additional width may be required at intersections to accommodate turn lanes, transit by-pass lanes, or other street elements.

Street Type **DOWNTOWN / UNIVERSITY DISTRICT**

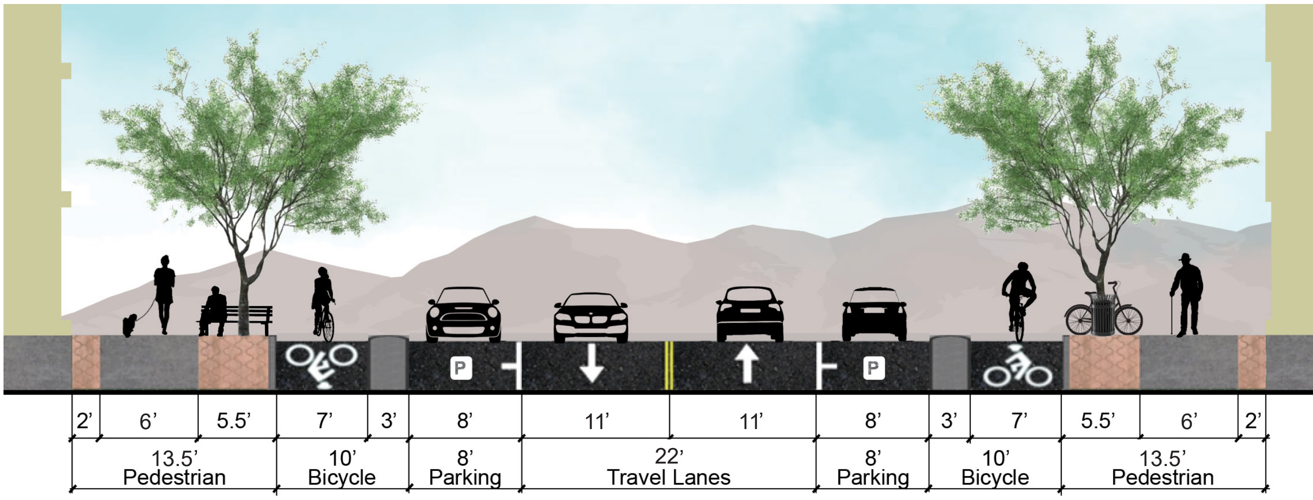
Section 1. 90-ft ROW, 3-lane, 2-way street, refuge island, parking-protected bicycle lane



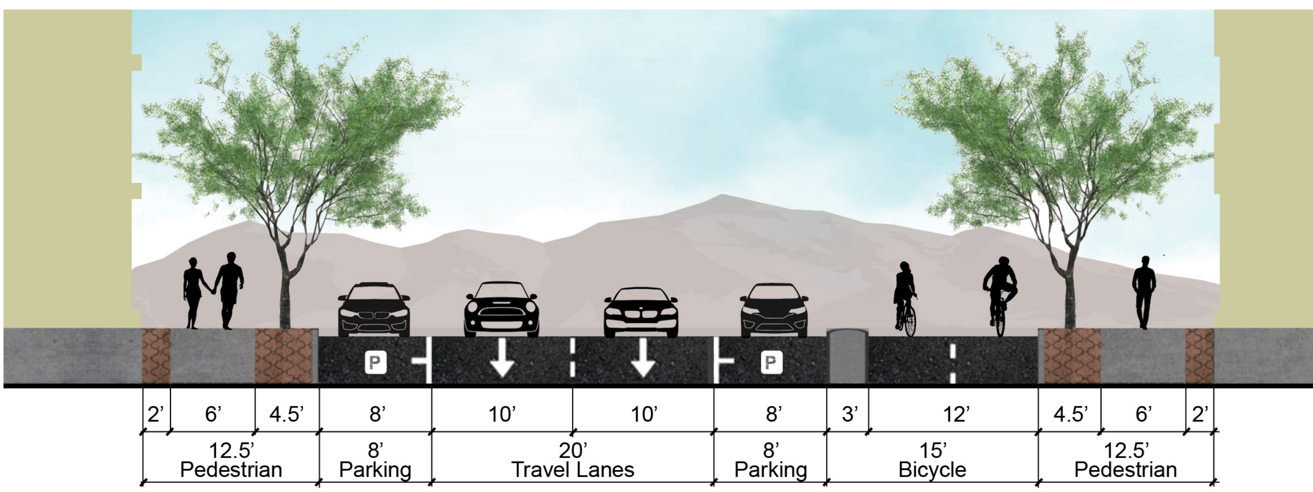
Section 2. 90-ft ROW, 2-lane, 2-way street, parking-protected bicycle lane



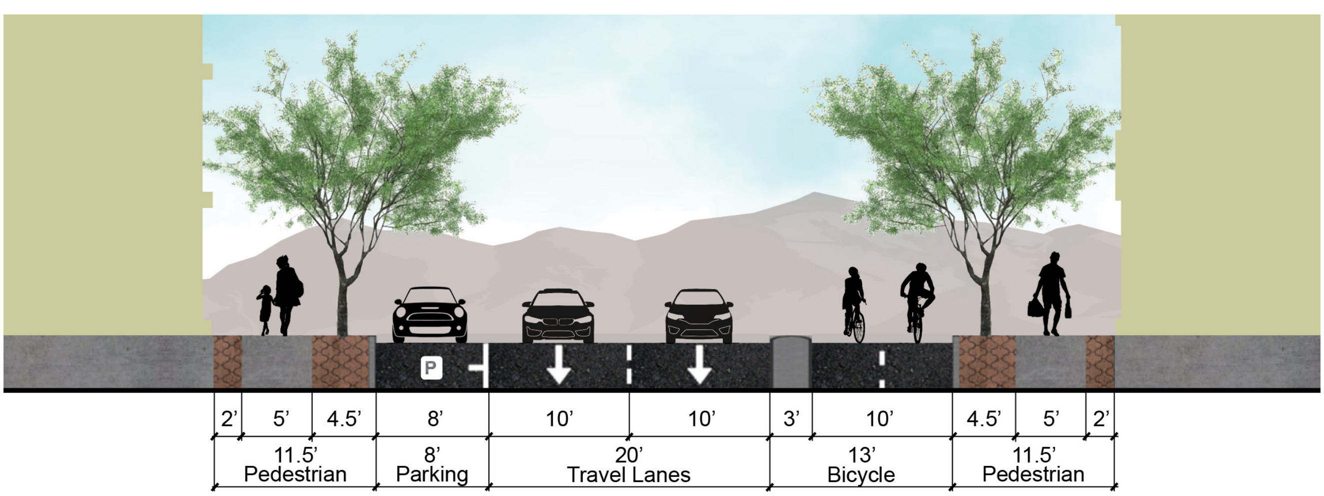
Section 3. 85-ft ROW, 2-lane, 2-way street, parking-protected bicycle lane



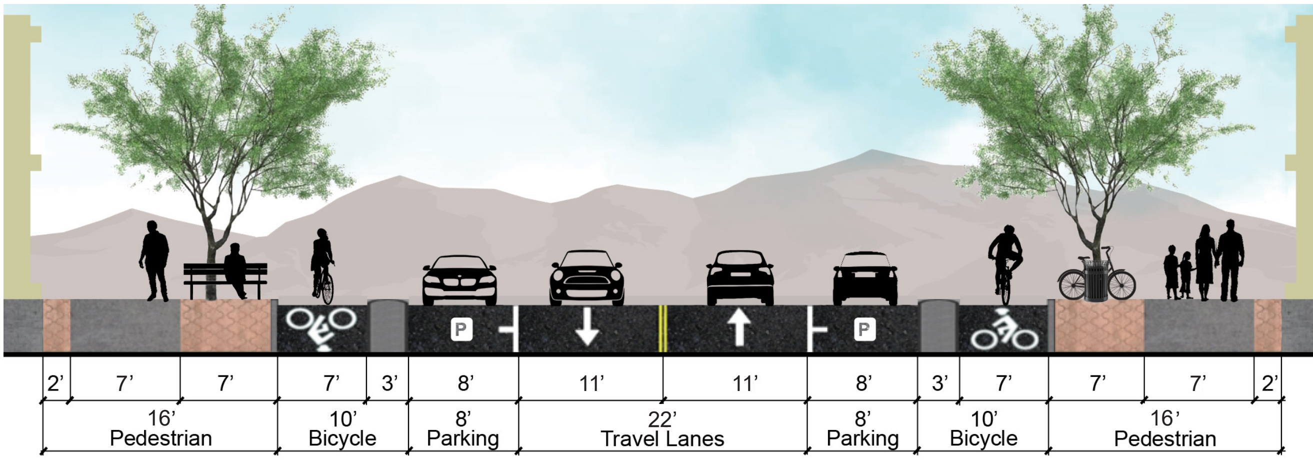
Section 4. 76-ft ROW, 2-lane, 1-way street, parking both sides of the street, 2-way protected bicycle lane



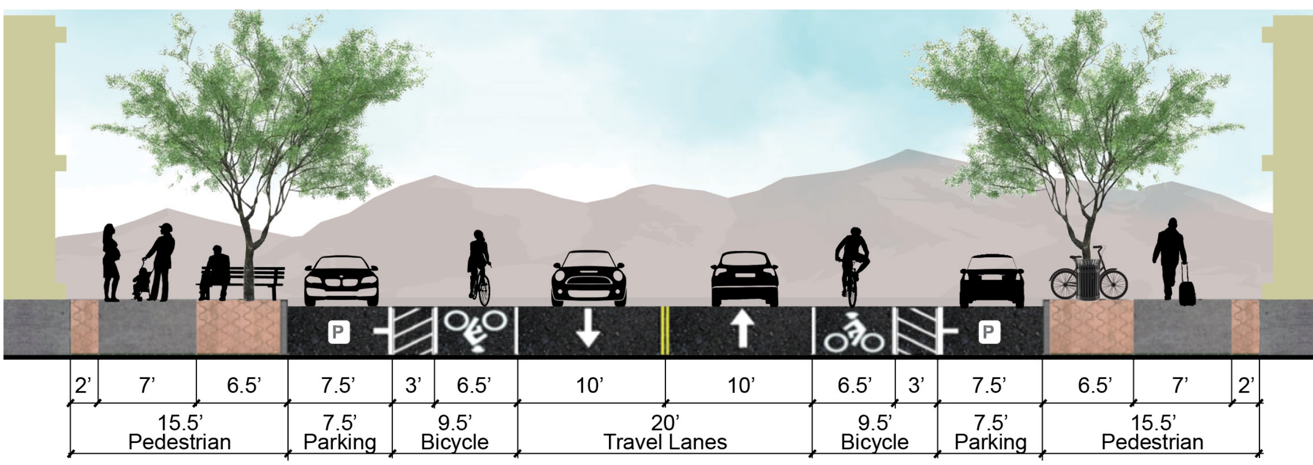
Section 5. 64-ft ROW, 2-lane, 1-way street, parking one side of the street, 2-way protected bicycle lane



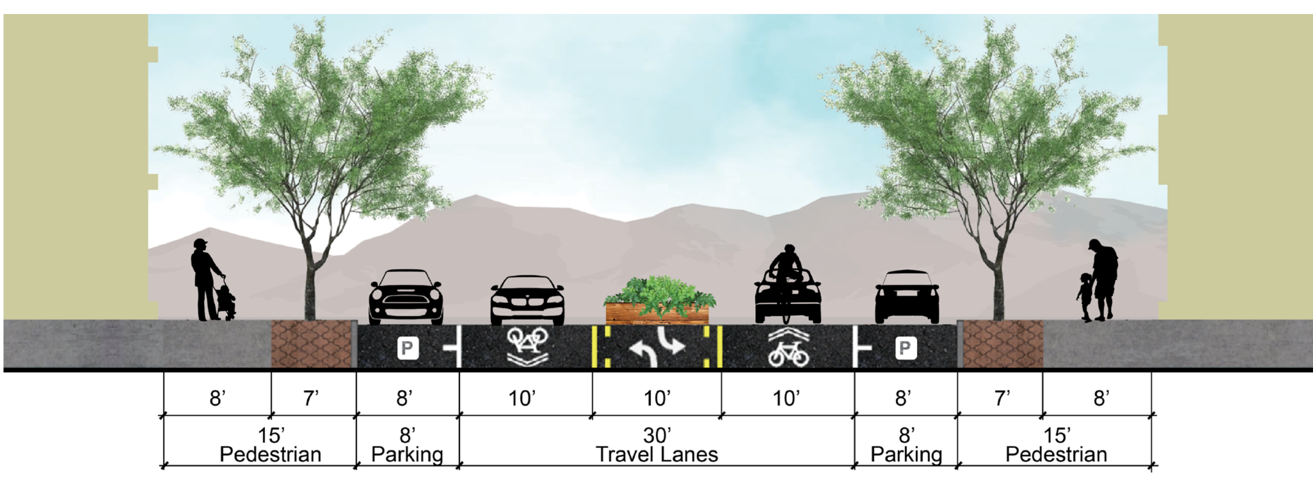
Section 6. 90-ft ROW, 2-lane, 2-way street, curb and parking-protected bicycle lane



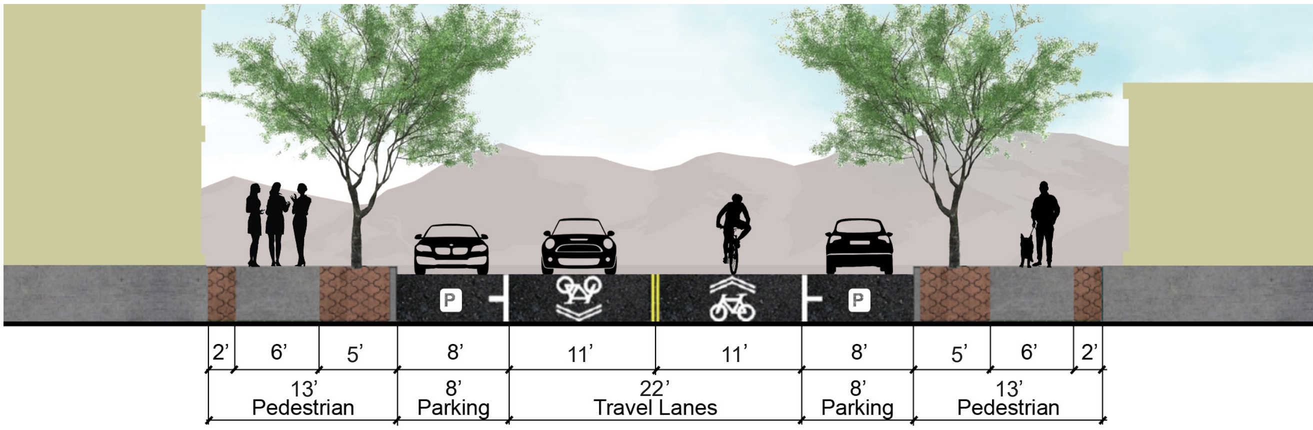
Section 7. 85-ft ROW, 2-lane, 2-way street, parking-buffered bicycle lane



Section 8. 76-ft ROW, 3-lane roadway, refuge island, shared lane marking (low volume / low speed)

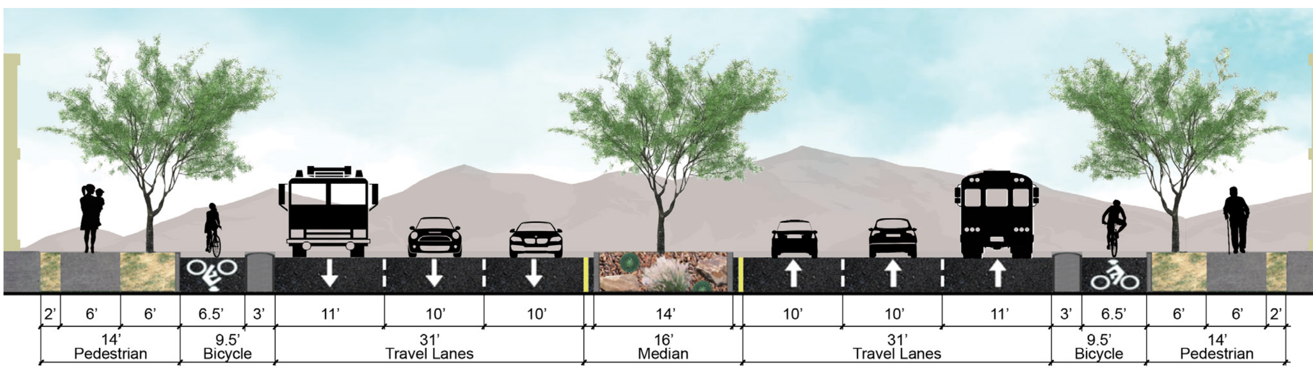


Section 9. 64-ft ROW, 2-lane, 2-way street with shared-lane markings and on-street parking (low volume / low speed)

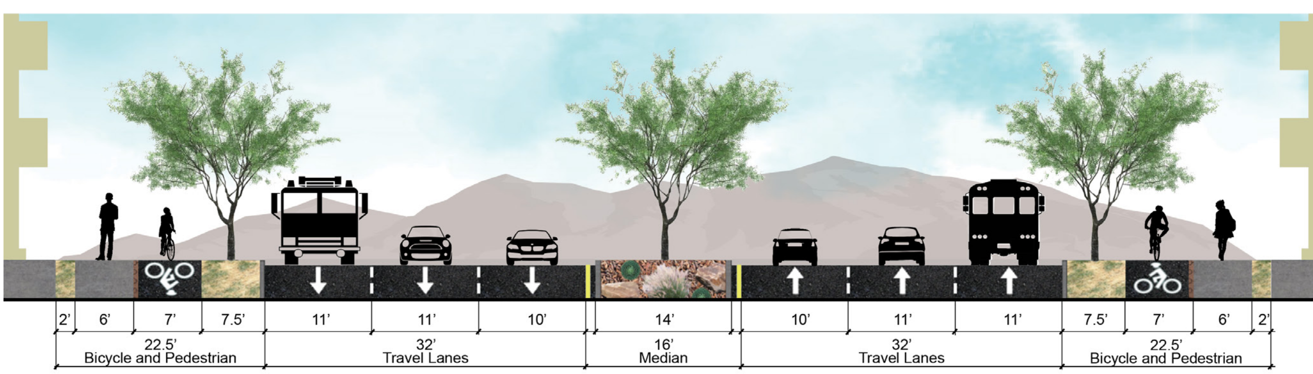


Street Type **THOROUGHFARE**

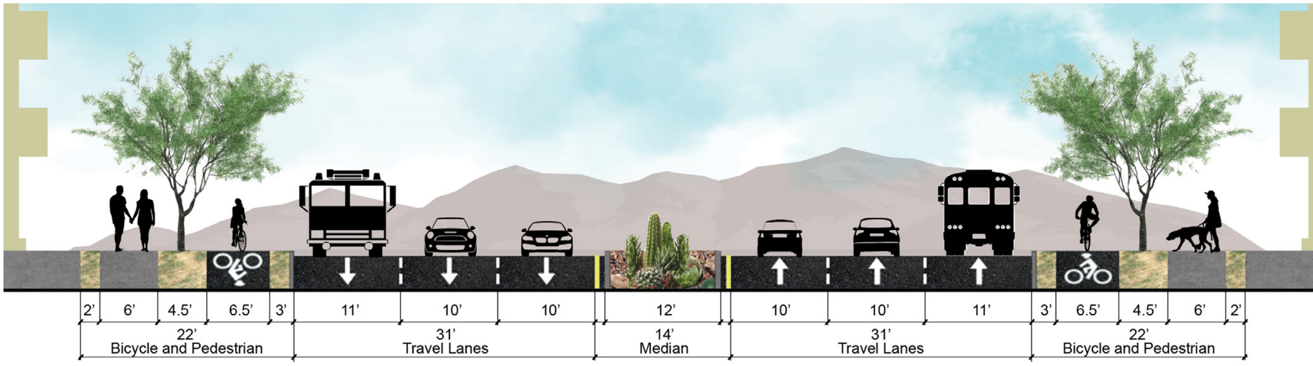
Section 10. 125-ft ROW, suburban 2-way, 6-lane street with raised median and curb-protected bicycle lane



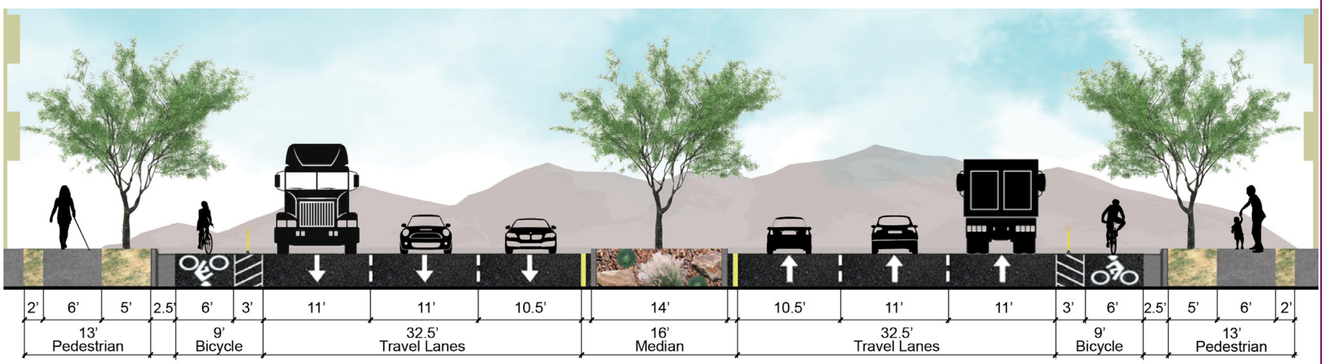
Section 11. 125-ft ROW, Regionally Significant Corridor, 6-lane, 2-way, raised median and raised bicycle lane



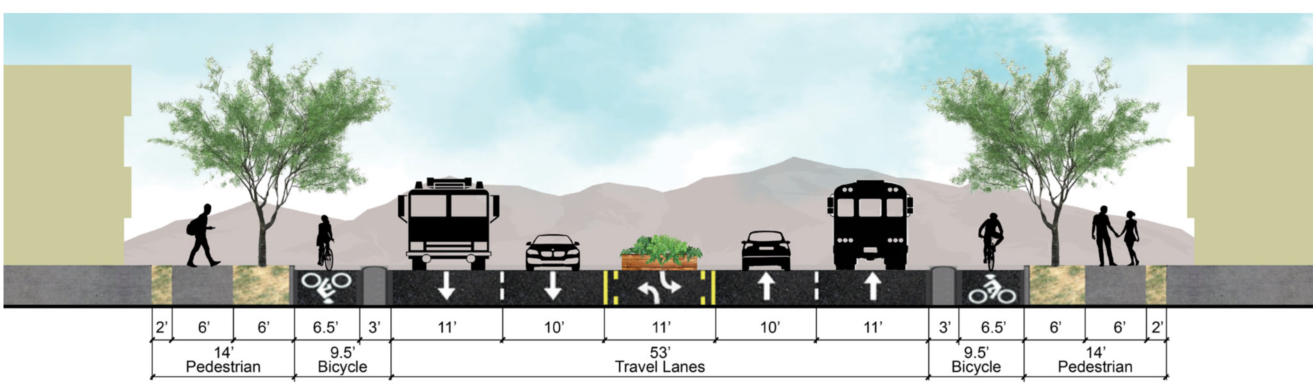
Section 12. 120-ft ROW, urban 6-lane, 2-way street with raised median and raised bicycle lane



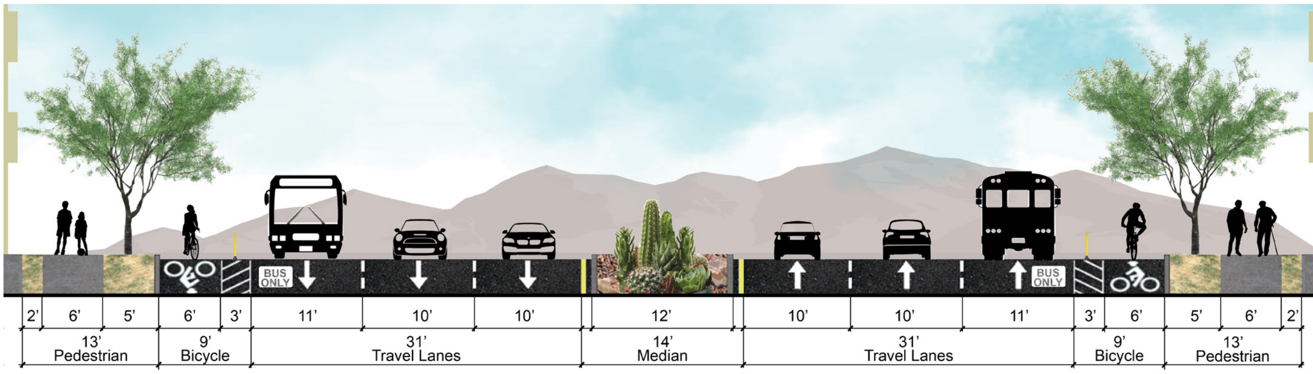
Section 13. 130-ft ROW, suburban 6-lane, 2-way street with raised median, object-protected bicycle lanes and gutter pan



Section 14. 100-ft ROW, urban 5-lane, 2-way street, pedestrian island, curb-protected bicycle lane

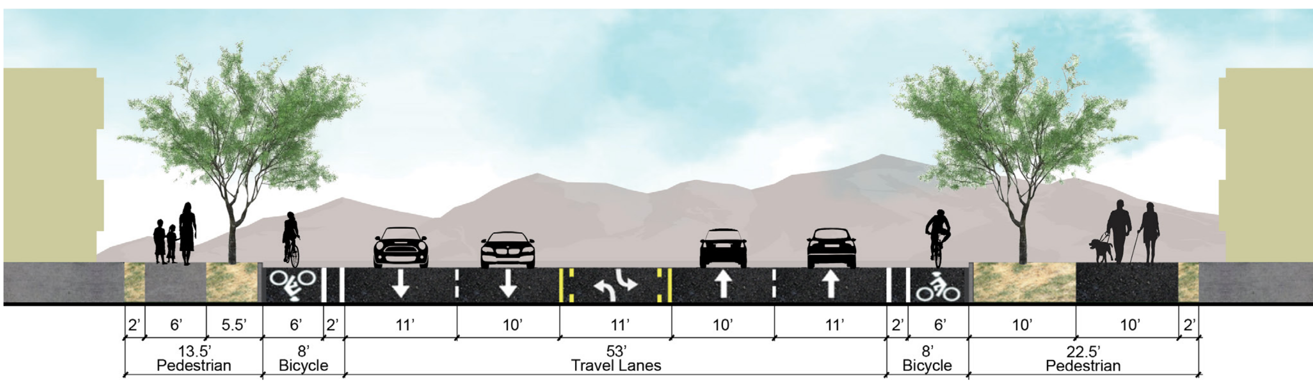


Section 15. 120-ft ROW, urban 6-lane, 2-way street, raised median, and object-protected bicycle lane

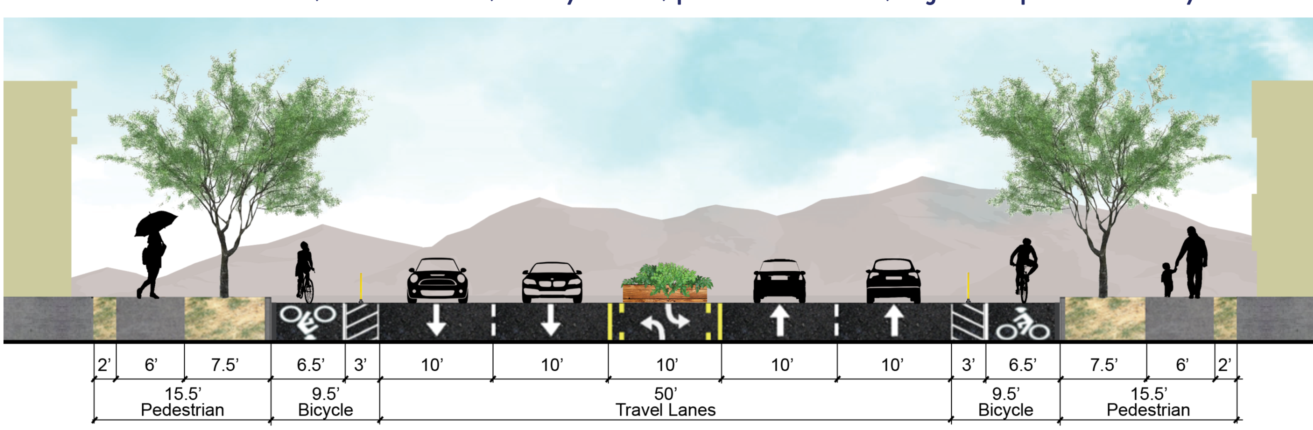


Street Type **CONNECTOR**

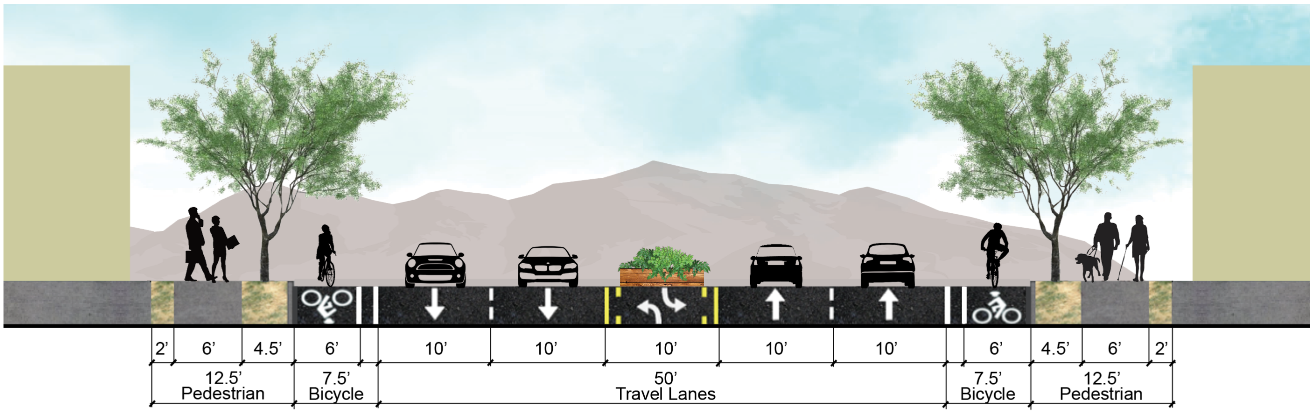
Section 16. 105-ft ROW, suburban 5-lane, 2-way street, buffered bicycle lane, asphalt side path on one side of the street



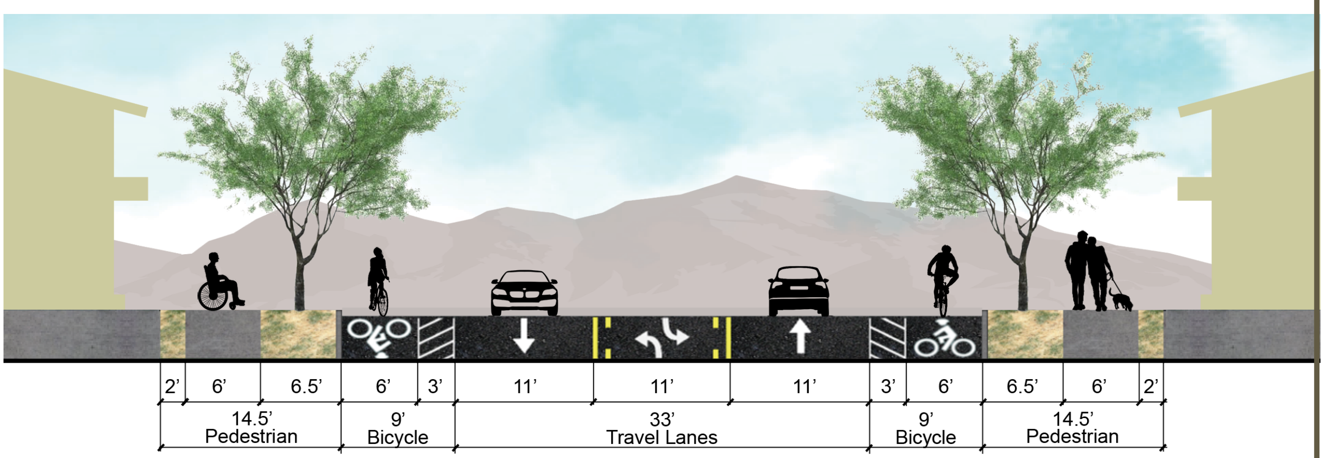
Section 17. 100-ft ROW, urban 5-lane, 2-way street, pedestrian island, objected-protected bicycle lane



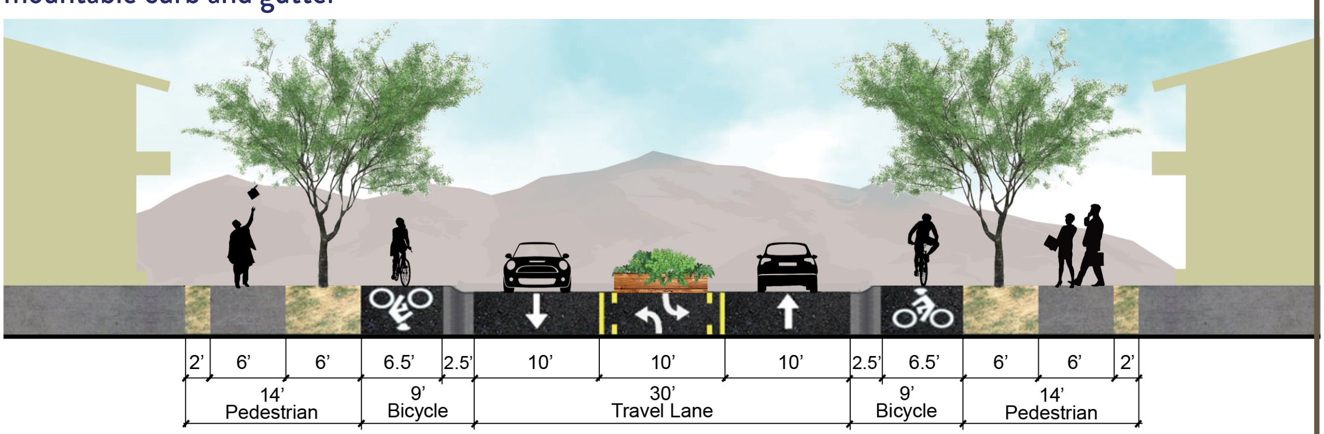
Section 18. 90-ft ROW, 5-lane, 2-way street, pedestrian island, buffered bicycle lane



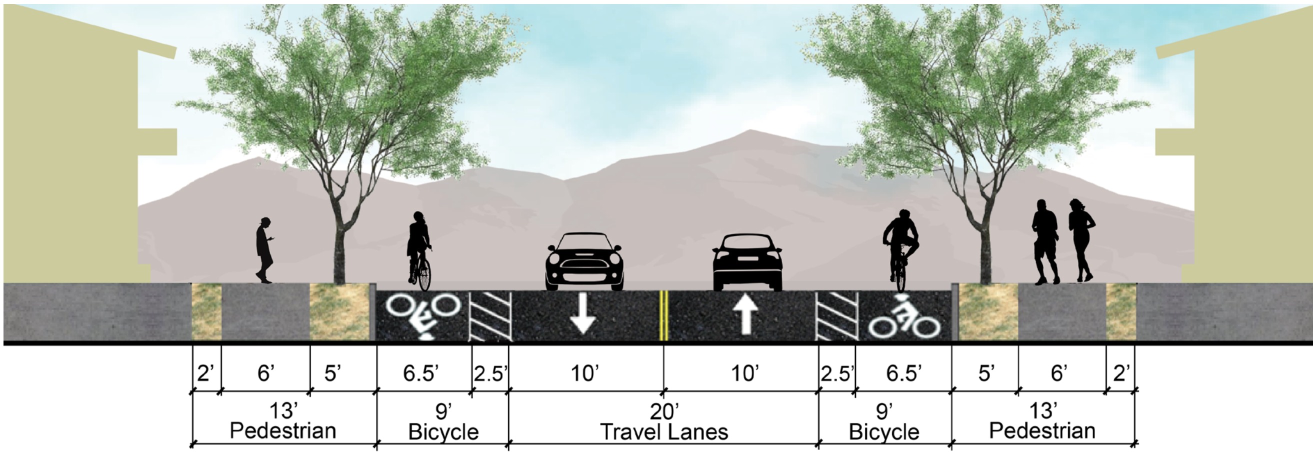
Section 19. 80-ft ROW, suburban 3-lane, 2-way street, buffered bicycle lane



Section 20. 76-ft ROW, urban 3-lane, 2-way street, pedestrian island, raised bicycle lane with mountable curb and gutter

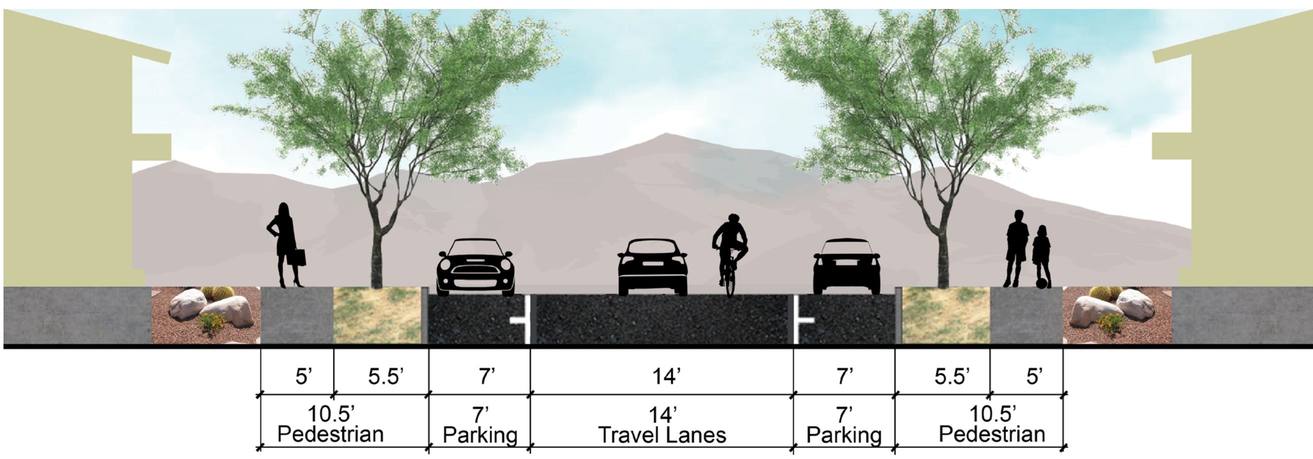


Section 21. 64-ft ROW, urban 2-lane, 2-way street, with buffer-protected bicycle lane

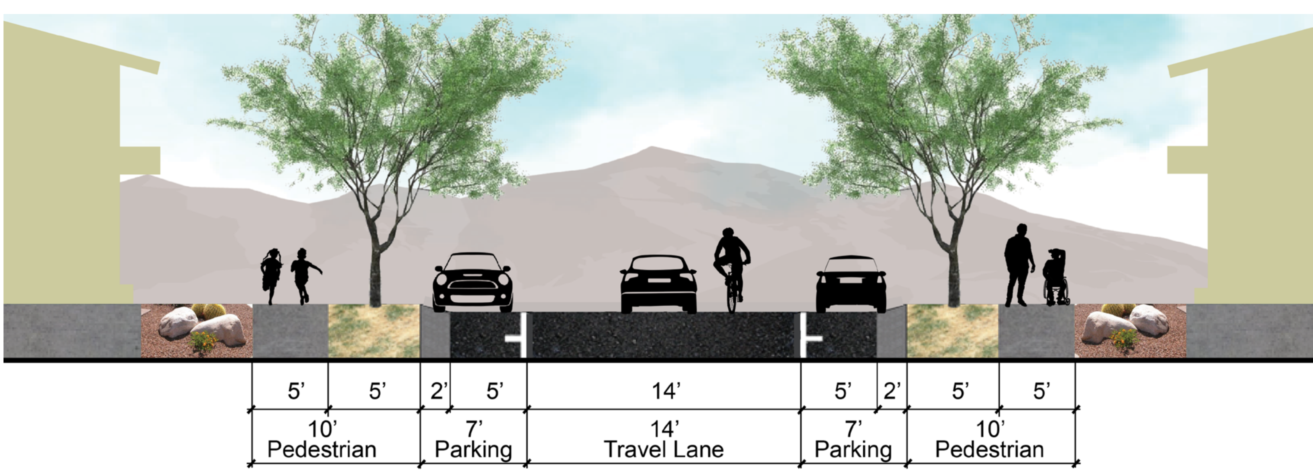


Street Type **NEIGHBORHOOD STREET**

Section 22. Typical local street dimensions with vertical curbs and parking on both sides

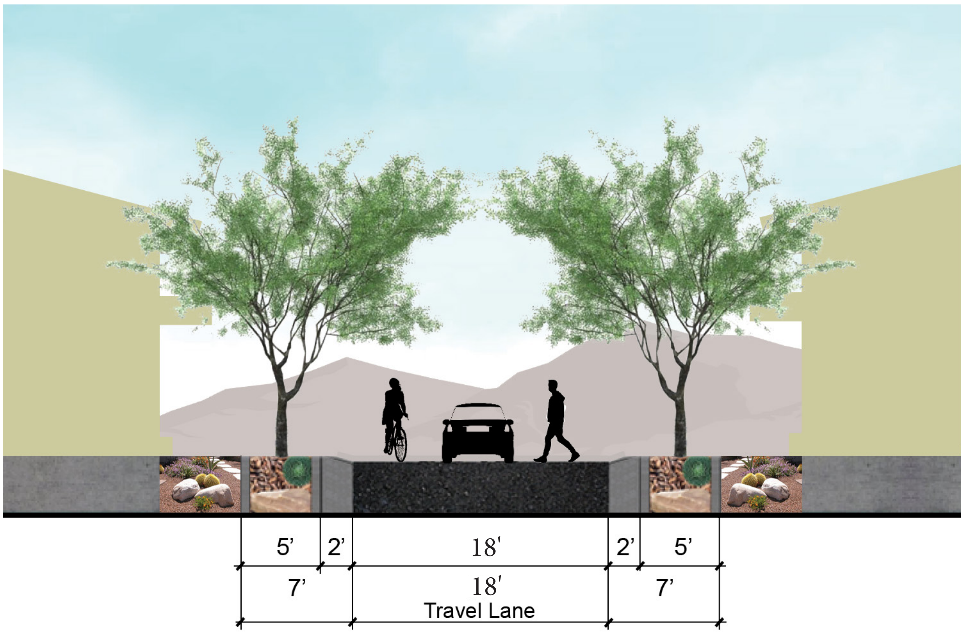


Section 23. Typical local street dimensions with 2-foot wedge curbs and parking on both sides



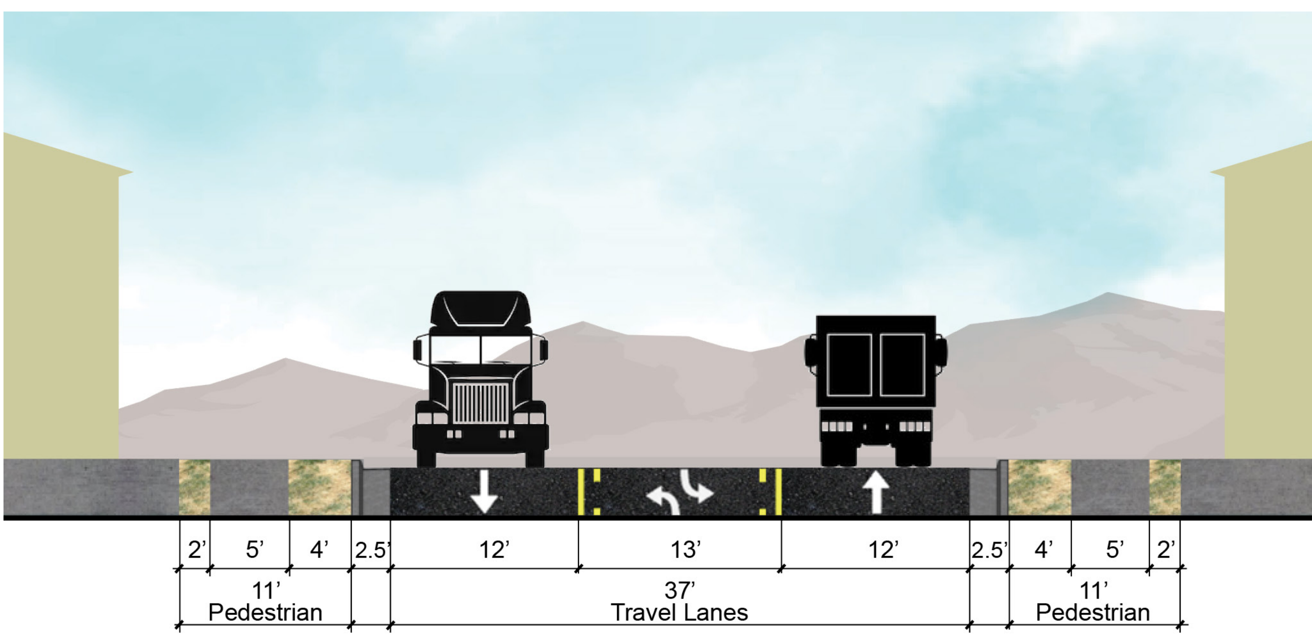
Street Type **SHARED STREET**

Section 24. Typical shared street dimensions with 2-foot wedge curbs



Street Type **INDUSTRIAL STREET**

Section 25. Example industrial street



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3


Cafe Passé
CAFE PASSE
EVERYDAY 4 - 6
BIERGARTEN
HERMOSA COFFEE &
ESPRESSO
PATIO IN THE BACK

THE PEDESTRIAN REALM

My

THE PEDESTRIAN REALM

Overview

Chapters 3 – 6 of the Guide provide general guidance for the different elements of the right-of-way. For each element, an overview is provided, as well as guidance for application and use, design and operation, and other considerations.

Taken together, these chapters serve as a "toolkit" to give project design teams options and direction for how to design the roadway consistent with the Complete Streets approach.

Pedestrian Design

Perhaps no element is more important to Complete Street design than a safe and comfortable pedestrian realm, the part of the right-of-way located between the curb edge and property line or building façade. A well-designed and inviting pedestrian realm does more than just provide a walkway, it also,

- enhances the sense of places
- encourages active street life and connects people to the city
- provides access for people with disabilities
- supports recreational walking and running
- makes waiting for transit more comfortable and
- increases property values.

[Previous two-page spread]
The Pedestrian Realm on 4th Avenue. Source: "1511 Tucson Trip-22" by Devon Christopher Adams under license CC BY-NC 2.0

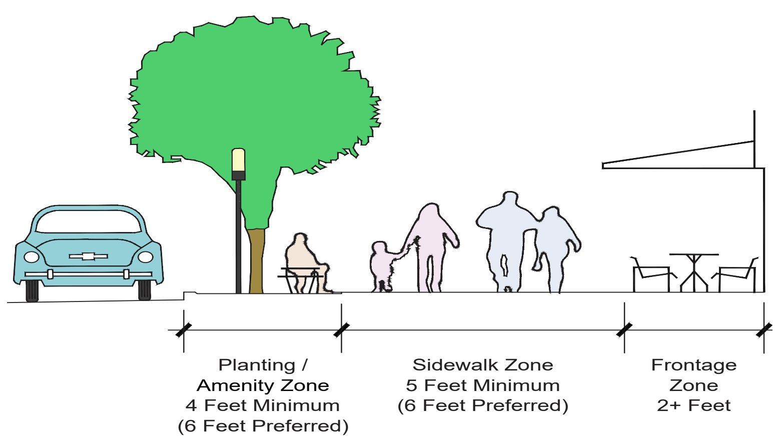


Image 3.1
Section of the Pedestrian Realm

The pedestrian realm contains many of the elements that improve people's walking experience and perception of the city as well as elements that perform a vital function in the operation of the roadway. Some common elements in the pedestrian realm include sidewalks, street trees, landscaping, decorative pavers, seating, signage, light poles, water harvesting features, bus shelters, driveways, utilities (both above ground, and underground), signal poles and cabinets, and more.

To help organize the placement of these elements, the Pedestrian Realm is divided into three zones: the frontage zone, the sidewalk zone, and the planting/amenity zone.

Frontage Zone – This is the portion of the pedestrian area immediately adjacent to the property line or building wall. The frontage zone is an important consideration in walkable commercial districts and locations where buildings are built to the sidewalk. It provides space for building entrances, retail displays, awnings, and café seating, without encroaching into the sidewalk zone. On most connectors and thoroughfares, the frontage zone is typically accommodated through building setbacks, though even on these street types, structures such as fences and walls should be offset from the sidewalk to account for pedestrian shy distance.

Sidewalk Zone – This is the portion of the pedestrian realm dedicated to pedestrian travel, where sidewalks are located. Sidewalk refers specifically to the paved, continuous, walking area for use by pedestrians. Minimum unobstructed dimensions must be maintained in the sidewalk zone.

Planting / Amenity Zone – This is the area located between the street curb and the sidewalk zone. The planting/amenity zone may either be designed as hardscape, with pavers or concrete, or landscaped. This the zone in which street furniture, signs, bike parking, street trees, and other elements are most likely to be located.

Currently, many Tucson streets lack continuous and complete sidewalks. Often times, where sidewalks are present, they can feel uncomfortable and uninviting.

Addressing this issue will continue to be a challenge, given the limited space that is often available in the pedestrian realm and the number of existing conflicts. The best opportunities, though rare and expensive, will occur through projects that offer the ability to move curbs and relocate utilities.

However, even where full corridor improvements are not currently planned, other opportunities must be pursued for improving accessibility and comfort in the pedestrian realm, even if it means reducing dimensions below preferred widths.

This chapter covers essential design considerations for elements located in the pedestrian realm.

Frontage Zone

OVERVIEW

Defining a frontage zone ensures that the pedestrian pathway can be maintained clear of obstacles and is easy to navigate.

APPLICATION AND USE

- At its most basic, the frontage zone provides shy distance to allow pedestrians to walk clear of adjacent vertical barriers, such as building façades, fences, walls, hedges, etc. and allows people to exit buildings without blocking the sidewalk.
- A larger frontage zone allows space to locate business signs, planters, café seating, benches, and other amenities.
- Defining the frontage zone is critical in walkable areas where buildings are built close to the sidewalk. In these contexts, there are multiple elements competing for space in the right-of-way. Having a well-defined frontage zone allows for more amenities to be placed in or near the right-of-way without creating conflicts with pedestrian through-travel.
- In high-volume pedestrian areas, the frontage zone can serve as a gathering place for people who wish to linger without impeding other pedestrians.
- Outside of walkable districts, such as on many Connectors and Thoroughfares, maintaining the frontage zone between the sidewalk and vertical barriers allows for comfortable passing and makes it easier for two people to walk side-by-side without feeling restricted.

DESIGN AND OPERATION

- **A shy distance of at least 2 feet should be maintained between the sidewalk and any vertical barriers that stand more than 3.5 feet above the sidewalk.**
- Cacti, yuccas, and agaves should be placed so that the mature plant is a minimum 3 feet clear of the sidewalk zone.

• Other shrubs/groundcover must be located, so the edge of the mature shrub or groundcover is a minimum of 2 feet clear of the sidewalk zone.

• Shy distances do not apply to handrails that are required on ramps, slopes, or stairs.

OTHER CONSIDERATIONS

• The frontage zone can be located on either public or private property.

• A larger frontage zone in walkable districts permits café seating and other amenities. (Businesses that wish to locate private structures within City right-of-way will need to submit a site plan and apply for a Temporary Revocable Easement (TRE) through the City Real Estate Division.)

• Overly large building setbacks, with front-side surface parking, should generally be avoided in urban areas as these reduce the sense of pedestrian enclosure and decrease comfort. This Guide recommends reducing building setbacks by:

o locating surface parking behind buildings

o reducing the street perimeter yard requirements in the Tucson Unified Development Code to allow buildings to be built closer to the sidewalk

o allowing developments to meet part of the street landscape border within the public right-of-way.

Image 3.2
Downtown sidewalk with street furniture

Sidewalk Zone

OVERVIEW

Everyone is a pedestrian, and sidewalks, in urban and suburban areas, are the fundamental elements of the pedestrian system. They are used by people of all ages and all abilities for a variety of purposes. Sidewalks provide a clear, unobstructed walking path that is sufficient to accommodate persons with disabilities.

Well-designed sidewalks encourage walking as an appealing form of transportation, providing a viable alternative to driving for shorter trips. In more walkable districts, sidewalk design can accommodate small groups passing in opposite directions, as well as people stopping and talking. Sidewalks, particularly in walkable districts, are inherently social environments, which should be accounted for in their design.

APPLICATION AND USE

- Sidewalks should be provided on both sides of the street where the roadway is in a developed area.
- All major corridor projects should install sidewalks on both sides of the roadway.
- Where current development intensity and anticipated pedestrian volumes don't necessitate the installation of sidewalks, but they may do so in the future, adequate public right-of-way should be retained for future sidewalk installation, including the frontage zone and planting / amenity zone.
- In suburban and rural areas, a shared-use path may be installed in place of, or in addition to, a sidewalk.
- The City of Tucson Technical Standards Manual requires that sidewalks be constructed along the street frontage of the new development of all properties, and where the floor area, site area, or parking area is expanded by 25% or more (Section 10-01.3.3).

DESIGN AND OPERATION

- All sidewalks should be built to comply with the requirements of the Americans with Disabilities Act.
- The quality of the surface is of utmost importance in the sidewalk zone. Concrete is preferable for sidewalks, but other materials are acceptable so long as they can be effectively maintained as smooth, stable, and skid resistant, with minimal gaps, rough surfaces, and vibration-causing features.

• Treating an asphalt parking lot as a pedestrian walkway is not an acceptable practice unless the sidewalk zone is clearly delineated, clear of obstructions, not meandering, and free from excessive slopes.

• In walkable commercial districts, such as in Downtown, near the University, and along 4th Ave., concrete unit pavers or decorative concrete may be used to better define the district and enhance the character of the street. These features must comply with ADA requirements, and vibration-causing effects should be minimized for wheelchair users and strollers.

  o Concrete pavers or textured concrete may be used in the entirety of the amenity zone and the frontage zone. Pavers in the frontage and amenity zones must be non-slip and well-maintained to avoid becoming a trip hazard.

  o **Concrete pavers should be limited to 30% or less of surface area in the sidewalk zone.** Concrete paver strips should not exceed 2 feet in width.

  o When concrete pavers are located in the sidewalk zone, they should be installed level with the concrete sidewalk. Vertical relief between surfaces should not exceed 1/8 inch.

  o Clay brick pavers should not be used within the pedestrian clear zone (concrete pavers are an acceptable alternative).

  o Special design guidelines can be developed for downtown and other walkable commercial districts describing materials, patterns, and textures in more detail.

• The sidewalk zone should be at least:

  o 6 feet on Thoroughfares and Connectors;

  o 5 feet on Neighborhood Streets; and

  o 6 to 8 feet, or more, in walkable commercial districts and downtown.

• Sidewalks wider than the preferred dimensions for all street types should be considered near schools, transit centers, around the University, or where otherwise merited by pedestrian volumes.

• In retrofit situations, where the cost of eliminating pinch points is prohibitive, a minimum sidewalk width of 4 feet may be used, but only after other options for installing wider sidewalks have been explored.

• All sidewalks will have an unobstructed vertical clearance of 84 inches above the walking surface.

• The path of travel along sidewalks should generally be straight without unnecessary curving, offsets, or obstacles which can be hazardous to people who are blind or have visual impairments.

• Sidewalks must have an adequate cross slope to facilitate stormwater run-off, but not so much that they cause discomfort or violate ADA requirements. Cross slopes should be between 1% and 1.5% running towards the planting/amenity zone to support irrigation of plantings. Cross slopes may not exceed 2%.

• **Sidewalks should be buffered from the vehicle travel way through a planting/amenity strip.** The width necessary to provide pedestrian comfort on the sidewalk increases proportionally to vehicle travel speeds in the roadway. Bicycle lanes and on-street parking can be used to create separation, but the inclusion of a planting/amenity strip in addition to bicycle lanes is preferable to enhance comfort.

  o In rare cases, where rights-of-way are constrained or there are other conflicts, the sidewalk may be built to the back of the curb. In such cases, the sidewalk should be no narrower than 7 feet to accommodate a 5-foot sidewalk zone and 2 feet for signs, utility poles, and other elements. If the space is available, 8 feet is preferable on Connectors and Thoroughfares to accommodate an unobstructed 6-foot sidewalk zone with 2 feet for other elements.

• Sidewalks should be constructed in conformance with the composition requirements of Standard Specifications and Details for Public Improvements.

OTHER CONSIDERATIONS

• When sidewalks are built as part of major corridor projects, they should be built to the highest standards for achieving pedestrian comfort, safety, and accessibility.

• In retrofit situations, every effort should be made to attain preferred dimensions, but reductions may be necessary due to conflicts.

• Owners of the property abutting sidewalks are responsible for keeping the sidewalk in good order and making repairs, as per Section 25-12 of the City Code.

• Utility access covers, when in the pedestrian realm, can be located in the frontage zone, sidewalk zone, or the plating/amenity zone. If utility access covers are located in the sidewalk zone, they should be made of non-slippery materials and should be installed flush with the sidewalk.

• On curbless roadways, or in less intensely developed locations, an asphalt side path may be used in place of a concrete sidewalk. Asphalt paths must meet all of the same accessibility standards as concrete sidewalks.

• Where construction or temporary traffic controls affect the sidewalk, a fully accessible pedestrian path must be maintained through the work zone. If this is not feasible, and the pedestrian path must be diverted, the diversion path must be clearly marked and detectable by pedestrians with visual disabilities. An advanced warning should be given about sidewalk closures in a location that allows pedestrians to cross safely to an unobstructed sidewalk or walkway.[3-1]

• The use of permeable pavement to construct sidewalks may be considered so long as it is firm, stable, and slip resistant without excessive vibration causing features.

• To improve comfort of pedestrians and encourage walking, sidewalks should be continuously shaded. Shade can be provided by native trees planted 20 feet apart, shade structures, or in more urban contexts, by buildings.

3-1 For more information on City of Tucson requirements for Work Zone Traffic Control Management see Additions by the City of Tucson to the Manual on Uniform Traffic Control Devices for Temporary Traffic Control. 2015

Image 3.3 *(above)*
Brick Sidewalk

Image 3.4 *(below)*
Six-foot sidewalk with well-defined frontage zone and wide planting strip

Planting / Amenity Zone

OVERVIEW

The planting/amenity zone is the space between the back of the curb and the sidewalk zone. A planting/amenity zone should be included along streets for safety, comfort, accessibility and aesthetics.

The planting/amenity zone provides many benefits to the pedestrian. It increases lateral separation between the sidewalk zone and the vehicle travel way, thereby improving pedestrian comfort; it provides a space for locating street furniture, landscaping, water harvesting/green infrastructure, signage, fire hydrants, and other roadway elements; it makes it easier to accommodate level crossings of sidewalks at driveways; and the additional separation from the roadway reduces the likelihood that pedestrians will be splashed by passing vehicles when raining.

APPLICATION AND USE

- A planting/amenity zone meeting the preferred dimensions indicated in Table 5 should be included as part of the pedestrian realm in all corridor projects and where sidewalks are installed along the frontage of private developments.
- In sidewalk retrofit projects, maintaining the preferred width of the planting/amenity zone is strongly encouraged, but it should only be installed if it can be done without reducing the sidewalk zone below the minimum (5-foot) dimension.

DESIGN AND OPERATION

- In walkable commercial or mixed-use districts, or where buildings are built to the sidewalk, the planting/amenity zone can be paved, either with concrete or decorative pavers.
- On Thoroughfares, Connectors, or Neighborhood Street, the planting/amenity zone can either be composed of a natural strip of earth with landscaping, or paved treatments to reduce maintenance costs associated with weed removal. Where paved, the use of different materials, such as brick pavers, exposed aggregate, or stamped concrete, can help to differentiate the sidewalk zone from the planting/amenity zone.
- Tree wells or green infrastructure features can be installed in the paved planting/amenity zone to provide street trees between the sidewalk zone and the roadway where space is available.
- A 4-foot planting strip is the minimum width for tree or shrub planting, though a wider strip is preferable to accommodate the roots of most locally used street tree species (see Chapter 6 for more discussion of street trees and landscaping).

OTHER CONSIDERATIONS

- The planting/amenity zone should be kept clear of obstructions near intersections and commercial driveways to maintain appropriate sight distances.
- Where appropriate, green infrastructure features should be incorporated into the planting/amenity zone.
- Where the planting/amenity zone is paved, permeable materials should be considered, such as porous unit pavers with interlocking designs or permeable concrete. High-albedo pavers are preferable to reduce heat absorption and the effects of the urban heat island effect.
- In walkable districts, where there is high competition for space, shared e-scooter parking can be restricted to designated parking areas, in order to keep the vehicles out of the sidewalk area. These areas can be located in the planting/amenity zone or the parking zone.

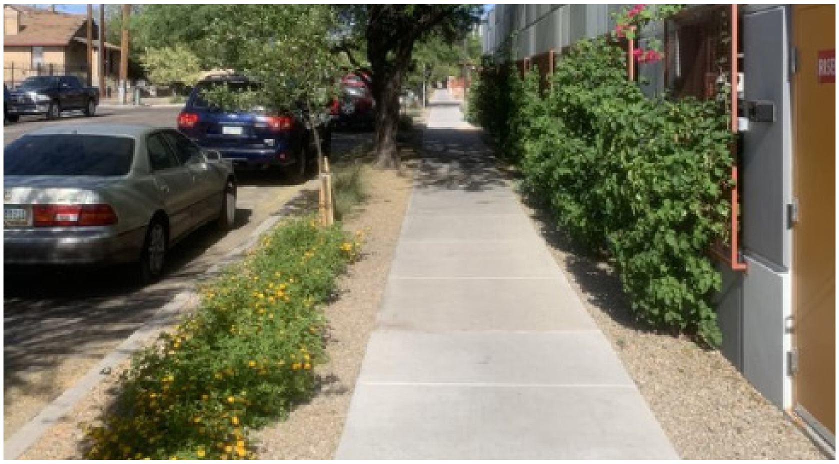
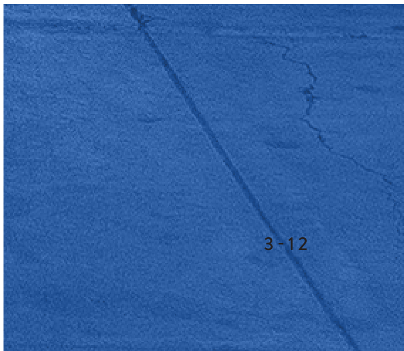


Image 3.5 *(above)*
Planting strip with vegetation

Image 3.6 *(below)*
Planting strip without vegetation



Driveways

OVERVIEW

A driveway, as defined in Section 25-29 of the Tucson City Code, is the portion of the public right-of-way from the property line to the curb—or to the improved part of the roadway where there is no curb—which is used to provide vehicular access to a property. To provide access to properties, driveways must cross through the pedestrian realm, creating a conflict between entering and departing vehicles and pedestrians traveling along the roadway. If not carefully designed, driveways can present excessive cross slopes in the sidewalk zone, making sidewalks largely inaccessible to people using mobility devices and uncomfortable for everyone else. Due to these challenges, the design, location, and frequency of driveways have a considerable influence on pedestrian safety and comfort.

APPLICATION AND USE

- Driveways are needed for ingress and egress to property, but too many driveways increase the number of conflict points in the right-of-way.
- Driveways should not be located within the functional area of an intersection. **On Thoroughfares and Connectors, driveways should be at least 150 feet from the nearest signalized intersection**, measured at the curb line from nearest pavement edge of any ingress or egress driveway to the curb line of the intersecting Thoroughfare or Connector roadway.
- **Driveways should be placed no closer than 20 feet from crosswalks** to provide good sightlines between vehicles and pedestrians and so that vehicles do not block the visibility of pedestrians.
- Entrance and exit drives crossing arterials and collectors are limited to two per 300 feet of frontage along any major roadway. The nearest pavement edges should be spaced at least 80 feet apart.
- During both major corridor projects and retrofits, project teams should look for opportunities to reduce the number of driveways. Reducing driveways through closure or consolidation will reduce conflict points and create a more welcoming pedestrian atmosphere (information about driveway location and spacing can be found in the City of Tucson's Transportation Access Management Guidelines).

DESIGN AND OPERATIONS

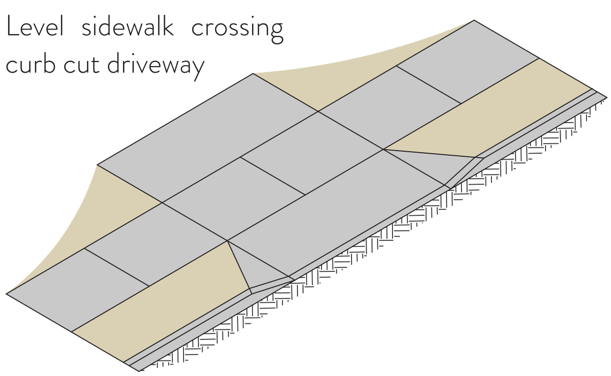
- **Where sidewalks cross driveways, the sidewalk should be dominant, maintaining the level, slope, and material of the sidewalk.** This signals to drivers to be aware of potential pedestrian activity and makes the pedestrian route more accessible and comfortable.

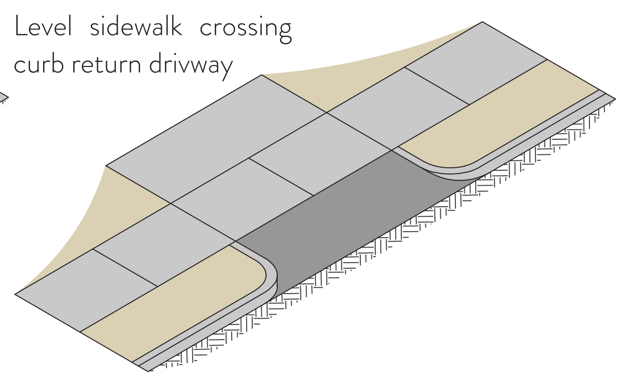
• The slope of the driveway apron should be located in the planting/amenity zone to allow level crossing of the sidewalk.

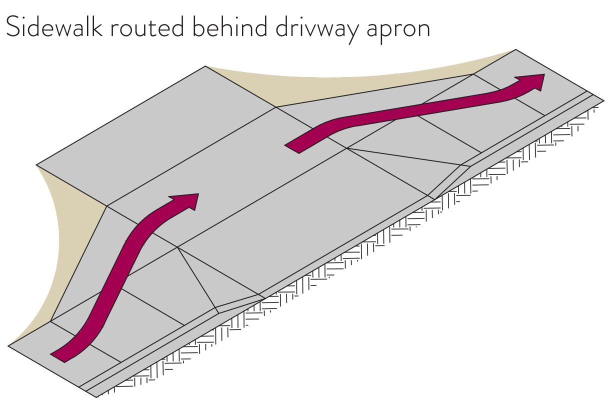
• Where no planting/amenity zone exists, the sidewalk should be routed behind the driveway apron. This may require an easement through the adjacent property.

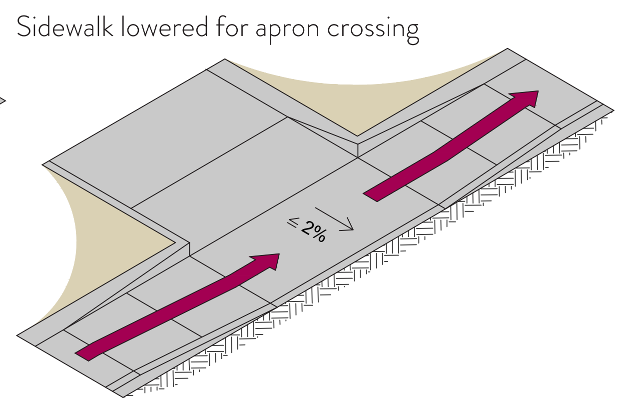
o If it is infeasible to route the sidewalk behind the driveway apron, the sidewalk may be lowered to meet at the level of the driveway in order to eliminate excessive cross slope. The sidewalk should only be lowered after all other options have been explored.

Designs for Driveways Crossing Sidewalks









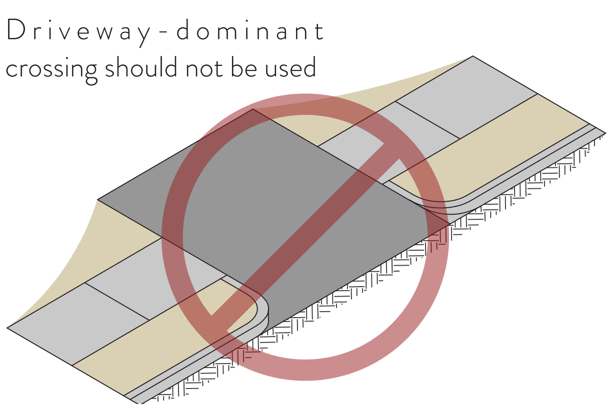


Image 3.7
Designs for driveways crossing sidewalks

• Driveways should be designed for 10 mph turning speeds for passenger cars.

  o Driveways designed with curb returns (as opposed to aprons) should use the smallest practical curb return radius to encourage slow turning speeds.

• Where commercial driveways are provided with yield or stop control, detectable warning surfaces should be provided at the junction between the pedestrian route and the vehicular route.[3-2]

• On Urban Thoroughfares and Urban Connectors, commercial driveway widths of 24 feet or under depending on the type of the development, measured at the property side of the sidewalk, are preferable[3-3]

• On Suburban Thoroughfares and Connectors, larger commercial driveway widths may be appropriate, so long as they do not exceed the maximum widths in Sections 25-38 to 25-40 of the Tucson City Code.

[3-2] United States Access Board. Public Rights-of-Way Accessibility Guidelines. Chapter R2: Scoping Requirements. (Advisory 208.1). https://www.access-board.gov/guidelines-and-standards/streets-sidewalks/public-rights-of-way/proposed-rights-of-way-guidelines/chapter-r2-scoping-requirements

[3-3] Institute of Transportation Engineers. Implementing Context Sensitive Design on Multimodal Thoroughfares: A Practitioners Handbook. 2017. https://ecommerce.ite.org/IMIS/ItemDetail?iProductCode=IR-145-E

OTHER CONSIDERATIONS

• Frequent driveways make the installation of protected cycling facilities difficult, as driveways present conflict points and limit where protective elements can be installed.

• Concrete sidewalks across driveways should be built to no less than 6-inches in-depth to support traffic load and extend their life cycle.

Image 3.8
Level sidewalk crossing at driveway with sidewalk dominant

Shared-Use Paths

OVERVIEW

A shared-use path, sometimes called a greenway or multiuse path, is a pathway that is physically separated from vehicular traffic by open space or a physical barrier. Shared-use paths may be located within the roads right-of-way, or they may be separate pathways that follow old rail lines, rivers or washes, utility corridors, or some other natural or constructed feature. Shared-use paths can be used by bicyclists, pedestrians, in-line skaters, joggers, wheelchair users, equestrian users, and other non-motorized users, such as e-bikes and scooters.

Shared-use paths offer opportunities for recreational walking, running, and riding, which are fundamentally different from travel along the roadway. Shared-use paths are designed to be low-stress facilities that provide safe and comfortable options for people who may not feel comfortable riding in the roadway or want to travel along a more scenic route.

APPLICATION AND USE

- Shared-use paths can be valuable community amenities that provide safe and comfortable active recreation and commuting opportunities.
- In more developed urban areas, shared-use paths should be distinct and separate routes from the road network to minimize road crossings, or they should be located where access points are minimal, such as in or around parks.
- In suburban or rural areas, shared-use paths can be used in place of, or in addition to, sidewalks along the roadside where driveway access and cross streets are limited.

DESIGN AND OPERATION

- Shared-use paths can be paved (asphalt, or concrete) or unpaved (crushed stone or aggregate) but must be firm, stable, and slip-resistant. Crushed stone paths are generally not encouraged unless a paved pathway is also present due to the difficulty of maintaining ADA compliance on unpaved paths.
- Paved shared-use paths with bi-directional bicycle travel should be at least 10 feet wide, and 14 feet or more in areas with higher bicycle volumes. In some instances, an 8-foot path is acceptable, but only where either bike or pedestrian volumes are very low or in extremely constrained conditions.
- Bidirectional shared-use paths may use a centerline stripe to clearly delineate opposing lanes of travel. This can be helpful in locations with poor visibility or where the path is narrow.

• The slope of the driveway apron should be located in the planting/amenity zone to allow level crossing of the sidewalk.

• Shared-use paths must be ADA compliant.

• Intersections between paths and roadways are a critical issue in shared–use path design. Where a shared-use path is immediately adjacent to the roadway (sometimes called a sidepath), it should cross a roadway within the functional area of the intersection where a crosswalk would normally be placed at a controlled intersection. Where the shared-use path has its own right of way, crossings should occur outside of the functional area of the intersection. Paths should be designed to minimize road and driveway crossings. Where shared-use paths must cross roadways:

o Paths should intersect roadways at right angles where possible.

o Path approaches to roadways should be flat at the grade of the intersecting roadway to provide adequate sight distance and stopping distance for bicyclists.

o Crossings should be highly visible and logical, channeling path users to a clearly defined location.

o Warning signs and markings should be used to notify both drivers and path users of the conflict. Crossings can be enhanced with high-visibility crosswalks, raised crosswalks, median islands, warning signs, or beacons.

o Staging and waiting areas should be provided at the crossing for path users.

o Gateway treatments can be considered to draw motorists' attention to the crossing.

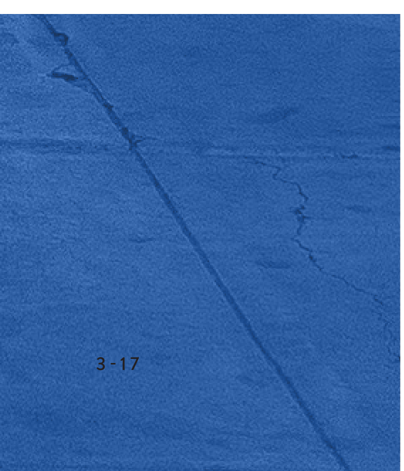
o Grade separation is usually a preferred, if expensive, solution where shared-use paths cross major thoroughfares. Care should be taken in the design of separated crossings to ensures they are secure and inviting.

o Where paths that are located within their own dedicated rights-of-way, such as river paths, cross higher volume roadways, stop or yield signs should be used for the path user.

o Where paths are located adjacent to roadways and share the right-of-way, the shared-use path should be given the same priority through intersections as the adjacent roadway.[3-4]

o Crossing, signage, and markings should make it clear to road and path users who has the right-of-way.

[3-4] Federal Highway Administration (FHWA). Small Town and Rural Multimodal Networks. 2016. https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/small_towns/



OTHER CONSIDERATIONS

- Installation of a shared-use path can be an opportunity to increases network connectivity for non-motorists, such as where there are cul-de-sacs, dead-ends, incomplete street grids, or other network discontinuities.
- The use of permeable pavement to construct shared-use paths may be considered so long as it is firm, stable, and slip resistant without excessive vibration causing features.

Image 3.9
Shared-Use Path

Transit Stops

This section provides guidance on the placement, design, and use of the different types of transit stops. Transit and walking are complementary modes since transit riders must use the sidewalks as part of their trip, either to get to the transit stop or to travel from the stop to their destination. It is critical that transit stops are well-integrated into the pedestrian realm and that pedestrian routes are fully accessible to all users. Well-laid out transit stops provide passengers visual cues on where to wait; they clearly define the stop location; they permit ease of access between the sidewalk, the transit stop, and the transit vehicle; and they do not block the path of travel on the adjacent sidewalk.

Well-placed and well-designed transit stops can improve the rider experience. Amenities, such as trash cans/recycling receptacles, vegetation, shade, shelters, lighting, bicycle storage, and seating should be considered in stop design.

The Tucson Department of Transportation and Mobility is responsible for the installation and maintenance of all Sun Tran and Sun Link transit stops within the Tucson city limits, and contracts with private entities to have stops maintained in exchange for advertising rights.

This section covers:

- Bus Stops
- Bus Shelters

A discussion of in-street transit elements is provided in Chapter 4.

Bus Stops

OVERVIEW

Bus stops provide a space for people to get on and off the bus. Stops should be comfortable, accessible, and safe for people waiting for the bus. Bus stops can range from a simple sign on a level concrete boarding area, to a bench, to a full shelter with lighting (discussed in the following section).

APPLICATION AND USE

- In Tucson, bus stops are usually placed every ¼ mile along local fixed routes.
    - o Additional stops may be considered to serve major trip generators such as college campuses, high schools, shopping centers and hospitals.
    - o Stops can be placed less frequently where adjacent land uses are vacant or sparsely populated.
- Bus stops should be located on the far side of major intersections. Locating on the far side of the intersection puts the crosswalk behind the bus which improves pedestrian visibility and safety.
    - o Stops located on the near side of signalized intersections are acceptable where the near-side stop is closer to major destinations, such as schools, shopping centers, hospitals, senior centers, parks, and other generators.
- On the far side of major intersections, bus stops should be located as close as is safely practical to the nearest crosswalk, usually within 100 feet for single bus storage and 200 feet for the storage of two buses. **Locating stops too far from crosswalks requires pedestrians to travel farther out of their way to make a safe crossing.**
- Bus stops should not be placed in the sidewalk zone. They can be located either in the planting/amenity zone or in the frontage zone, depending on space available for the bus boarding area.
- Bus stops should be connected both to the sidewalk and to the street.
- Stops should be located in the public right-of-way, not on private property.
- Pedestrian access should be maintained around and through the bus stop loading area.
- Bus stops should not be located too near driveways where the standing bus will block visibility and access to or from major destinations.
- Bus stops should be kept clear of obstacles between the sidewalk and the stop and between the stop and bus boarding area. Avoid placement of stops in front of storm drains and other obstacles.

DESIGN AND OPERATION

• A concrete or asphalt level landing pad should be provided at all new stops per ADA standards. **The minimum dimensions to deploy a lift are 5 feet wide parallel to curb and 8 feet deep from the back of the curb. If sufficient space is available, a 30-foot wide by 10-foot deep level landing pad is preferred.** The landing pad allows the bus to deploy its ramp so that passengers in wheelchairs may board and alight on a level surface.

• In addition to the ADA-required landing pad where the ramp deploys, bus stops should also provide a paved surface at the rear door of buses so passengers can safely exit onto a firm and stable surface.

• Stops and shelters should post critical information on an official bus stop sign that includes route number, stop number, direction or destination, and system logo.

• Bus stops should be well-lit to give a sense of security and so that operators can see waiting passengers. Stops can be located near existing streetlights or additional lighting can be installed as needed.

• Stops should provide seating to waiting passengers. Benches must be designed to discourage people from lying down.

[3-4] National Association of City Transportation Organizations. Transit Street Design Guide. 2016

OTHER CONSIDERATIONS

• Shade makes bus stops more comfortable during the heat of the day in Tucson and should be incorporated into stop design. Shade can be provided by street trees, nearby buildings, or through the installation of a bus shelter (discussed on the following pages.) Street trees and landscaping should not obstruct the visibility of the stop.

• For guidance on how to accommodate bicycle lanes through bus stops, refer to NACTO's Transit Street Design Guide. [3-4]

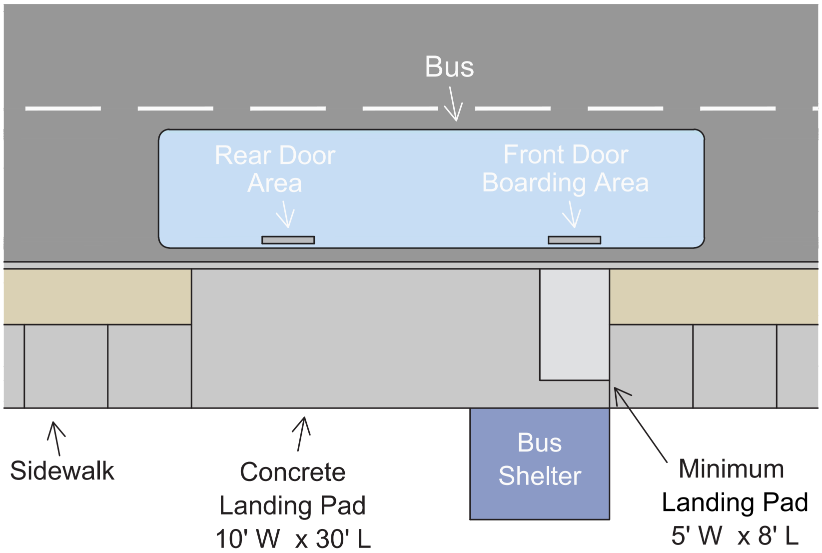
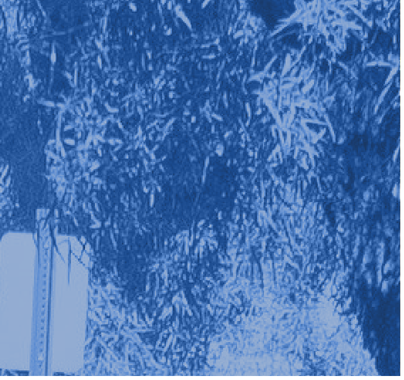


Image 3.10
Bus Stop Design



[3-5] Yingling Fan, Andrew Guthrie, and David Levinson. Perception of Waiting Time at Transit Stops and Stations. University of Minnesota (2015).

Bus Shelters

OVERVIEW

Bus shelters are durable shade structures attached to concrete foundations that should be installed at high-use bus stop locations. Shelters provide shade and cover from the rain and may also include other amenities. Shelters can also reduce perceived waiting time for passengers, particularly at stops where wait times exceed 10 minutes.[3-5]

APPLICATION AND USE

- Shelters should be installed at bus stops with 50 or more boardings per day, as part of corridor improvement projects and with the construction of bus pullouts.
- Shelters may also be installed upon public request based on a Transportation Department review of stop characteristics and available funding.
- Shelters may be located behind the sidewalk or between the sidewalk and the curb—space permitting—but may not reduce clear sidewalk width below the minimum dimension.
- The level boarding area should be connected to the shelter by an accessible pedestrian route.
- Shelter placement should avoid blocking visibility of driveway ingress and egress as well as pedestrian movements in the public sidewalk area. Sight Visibility Triangles (SVT) for each proposed shelter location are reviewed by Tucson Transportation Engineering before installation is granted.

DESIGN AND OPERATION

- Shelters should be designed so that waiting passengers can be seen from outside of the shelter.
- In shelters where seating is provided, a 2.5-foot wide by 4-foot deep minimum clear space should be located entirely within the shelter to allow wheelchair users to wait under cover.
- Shelters should be well-lit to give a sense of security and so that operators can better see waiting passengers in the dark.
- Shelter benches should comply with ADA regulations.
- Shelter size and capacity can be determined based on stop usage conditions.

OTHER CONSIDERATIONS

• At a minimum, garbage receptacles should be provided near bus shelters. A maintenance plan or agreement must address regular emptying of the receptacles and other bus stop cleaning needs. If funding is available, opportunities should also be pursued to include recycling receptacles.

• Advertisements at shelters should not block sightlines between waiting passengers and drivers.

• Whenever possible, trees and landscaping should be incorporated into shelter sites to enhance the passenger experience and provide additional shade. The visibility of the shelter should not be obstructed.

• The sidewalk can serve as the accessible landing pad where shelters are placed on the building-side of the sidewalk.

• Accessible boarding areas and clear paths may be partially under the shelter canopy as long as the shelter structure does not obstruct the boarding area and accessible route.

• Shelters serving enhanced or high-capacity transit (HCT) routes, such Bus Rapid Transit (BRT) or streetcar, should include a greater level of amenities or features. BRT or streetcar stops should be branded to give a unique sense of identity and to emphasize their special nature. Additional treatments at these locations may include platform-level boarding, off-board fare payment systems, real-time vehicle arrival information, enhanced system information and wayfinding, special paving or landscaping, premium materials, and others.

  o HCT shelters or stations may be located in the pedestrian realm or in the median zone depending on how the system is designed to operate.

Image 3.11
Bus Shelter

Street Lighting

Roadway and pedestrian lighting are intended to help roadway users better identify objects at night. Lighting is essential for improving roadway safety in dark conditions and giving roadway users an increased sense of security, particularly those who are walking. It is a key streetscape element that defines the nighttime experience of the right-of-way user and supports nighttime activities.

The Tucson Department of Transportation and Mobility operates more than 22,000 lights across the City of Tucson. Tucson Electric Power (TEP) owns and operates another 1,000 lights. The lights consist of a combination of both roadway lighting and of decorative or specialty fixtures, which are primarily used to illuminate and enhance the pedestrian environment.

The Tucson Department of Transportation and Mobility has recently converted more than 20,000 streetlights to Light-Emitting Diodes (LED) lights which reduces energy consumption and limits light pollution. It is estimated that the conversion to LED lighting will save the City $2.6 million in maintenance costs over a 10-year period and reduce energy consumption by 70 percent. Reduced energy consumption will save the City an estimated $180,000 a month in electricity costs and will also reduce greenhouse gas emissions. The conversion to LED reduced light pollution and decreased skyglow in Tucson by 7 percent.[3-6]

[3-6] International Dark-Sky Association. Tucson, Arizona, U.S. Skyglow Reduced 7% after Street Light Conversion. (2018). https://www.darksky.org/tucson-arizona-u-s-skyglow-reduced-7-after-street-light-conversion/

This section discusses:

- Roadway Lightning and
- Pedestrian Lightning.

Roadway Lighting

OVERVIEW

Roadway lights are placed along the roadside to illuminate the travel way. The poles are typically located in the pedestrian realm with the light fixtures extending over the roadway via a mast arm. Roadway lights are largely utilitarian in design, but are vital for safe travel by motorists, bicyclists and pedestrians. In urban areas, illuminating the roadway can reduce all crashes by between 16 and 32 percent, and nighttime vehicle/pedestrian crashes at intersections between 40 and 60 percent.[3-7]

[3-7] Federal Highway Administration. Crash Modification Factors Clearinghouse. http://www.cmfclearinghouse.org

APPLICATION AND USE

- Light fixture placement should be guided by the light level and uniformity requirements indicated in the Illuminating Engineering Society of North America (IESNA) Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting (ANSI/IES RP-8-18).
- Lighting should be spaced to provide continuous and uniform illumination in the travel way.
- Light poles can be placed on one side of the road only, staggered on opposite sides of the road, or placed directly opposite one another. Where space is available, lights can be placed in the median so long as clear zone requirements can be met or where poles can be protected by barriers. Typical light fixture layout is as follows:

Table 3.1 Roadway Lighting Layout

POLE LAYOUT*	ROAD LAYOUT
One-sided	One-to-three lanes
Staggered	Three-to-six lanes
Opposite	Five or more lanes

*Source: Federal Highway Administration. Lighting Handbook. August (2012).

- Light poles should not be located within the sidewalk zone. They should be placed in the planting/amenity zone or in the frontage zone to maintain a clear pedestrian pathway of travel.
- Light fixtures should not be located next to tree canopies that may block the light.
- Poles should have consistent spacing and be placed at frequencies to meet light level and uniformity targets.
- Marked crosswalks, intersections, and transit stops must be well-lit and should be prioritized for lighting improvements, starting with locations with high pedestrian volumes and/or a history of crashes. **Crosswalk lighting should provide a color contrast from standard roadway lighting.**
- **At marked crosswalks and intersections, light fixtures should be placed 10 feet in front of the intersection or crosswalk** on the side of the approaching vehicle to illuminate the front of a crossing pedestrian. Lights should not be placed directly over a marked crosswalk.

DESIGN AND OPERATION

- Light fixtures should be selected to efficiently direct light to the desired area of the roadway and sidewalk. Light fixtures should enable a variety of light distributions to adapt to different street and sidewalk configurations while maintaining the same fixture appearance.
- Pole and light fixture mounting height should be determined based on land use, road width, reach of service maintenance vehicles, power line conflicts, desired illumination levels, and uniformity. In Tucson, light fixtures are usually mounted at 35 feet on Thoroughfares and Connectors, but other street lights can be used in special conditions.
- Dark-sky-friendly luminaires, which direct most of the light downward in order to protect the night sky for the regional astronomy and optics industries, should be selected for roadway lighting. These luminaires reduce glare and minimize light trespass.
- Most street lighting fixtures in Tucson are of the "cobra head" variety. Special, more decorative lighting poles and fixtures, such as the green pendant bell fixtures installed along the streetcar line, should be considered in walkable destination areas. These fixtures should complement the land use and design features of the district.

OTHER CONSIDERATIONS

- Tucson's streetlights are connected to a central control system known as the Remote Operations Asset Management System (ROAM). ROAM provides monitoring and control capabilities to Transportation staff. It alerts staff about failing or failed fixtures and provides light dimming and energy consumption monitoring capabilities. Lights can be dimmed in low-pedestrian activity areas to reduce energy consumption. Lights should not be dimmed at signalized intersections, marked and signalized mid-block crosswalks, at roundabouts, or at rail crossings.
- Transportation has implemented a dimming strategy that addresses roadway use during off-peak hours. All newly installed LED roadway light is centrally controlled to set initial light levels at 90% of output capacity when first illuminated each day. Most lights are then dimmed to 60% of output capacity in the off-peak hours. Intersection lights and pedestrian crosswalk lighting are not dimmed beyond the initial 90%. All residential LED lights are scheduled to be dimmed to 60% at midnight, in accordance with the safety practices adopted by the Federal Highway Administration.
- In the event LED light trespasses on a dwelling, the City can install a shield. Shields are installed to mitigate light trespass but it must not restrict effective lighting on the roadway and any sidewalks present.

Pedestrian Lighting

OVERVIEW

Pedestrian lights tend to be more decorative than roadway light fixtures, often matching or complementing the dominant architectural styles or historic character of buildings and other street elements in the area. Pedestrian lights are designed at the human scale, located closer to the ground than roadway lighting, and oriented towards the sidewalk area.

The most common decorative pedestrian lighting seen in Tucson is the globe-style light fixture, though post-top lights are also fairly common. These are largely found in and around downtown and in the nearby historic neighborhoods. Tucson's decorative pedestrian lights consist of a mix of the original historic light poles and replicas of historic styles.

APPLICATION AND USE

- Pedestrian lights should be installed in walkable destination districts, such as downtown, universities, and walkable commercial districts.
- Pedestrian lights may also be used on shared-use paths, areas with high pedestrian volumes, and areas with pedestrian safety concerns.
- Pedestrian lights should be spaced more closely together than streetlights. For good illumination levels, pedestrian lights should be located every 50 to 60 feet along the sidewalk.
- Pedestrian light fixtures can be affixed to the same pole as roadway lights to save on installation costs and reduce the number of poles in the pedestrian realm.

Image 3.12
Pedestrian light in downtown Tucson

DESIGN AND OPERATION

- Pedestrian luminaires are typically mounted less than18 feet above the sidewalk and they should be designed at the pedestrian scale.
- The design of the lights should complement existing decorative light styles, but should also be functional, providing adequate light levels to improve pedestrian safety and security.
- In some contexts, bollard lights may be preferable to illuminate pathways without creating excessive ambient light.

OTHER CONSIDERATIONS

- Historic and decorative pedestrian lights in and around downtown should be preserved. Historic lights can be supplemented with newer pedestrian lights that increase illumination in walkable commercial districts.
- Even during the day, well-designed pedestrian lights contribute to the character of the district, and can even be a defining feature. Therefore, great care should be taken in the selection of pedestrian lighting types.
- Lighting level targets and light design can be established in district-specific guidelines.
- Pedestrian lighting should only be installed in areas with a continual presence of people in order to discourage vandalism.

Street Furniture

Street furniture is a general term that applies to the various objects installed along the street to enhance the pedestrian realm and make the street more vibrant and functional. Well-designed and well-placed street furniture improves people's experience of the pedestrian realm by offering places to rest and socialize and contributing to the sense of place. It helps to manage parking for bicyclists and to keep the streets clear of litter. The design and deployment of street furniture should be compatible with the context of the street.

When street furniture is not well-placed, it can obstruct and clutter the pedestrian travel way. This section provides design guidelines for street furniture in the pedestrian realm. The elements covered in this section include:

- Seating
- Bollards
- Bicycle racks

Seating

OVERVIEW

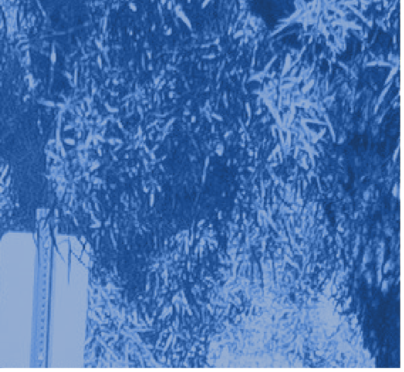
Seating is a valuable enhancement in areas with high levels of pedestrian activity. It gives pedestrians a place to rest, wait, read, people-watch, and enjoy the street life. Providing comfortable, inviting places to sit can transform a sidewalk into a gathering place and expand its role as a public space and community amenity. Using seating to create a place that people seek out and want to linger is the mark of a successful public space.

APPLICATION AND USE

- Street-side benches and other seating are most appropriate in walkable commercial districts and other destination streets such as downtown/university streets and neighborhood commercial districts.
- Seating may be installed by individual property owners, residents, and merchants, or by community groups like neighborhood or merchant's associations, or as part of a larger package of public improvements.
- Seating can be formal, such as benches or temporary/moveable seats, or informal, such as low walls and edges.
- Both permanent and temporary/moveable seating should be located outside of the sidewalk zone. Seating can be located in the frontage zone, the planting/amenity zone, or in plazas and parklets.
- Benches and seating should be oriented towards areas of activity. Benches located next to the curb should be oriented towards the buildings, and benches located next to a building façade should be oriented to the street. Benches and seating can also be oriented perpendicular to the primary direction of travel on the sidewalk.
- Permanent seating should be located in a way that does not interfere with building entrances, loading zones, access to fire hydrants, parked vehicles or other conflicts.
- Seating should be placed in shaded locations, near street trees or other structures, and shade should be provided for seating locations.

DESIGN AND OPERATION

- Seating should be provided for a minimum of two people for socializing.
- Bench seat heights should be at least 17 inches and no more than 19 inches above the ground.
- Benches will be most useful if they have full back support and armrests to assist with sitting and standing
- Where there are multiple benches, some should be provided without armrests to allow wheelchair users to slide onto the bench if desired.



[3-8] See R404 of Public Right-of Way Accessibility Guidelines (PROWAG) for additional clear space requirements near benches.

OTHER CONSIDERATIONS

- Where benches without tables are provided, at least 50 percent, but no fewer than one, should provide a clear space of at least 2.5 feet by 4 feet at the end of the bench for people in wheelchairs.[3-8]
- Seating should be designed to encourage seating, but discourage lying down. Seating areas longer than 4 feet should provide armrests or other dividers to discourage reclining.
- Permanent seating should be made of durable, high-quality materials.
- Seating should complement other streetscape elements and should be included in district-specific design guidelines.

Bollards

OVERVIEW

Bollards are permanent or temporary posts or objects used to create a boundary between different roadway users or to prevent vehicles from entering certain locations. Bollards can be fixed, flexible, or movable. They can be designed to withstand heavy impacts, or give way on impact. Movable and breakaway bollards deter vehicle access, but allow entry for fire engines and ambulances in case of an emergency. Bollards come in a variety of shapes and sizes, from standard posts to public art.

Image 3.13
Bollards

APPLICATION AND USE

- Bollards protect pedestrians, bicyclists, buildings, and specific areas from vehicular access and to highlight traffic calming measures.
- In walkable districts where the sidewalk abuts the street, fixed bollards are prevent motor vehicles from driving onto the sidewalk. These features can add color and interest to the streetscape in addition to providing security on the roadway and in front of certain buildings.

• Fixed or moveable bollards can be used to eliminate vehicular access to create pedestrian-only streets and plazas.

• Fixed bollards allow the pedestrian realm to be better defined if curbs are absent.

• Flexible, high-visibility bollards (often called flex posts or flexible delineators) should be used to warn drivers of certain in-street elements, such as chicanes, other traffic calming measures or in street green infrastructure features.

• Flexible bollards can be installed in bike lane buffers to increase the sense of separation between motorists and bicyclists to create a protected bicycle lane.

• Flexible bollards are also a powerful tool for installing low-cost design changes on streets, such as reducing turn radii at intersections.

DESIGN AND OPERATION

• In-street flexible bollards should be brightly colored with reflective bands.

• Permanently installed bollards in walkable districts should be functional as well as attractive and visually complementary to the surrounding streetscape.

OTHER CONSIDERATIONS

• In-street flexible bollards require proper maintenance as they will be struck by motor vehicles.

• In destination districts, bollards should be considered as part of the overall street design. They can serve multiple functions in these areas, such as being street art or providing additional bicycle parking, if designed with elements that allow locking and support.

Bicycle Racks

OVERVIEW

Having secure places to park with reasonable protection against theft is essential to encouraging people to bike more often. Bicycle parking is most effective when it is located close to trip destinations, is easy to find and is accessible. Good bicycle parking designs are permanently fixed to the ground, maximize capacity, maintain an orderly appearance, are secure, and are simple to use.

APPLICATION AND USE

- The City of Tucson requires that bicycle parking be provided with most new developments.
- Placement and spacing of bicycle racks should consider dimensions when occupied.
- Bicycle racks should be placed so that parked bikes do not project into the sidewalk zone.
- On walkable destination streets, bike racks should be located in the public right-of-way, in the planting/amenity zone or on curb extensions (in-street bike corrals are discussed in Chapter 4).
- In commercial shopping centers and on roadways with larger building setbacks, bicycle racks should be placed near, but not directly in front of building entrances. These racks will likely be located on private property, ideally within 50 feet of the business entrance.
- Where space permits (at least 13 feet of paved surface from the building to the face of the curb), bicycle racks in the amenity zone should be oriented perpendicular to the sidewalk. Where space is not available bike racks may be located parallel to the curb or angled. A 6-foot clear pedestrian area should be maintained in walkable districts (which can include portions of unobstructed frontage and planting/ amenity zones.)
- **Racks should be placed at least 3 feet apart and 3 feet from other street furniture to allow uncluttered access.**
- **Racks should be placed at least 2 feet from the curb.**

DESIGN AND OPERATION

- Racks should be sturdily secured to the ground.
- Racks should provide two points of contact with the bike.
- Steel and stainless steel are common and appropriate materials for most general use racks.
- Bike racks should have a 2-inch diameter.
- Inverted U and post-and-ring racks are recommended designs. Wave-style racks are discouraged. (Note: for guidance on in-street bicycle corrals, see Chapter 4 of this Guide.)

[3-9] Department of Transportation: A Standard Guide for the Distribution and Installation of Bicycle Racks by the City of Tucson Department of Transportation. https://www.tucsonaz.gov/files/bicycle/Bike_Rack_Distribution_Policy.pdf

OTHER CONSIDERATIONS

• The City of Tucson Director of Transportation signed a policy in 2013 to provide new bike racks to Tucson businesses who request them.[3-9] Businesses need to request bike parking and a Tucson Transportation and Mobility staff member will evaluate the site to determine the best location and type of bike parking.

• If the best location for a bicycle rack is in the public right-of-way, the rack will be installed by the Transportation and Mobility Department. If the best location is on private property, the property owner is responsible for installation.

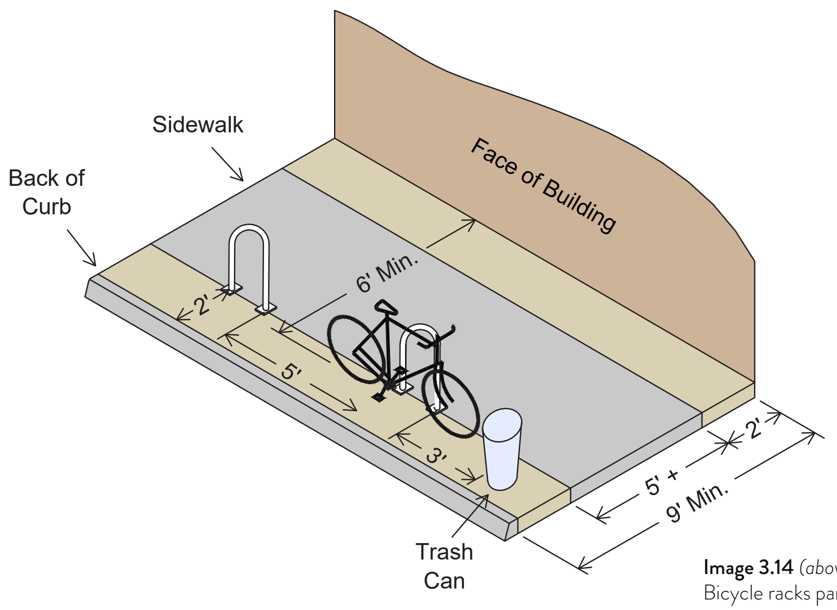
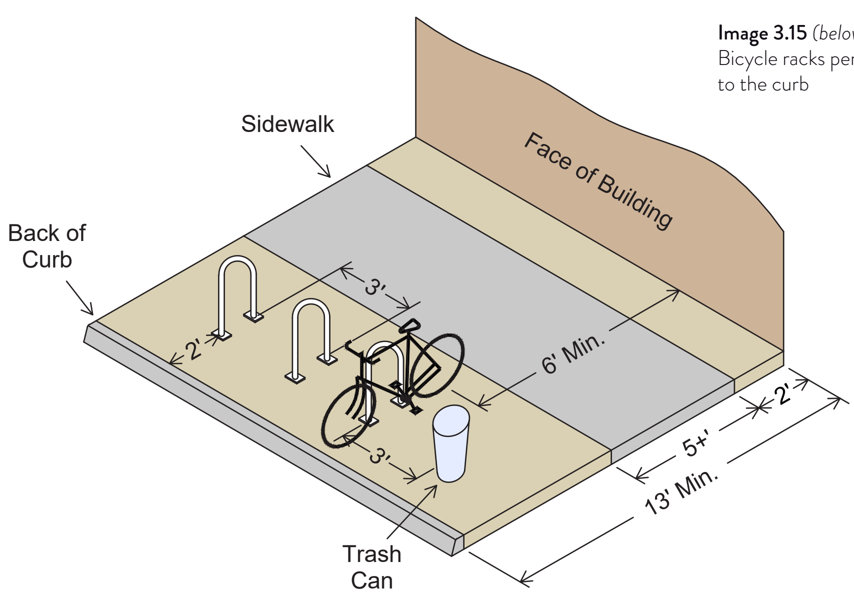


Image 3.14 *(above)*
Bicycle racks parallel to the curb

Image 3.15 *(below)*
Bicycle racks perpendicular to the curb



Trash and Recycling Receptacles

OVERVIEW

Sidewalk trash and recycling receptacles are important for helping to keep Tucson's sidewalks clear of litter. While the receptacles themselves are not the most attractive elements within the right-of-way, when regularly emptied they do reduce the amount of refuse on the street which improves the overall quality of the urban environment.

APPLICATION AND USE

- Trash and recycling receptacles should be placed at regular intervals in walkable commercial districts and areas with heavy pedestrian activity.
- Receptacles should be located as close as is practical to corners without obstructing pedestrian access.
- Receptacles should be placed in the planting/amenity zone and should not be in the sidewalk clear zone.
- They should be near major activity centers, like transit stations.
- On Thoroughfares and Connectors with lower levels of pedestrian activity, receptacles should, at minimum, be located at transit shelters and other high ridership bus stops. Additional receptacles can be installed as needed based on pedestrian activity.

DESIGN AND OPERATION

- Receptacles should be considered a design element that complements nearby street elements.
- Receptacle design should be included in district-specific street design guidelines, if developed.
- Receptacles should be made of durable, high-quality materials such as galvanized or stainless steel with finishes that are resistant to fading and peeling.
- Receptacles should include both trash and recycling containers and should be able to open from the side to allow easy access for the removal of garbage bags.

OTHER CONSIDERATIONS

- Sidewalk trash and recycling receptacles are maintained by a variety of entities. In downtown Tucson, the Downtown Tucson Partnership is responsible for receptacles. At bus shelters, a contractor is responsible for emptying the cans. Elsewhere in the city, sidewalk receptacles are the responsibility of the Tucson Department of Transportation and Mobility.

Placemaking / Placekeeping

Placemaking/placekeeping is a concept that applies to streets, public spaces, and other geographic places that makes them attractive, unique, vibrant and a draw for all types of people. Placemaking is a people-centered approach to planning, design, and management of public spaces that builds on existing community assets.

A well-made place should be reflective of the community it serves and provides a sense of place that is unique to the history, geography, and people of the City of Tucson. Great places should foster a sense of connection to the city and should invite social interaction and gathering.

While ultimately, what makes a place unique and remarkable is not necessarily quantifiable or intentionally designable—resulting from some combination of the people, the history, the culture, the businesses, the architecture, and the natural environment of a given location—there are elements that contribute to a place's identity. Many of these have already been covered within this chapter, but those elements were largely functional components of the pedestrian realm. This section focuses instead on those elements of the pedestrian realm that may not serve a functional purpose in terms of moving people (in fact, they are probably better for stopping people), but are potential design elements to support the larger goals of creating great places. These elements include:

- Sidewalk dining
- Wayfinding signs and district identifiers
- Public art
- Public plazas, pocket parks, and parklets.

Image 3.16
Gateway arches at Five Points on S. 6th Ave.

Sidewalk Dining

OVERVIEW

Sidewalk dining is an extension of adjacent restaurants into outdoor areas. They are private spaces located in or near the pedestrian realm. Sidewalk dining is a valuable enhancement to an area as outdoor dining enlivens the street, adds visual interest for pedestrians, and allows diners to watch and engage with active street life.

Given Tucson's desert climate, with mild winters and relatively cool summer evenings, outdoor dining can be enjoyed for most of the year. This is an opportunity that can be expanded on to solidify Tucson's position as a culinary destination and internationally recognized City of Gastronomy. Outdoor dining can be used as another way of publicly celebrating and showcasing the city's food culture.

APPLICATION AND USE

- Sidewalk dining is most appropriate and should be encouraged in areas with high levels of pedestrian activity, such as downtown and walkable commercial districts.
- Sidewalk dining can be located behind the sidewalk on private property or within the public right-of-way. Sidewalk dining in the right-of-way can either be located in the frontage zone or in the planting/amenity zone.
- Sidewalk dining areas located in the public right-of-way will require a Temporary Revocable Easement (TRE) granted by the Tucson Department of Transportation and Mobility Real Estate Division. Applicants for a TRE must include a site plan and other information for consideration of approval.[3-10]
- Sidewalk dining should not reduce the sidewalk zone to less than 6 feet and should not cause significant redirection of pedestrian travel around the dining area.
- Fixed structures should not obstruct access to utility vaults.

[3-10] The TRE application can be found at https://www.tucsonaz.gov/files/realestate/TREAPP-4.pdf

OTHER CONSIDERATIONS

- In order to serve alcohol in a non-contiguous sidewalk dining area, the area must be within 30 feet of a licensed premises and the area in which alcohol is served must be enclosed by a permanently installed fence at least 3 feet tall (Arizona Department of Liquor R19-1-105).

Community Wayfinding Signs

OVERVIEW

Community wayfinding signs are visually engaging signs that direct motorists, pedestrians, and bicyclists to key landmarks, cultural assets, and other important destinations. Wayfinding signs distinguish different parts of the city and unique districts, to communicate to people that they are in a tourist zone or other notable area.

APPLICATION AND USE

• Wayfinding signs can be used in areas with a particular concentration of cultural sites or areas that are tourist destinations.

• Wayfinding signs should be located close to intersections and crosswalks. Pedestrian signs should direct pedestrians to safe crossing opportunities.

DESIGN AND OPERATION

• Community Wayfinding Signs should comply with Section 2D.50 of the MUTCD.

• Wayfinding signs should be easy to understand, clear and concise with limited text in order to be quickly read.

• Signs can be designed to distinguish different districts through color-coding or the use of different icons.

• Wayfinding signs intended for motorists should have larger letters, be mounted higher, and be located along gateways to tourist districts. Wayfinding signs intended for pedestrians should be placed at pedestrian eye level, with a smaller font, and oriented towards the sidewalk or located in public spaces.

• Vehicular wayfinding signs should be located in the planting/amenity zone, while pedestrian wayfinding signs could be located in the planting/amenity zone, in plazas, or in the frontage zone so long as they do not impede on the sidewalk clear zone.

Image 3.17 Neighborhood Identification Signs

OTHER CONSIDERATIONS

- On-street maps can be used to supplement signs, giving pedestrians an opportunity to orient themselves to their surroundings without needing to rely on a mobile device.
- In addition to wayfinding signs, Tucson also has a neighborhood sign program to help residents and visitors identify different communities within Tucson. The City of Tucson Department of Transportation and Mobility allows Neighborhood Identification Signs to be posted at the neighborhood's boundaries.[3-11] With this program, a neighborhood's name and logo can be displayed on aluminum panels below the official street name signs.

[3-11] City of Tucson Neighborhood Identification Signs: https://www.tucsonaz.gov/tdot/neighborhood-identification-signs

Public Art

OVERVIEW

Public art is an important element of community and street improvements. Art can help to unify the character of a district; celebrate neighborhood history, identity, and cultural heritage; provide visual interest to people on the street; establish gateways to different neighborhoods or areas; and promote civic pride. In Tucson, public art is a celebration of the community's diversity, history, and southwestern culture as well as a showcase for local artists and the region's strong artistic tradition.

The City of Tucson funds a public art program administered through a contract with the Arts Foundation for Tucson and Southern Arizona (AFTSA). It is funded through a set aside of 1% percent of the budget for capital improvement projects with high public contact and budgets over $100,000. The Regional Transportation Authority (RTA) also allocates 1% of corridor construction costs for public art, and Pima Association of Governments (PAG) manages another program, known as Transportation Art by Youth (TABY), in which youth enrolled in local arts programs partner with professional artists to design and construct public art projects. Private entities also commission artworks for the enjoyment by the public, most notably the many murals found on walls throughout Tucson.

APPLICATION AND USE

- Tucson's Public Art Program is described in more detail in Tucson's Administrative Directives 7.01-1 to 7.01-7.[3-12]
- Public art installations should be located in areas in which they can serve as pedestrian focal points and can help to orient the pedestrian or serve as gateways or points of interest to motorists and cyclists.

[3-12] City of Tucson Administrative Directives: https://www.tucsonaz.gov/hr/administrative-directives

• Thought should be given towards incorporating decorative or artistic treatments into other street elements, such as bike racks, poles, benches, wayfinding signs, and others.

• Public art should not obstruct the clear pedestrian path of travel.

DESIGN AND OPERATIONS

• Public art is unique to each situation and the artist who creates it. The scale and orientation of the works will vary depending on whether it is located on major traffic corridors, near recreational paths, or in smaller, more intimate pedestrian spaces.

OTHER CONSIDERATIONS

• Public art must be maintained, which should be a consideration in the selection of publicly funded arts projects.

Image 3.18
Flight of Time by Susan Wink at University Blvd. and 3rd Ave.

Plazas, Pocket Parks, and Parklets

OVERVIEW

Plazas, pocket parks, and parklets are small public open spaces integrated into the urban fabric. They provide space to rest and relax, take lunch, read, and other leisure activities. Collectively these spaces provide a space for people to just "be" outside, without the imperative to make purchases or payments for the right to occupy the space.

Plazas are small hardscaped open spaces, typically located in urban areas and designed at human scale. Plazas can enhance the public realm by accommodating active uses such as temporary markets or street performances as well as passive daily activities.

Pocket parks are small public spaces located near the sidewalk. Pocket parks can provide green space, shade, play areas, seating, grassy patches, or other public amenities. Pocket parks can be included in building developments or within the right-of-way where underutilized space is available.

Parklets are created by converting parking spaces into extensions of the pedestrian realm. Parklets can include amenities such as plantings, seating and sidewalk cafés. They are a low-cost solution to providing more public space and seating where existing sidewalk widths cannot accommodate these amenities Parklets can be temporary installations or they can be permanent constructions.

Image 3.19
Downtown Tucson Partnership and Tucson Parks and Recreation activated Jacome Plaza in downtown with temporary seating and activities

Image credit: Downtown Tucson Partnership

APPLICATION AND USE

- Plazas, pocket parks, and parklets can be installed on vacant land, surface parking lots, or parking spaces in areas with high pedestrian activity and minimal open spaces.
- Public space can also be incorporated into site design when new buildings are constructed in these areas.
- Reserving space in dense walkable areas as plazas, pocket parks, and plazas greatly enhances the urban environment and can allow people to linger for more time.

DESIGN AND OPERATION

- The design will be dependent on the space, but should incorporate at minimum seating and shade.
- Parklets should be placed in line with on-street parking and should be off-set from the travel lane or the bicycle lane. Reflective posts and striping can be used to make them more visible to reduce the risk of being struck.

OTHER CONSIDERATIONS

- Hosting temporary events or activities in public spaces, including streets can be a community attraction that enlivens the public sphere and encourages people to gather. Events and activities can include food trucks, artists' stalls, vendors, community festivals, block parties, and special events.[3-13]

[3-13] Applications for organizing special events can be found on the City of Tucson's Special Events page: https://www.tucsonaz.gov/business/special-events

Elements by Street Type

Table 3.2 provides a quick reference for which design elements from the Pedestrian Realm would be appropriate for each of Tucson's street types. During project development, selected design elements will ultimately depend on budget, project goals, constraints, and engineering judgment.

Table 3.2
Design Elements by Street Type

	Frontage Zone	Sidewalk Zone	Planting / Amenity Zone	Narrow Driveways	Shared-Use Path in ROW	Bus Stop	Bus Shelter
STREET TYPES							
Downtown / University	R	R	R	R	N	C	C
Neighborhood Commercial	R	R	R	R	N	C	C
Urban Thoroughfare	R	R	R	R	N	C	C
Urban Connector	R	R	R	R	N	C	C
Suburban Thoroughfare	R	R	R	C	C	C	C
Suburban Connector	R	R	R	C	C	C	C
Neighborhood Street	R	R	R	R	N	C	C
Shared Street	R	N	N	R	N	N	C
Industrial Street	R	C	C	N	N	C	C
MODAL PRIORITIES							
Frequent Transit Network	R	R	R	C	C	R	R
Regionally Significant Corridor	R	R	R	C	C	C	C
Freight Corridor	R	R	R	C	C	C	C
Bicycle Priority Street	R	R	R	R	N	C	C
Bicycle Boulevard	R	R	R	R	N	N	N

R = Recommended C = Case Specific N = Not Typical

Roadway Lighting	Pedestrian Lighting	Seating	Bollards	Bicycle Racks in ROW	Trash Receptacles	Sidewalk Dining	Wayfinding	Public Art	Plazas, Pocket Parks, Parklets
R	R	R	C	R	R	R	R	R	R
R	R	R	C	R	R	R	C	R	R
R	N	C	C	C	C	N	N	R	C
R	C	C	C	C	C	C	C	C	C
R	N	N	C	N	C	N	N	C	N
R	N	N	C	N	C	N	N	C	N
C	C	C	C	C	C	N	C	C	C
C	C	N	C	C	C	N	C	C	C
C	N	N	C	N	N	N	N	N	N
R	C	C	C	C	C	C	C	C	C
R	N	N	C	N	C	N	N	C	N
R	N	N	C	N	C	N	N	C	N
R	C	C	C	C	C	C	C	C	C
R	C	N	C	C	C	N	C	C	C

R = Recommended C = Case Specific N = Not Typical

Utilities

Public streets in Tucson often serve as utility corridors, accommodating overhead and underground power lines; telecommunications, internet, and cable infrastructure; water lines; sanitary sewers; and gas lines. Typical utility infrastructure includes utility poles, overhead wires, underground pipes, utility boxes, vaults, valves, and others. They are a necessary function of the street.

Location of Utilities

OVERVIEW

Because of their prevalence, utilities can constrain the ability to locate other streetscape elements—such as sidewalks, street trees, and green infrastructure features—and can create visual clutter. It is therefore important to consider the location and placement of above and below ground utilities when planning corridor improvements.

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.

APPLICATION AND USE

- Utilities should be placed to minimize disruption to pedestrian through travel and potential planting and site furnishing locations while maintaining necessary access for maintenance and emergencies.
- Utilities should desirably be located underground wherever feasible.
- Large utility vaults such as network or transformer vaults, and wet utility lines running the length of a city block, should be located in the roadway or parking lane where access requirements allow.
- Water lines should be placed below the roadway on the downstream side of cross drainage.
- Utility poles and surface-mounted utilities (such as utility boxes) must be kept out the sidewalk zone. Placement of above ground utilities should not reduce the sidewalk clear zone below 6 feet on thoroughfares and connectors and 5 feet on neighborhood streets.
- Utility poles must be placed a minimum of 1.5 feet back from the face of the curb. If space is available, utility poles should be located behind the sidewalk.

• Subsurface utility conduits should avoid running under the length of the planting/amenity area to minimize root interference. Underground dry utilities that run the length of a city block should be placed below the sidewalk.

  o In downtown Tucson, all underground utilities may be placed under the roadway given the difficulties of working under the sidewalk in the historic core of the city.

• Utility laterals should not run directly under landscaped areas in the planting/amenity zone, but instead under driveways and walkways wherever possible.

• Small utility vaults, such as residential water vaults, residential water meters, gas valves, gas vaults, or street lighting access, should be located in the planting/amenity zone at the back of the curb wherever possible. Small vaults should be aligned or clustered wherever possible. Utility vaults may be placed in the sidewalk zone as long as their surfaces are slip resistance and placed flush with the sidewalk

• Utility vaults and valves should be minimized in curb extensions and green infrastructure where plantings or site furnishings are desired.

• 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 planting/amenity zone is not feasible.

• Fire hydrants should be located between the curb and the sidewalk, where possible, for maximum accessibility. Hydrants must be placed at least 2 feet behind the curb but not more than 7 feet.

• Placement of poles, equipment, or other above ground infrastructure will need to evaluate the Sight Visibility Triangle. The criteria for the SVT is found in The City of Tucson's Technical Standards Manual, TRANSPORTATION, Section 10-01.5.

• For required planting clearances from underground utilities, see Table 17 in Chapter 6 of this guide. Controlling requirements for utilities in the right of way can be found in The City of Tucson Public Utility Administration Manual.

OTHER CONSIDERATIONS

• Utilities should be consolidated to the extent feasible for efficiencies and to minimize disruption to the streetscape. Dry utilities (telephone, cable TV, gas, electric, etc.) can have joint trench arrangements.

• When working in the right-of-way, private utility companies must ensure safe and accessible pedestrian and bicycle access through the work zone.

• If existing vaults conflict with curb ramp areas, vaults should be moved or modified to meet accessibility requirements as feasible as part of utility upgrades.

• Following improvements, utility companies must replace and restore such rights-of-way or public places in as good or better a condition as before the work performed by the licensee which caused such disturbance or damage, including to City owned landscape and irrigation equipment. • The city reserves the prior and superior right to lay, construct, erect, install, use, operate, repair, replace, remove, relocate, regrade, widen, realign, or maintain any rights-of-way and public ways, aerial, surface, or subsurface improvement.

• Upon the city's request, utilities will be relocated at provider's expense (unless state law expressly requires otherwise)

• Maintenance access must be maintained for utilities. In-street utilities can be accessed through the street, but pavement must be replaced to existing conditions following any work. For utilities located behind the curb, maintenance vehicles may park on the sidewalk, in the planting area, and into the frontage zone. An accessible pedestrian walkway should be maintained through the work area, but in cases where this is not practical, appropriate advanced warning must be given for sidewalk closures so pedestrians may cross over to an accessible route.

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4

STREET REALM DESIGN

STREET REALM DESIGN

Overview

The Street Realm refers to the area between the curbs—or between the road edge on curbless streets—where parked cars, bicyclists, transit vehicles, and private and commercial motor vehicles all co-exist (pedestrians enter the street realm while crossing, but crossings and intersections are addressed in Chapter 5).

Traditionally, the focus of transportation improvements occurring between the road edges was on moving motor vehicles more safely and efficiently, at times to the detriment of other users. Under a Complete Streets approach, the City of Tucson will view improvements more comprehensively, considering the roadway's function within the street network, potential user groups, and community goals. This means the efficiency of moving motor vehicle travel will be one consideration of many in project design, balanced with the needs of bicyclists, transit users, and pedestrians.

This chapter provides design guidance on in-street elements, which include bicycle facilities, transit facilities, parking, vehicle travel lanes, traffic calming, and medians. How space is allocated within the street and where each of the design elements discussed in this chapter is deployed will have a significant impact on vehicle operating speeds and how well a given corridor supports multimodal travel.

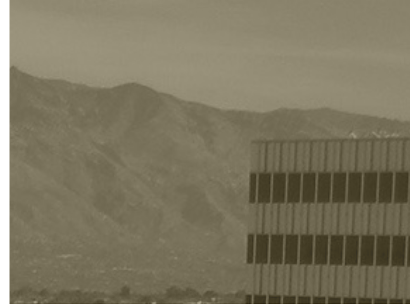
Bicycle Facilities

The first section of this chapter focuses on the bicycle elements of the roadway. A bicycle is defined, in the state of Arizona, as a device, including a racing wheelchair, that is propelled by human power and on which a person may ride. Bicycles can include devices with two or three wheels.

In the City of Tucson, the same rules that apply to bicycles also apply to E-bikes, which includes bicycles in which an electric motor provides assistance to the rider. E-bikes with maximum speeds below 20 mph can use the same city facilities as traditional bicycles.

With Tucson's flat terrain, desert climate, and dispersed land use pattern, bicycling has long been the travel mode of choice for many of the city's residents. Tucson-Eastern Pima County is recognized as a Gold-level bicycle-friendly community from the League of American Bicyclists as a result of the region's extensive bicycle network and bicycle encouragement and education programs.

[Previous two-page spread]
An aerial view of the street realm in Tucson. Source: "Downtown" by Daniel Lobo under license CC BY 2.0



Tucson is also regularly featured in various publications as a premier bicycling destination city due to the region's weather and strong bicycling culture. As of 2017, Tucson ranked in the top 25 cities nationally for the total number of bike commuters and in the top 10 of large cities for the bicycle commuter mode share.[20]

[20] League of American Bicyclists. Where We Ride: Analysis of Bicycle Commuting in American Cities. (2017)

However, many people who do not currently bicycle identify a lack of low-stress bicycling facilities as one of the keys factors in their decision not to ride. They are the potential riders who are uncomfortable cycling in traffic or in striped bike lanes on wide, higher-speed thoroughfares and connectors.

In order to increase bicycle ridership, the city will need to expand and connect the network of low-stress facilities to provide comfortable options for those residents who want to ride but do not feel safe using current facilities.

This section covers a number of bicycle facilities, including:

- Protected bicycle lanes
- Raised bicycle lanes
- Buffered bicycle lanes
- Conventional bicycle lanes
- Shared lanes
- Bicycle boulevards
- Bicycle corrals

Bicycle crossings are addressed in Chapter 5 of this guide.

Image 4.1
Bicyclists with Tugo bicycles

Protected Bicycle Lanes

OVERVIEW

Protected bicycle lanes, also called cycle tracks or separated bicycle lanes, are bicycle facilities that are located in or directly adjacent to the roadway but are physically separated from motor vehicle traffic with a vertical element. They are for the exclusive use of bicyclists, providing a riding experience that is close to that of a separate off-street bicycle path, but within the area of the street realm.

Protected bicycle lanes can be separated from travel lanes in two primary ways:

- **Curb Protected:** Curb protected bicycle lanes are protected from the adjacent travel lane by a permanent curb and median.
- **Object Protected:** Object protected bicycle lanes are protected from the adjacent travel or parking lane by a pavement marking and vertical object, such as flexible bollards, armadillo lane dividers, or other items approved be DTM.

Protected bicycle lanes can be one or two-directional and can be provided on one side or both sides of the street. Also, protected bicycle lanes have been shown to increase bicycle volumes on streets where they are installed.

Image 4.2
Curb Protected Bicycle Lane on Stone Ave

Below: Object Protected Bike Lane

APPLICATION AND USE

• Protected bike lanes are the preferred bicycle facility type on Tucson's high-volume, multi-lane roadways.

• Protected bicycle lanes should be installed, if feasible, under the following conditions[21]:

  o Posted speed of 30 mph or higher

  o AADT greater than 6,000 vehicles per day

  o More than 2 travel lanes

  o High potential bicycle demand

  o Connection to an existing or planned bicycle boulevard or off street shared-use path[22]

• Protected bicycle lanes work best where there are long blocks with few driveways or major signalized cross streets.

• Installing protected bicycle lanes on typical Tucson thoroughfares and connectors, where frequent driveways create a crash risk between vehicles accessing a property and bicyclists, requires that the designer pay special attention to driveway crossings. If possible, some driveways should be closed and consolidated to reduce the number of conflict points. Other steps include:

  o Restricting parking within 20 feet from driveways to maintaining good sight distance

  o Applying bicycle markings and green-colored pavement at conflict points

  o Installing additional signage notifying drivers to the presence of cyclists

  o Raising the bicycle lane above the level of the vehicle travel way (discussed in more detail below)

  o Slowing vehicle turning speeds decreasing driveway widths, minimizing driveway entrance radii, and installing turn wedges in bikeway buffer areas

• Two-way protected bicycle lanes, that allow bicycle movement in both directions on one side of the street, are appropriate on one-way streets, areas with very few driveways or cross streets, where most of the destinations or connections are better accessed from one side of the roadway, or where linking two sections of shared-use paths to maintain the rider experience.

• Where on-street parking is permitted, the protected bicycle lane should be placed between the parking lane and the sidewalk, using the parked cars to protect the bicycle lane from the travel lane. A 3-foot buffer should be provided between the bicycle lane and parked cars to keep cyclists separated from the door zone.[23]

[21] Adapted from FHWA "Bikeway Selection Guide". February 2019. https://safety.fhwa.dot.gov/ped_bike/tools_solve/docs/fhwasa18077.pdf and NACTO's "Designing for All Ages and Abilities: Contextual Guidance for High-Comfort Bicycle Facilities. December 2017. https://nacto.org/wp-content/uploads/2017/12/NACTO_Designing-for-All-Ages-Abilities.pdf

[22] See Table 9 in this chapter for Bicycle Facility Selection Guidance.

[23] NACTO. Urban Bikeway Design Guide. 2012

DESIGN AND OPERATION

[24] NACTO. Urban Bikeway Design Guide. 2012

[25] All dimensions for bicycle lanes refer to the ridable surface of the lane. Measurements are exclusive of gutter pans, where present.

- The minimum width for a protected bicycle lane is 5 feet, but 6.5-8 feet is preferred, with at least 2 feet of separation between the bicycle lane and vehicular traffic.[24, 25]
- Where 8 feet is available for a protected bicycle lane, the preferred configuration is:
    - o 5 feet of ridable surface with 3 feet of physical separation, when adjacent to on-street parking, or
    - o 6 feet of ridable surface with 2 feet of separation where there is no on-street parking
- Where 9 feet is available, the preferred configuration is 6 feet of ridable surface with 3 feet of physical separation.
- **Where curb medians are used to protect a bicycle lane that is narrower than 6.5 feet, a mountable wedge curb should be used** adjacent to the bicycle lane to reduce the risk of a pedal strike on the curb face.
- Vertical elements should be placed within the buffer a minimum of 12 inches from the edge of the bicycle lane.[26]
- Delineator-protected (flexible bollard) bicycle lanes should only be used in retrofit situations. For major reconstruction projects, a more permanent vertical element, such as curb, should be used.

[26] Additional design guidance can be found in FHWA's 2015 Separated Bike Lane Planning and Design Guide. https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/separated_bikelane_pdg/page00.cfm

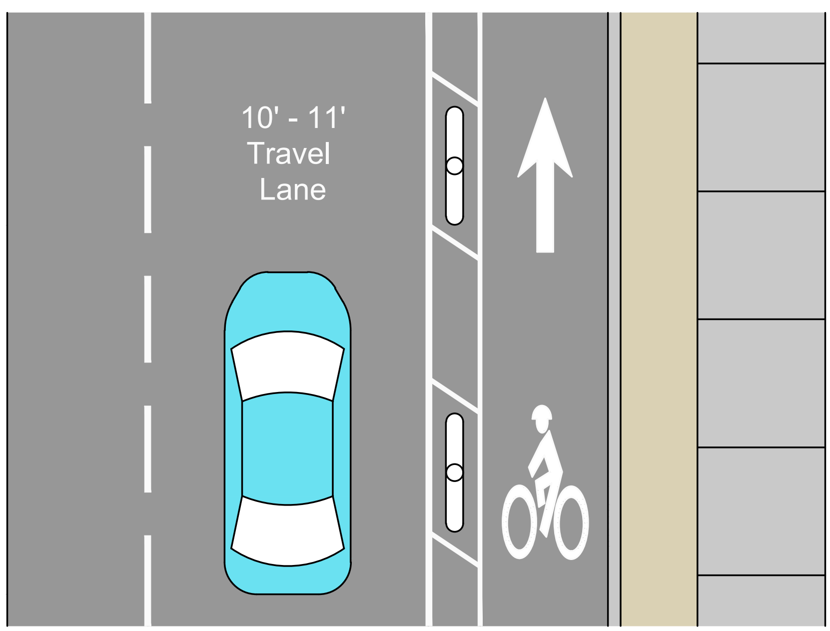


Image 4.3
Object Protected Bicycle Lane

OTHER CONSIDERATIONS

- Where protected bicycle lanes intersect with in-street frequent transit stops (frequencies of 15 minutes or better), it is recommended that the bicycle lane is routed behind the transit boarding platform with consideration of the other following enhancements:
    - o Provide a marked crosswalk from the sidewalk area to the transit platform
    - o Provide a YIELD HERE TO PEDESTRIANS sign at the crosswalk
    - o Consider installing a raised crosswalk to emphasize the preferred crossing location to reduce bicycle-pedestrian conflicts
    - o The transit platform must maintain the 5 foot by 8-foot level boarding area
- At stop locations with headways greater than 15 minutes, the bus may cross the bicycle lane to board passengers at the curb. Care should still be taken to provide an opportunity for bicycles to safely pass the transit vehicle on the left.
- Where a protected bicycle lane crosses a bus pull-out, the bicycle lane can maintain a straight line and pass on the left side of the bus. Green conflict markings should be applied to the roadway where the bus crosses the bicycle lane. Where approved on frequent transit network, Bike (Symbol) ON SIDEWALK OK sign can be used to route bicylists up onto sidewalk to avoid conflict with transit.
- Protected bicycle lanes requires the purchase of special street sweeping equipment that can be operated within the narrow dimensions of the bike lane. Protected bicycle lanes will need to be swept regularly, particularly during monsoon season, to ensure they are kept free of debris.
- Impacts on drainage must be taken into consideration where installing a continuous protective barrier, such as a curb.
- A minimum of 4 feet of ridable width should be maintained around drain grates and gutters in bicycle lanes. The gutter pan should not be included in the dimension of the bicycle lane or counted as a ridable surface. When streets are reconstructed, gutters should be removed where feasible.
- Adding vertical protective elements in the roadway can narrow the driver's perception of the vehicle realm and decrease vehicle operating speeds for many drivers.

Raised Bicycle Lanes

OVERVIEW

Raised bicycle lanes are a type of protected bicycle lane in which the lane is raised above the level of the adjacent roadways. Raised bicycle lanes may be raised to the level of the sidewalk, or they may be set at an intermediate level between the sidewalk and the roadway.

APPLICATION AND USE

- Raised bicycle lanes can be considered at any location where a protected bicycle lane would be appropriate, but where there is not enough available space for a horizontal buffer between the bike lane and travel lane(s) in which to place a vertical element.
- Raised bicycle lanes with mountable curbs may be a good option on corridors with more frequent driveways. The change in level will slow turning vehicles and improve the visibility of bicyclists.

DESIGN AND OPERATION

- A raised bicycle lane can be separated from the adjacent travel or parking lane by either a vertical curb or a mountable curb.
- Raised bicycle lanes should be at least 3 to 6 inches above the adjacent vehicle travel way.
- Where a raised bicycle lane is located adjacent to a parking lane, or where the buffer between the bicycle lane and the street is used for street furniture, there should be at least 3' of lateral separation between the bicycle lane and the roadway.
- **The desired width for raised protected bicycle lanes is 6.5 feet.** Five feet is acceptable at pinch points and intersections.
- When a raised bicycle lane is built adjacent to a sidewalk, a separation of at least 6 inches may be established between the two facilities to discourage conflicts between cyclists and pedestrians. Vertical elements between the sidewalk and the bikeway, such as low plantings, trees, pedestrian lighting, and signage indicating where people should walk vs. bike are strongy encouraged to reduce user conflicts. A detectable edge between the walkway and the bikeway is required, and may take the form of a landscaped buffer, textured unit pavers, detectable wayfinding strips, or 2-3" vertical curb in the case of an intermediate-level raised bike lane.
- Contrasting pavement, such as black-colored concrete, should be used for raised bike lanes to indicate that it is a bikeway, not a walkway.
- Where raised bicycle lanes cross driveways, the bicycle lane should be dominant, maintaining the level, materials, and slopes of bicycle lane through the driveway zone.
- If used, mountable curbs should be at least 1' wide with a maximum

4:1 slope. This allows bicyclists to easily enter and exit the bicycle lane for passing and allows vehicles to access properties. The curb should not be counted as ridable surface when calculating lane width.

• At intersections, the raised bicycle lane can be dropped to street level.

• Raised bicycle lane should be sloped to allow water to drain from the bicycle lane. Drainage grates should be located in the street or parking area, not in the bicycle lane.

OTHER CONSIDERATIONS

• A sight triangle to the bicycle lane of at least 20 feet should be maintained from side streets and 10 feet from driveways.

• Dashed green conflict markings, YIELD TO BIKES signage, and yield lines should be used at conflict points, such as driveways, to show that the bicycle lane has priority over entering and exiting traffic.

• Raised bike lanes are best integrated into major corridor or reconstruction projects because they can be constructed at relatively little cost. They are much costlier when installed as part of retrofit projects.

• Special maintenance procedures may be needed to keep raised bike lanes clear of debris. Dimensions of standard bicycle facility sweepers should be considered during design.

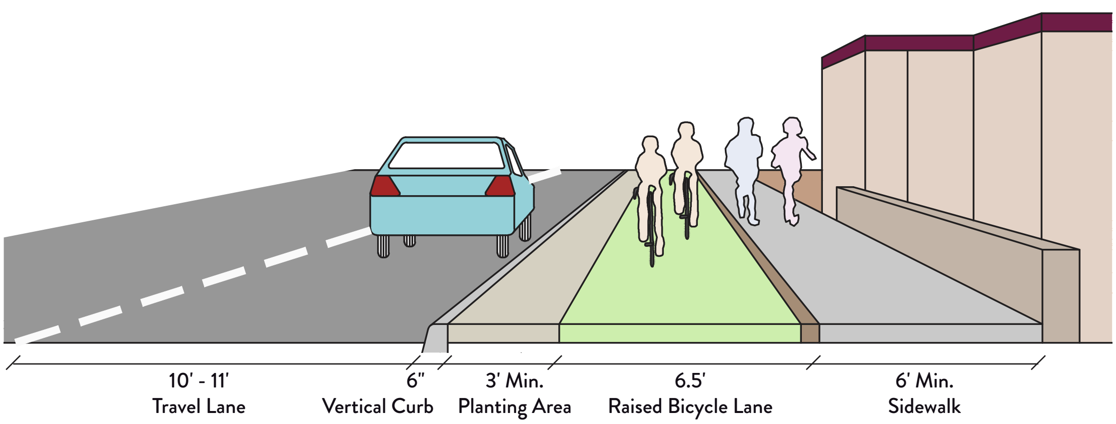


Image 4.4
Raised Bicycle Lane with a Vertical Curb

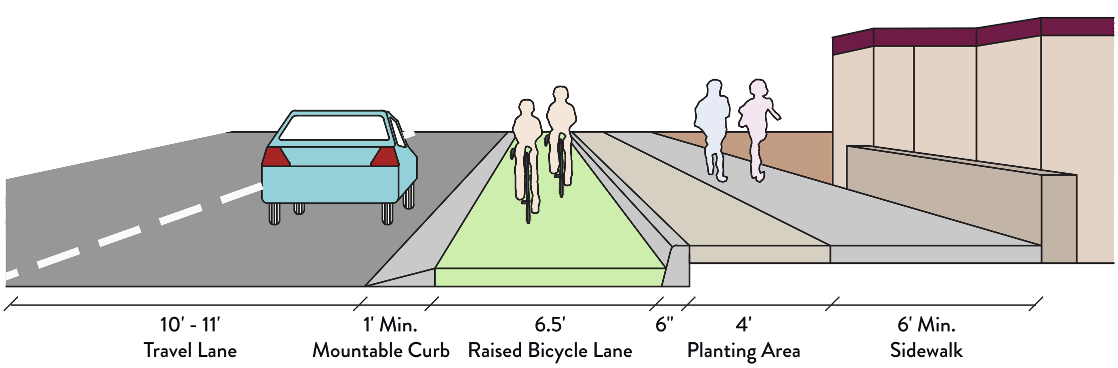


Image 4.5
Raised Bicycle Lane with a Mountanable Curb

Buffered Bicycle Lane

OVERVIEW

Buffered bicycle lanes are a type of bicycle facility that separates the bicycle lane from the vehicle travel lanes and/or parked cars through the use of a painted buffer area on the pavement. Buffered bicycle lanes improve comfort and perception of safety for bicyclists, potentially increasing ridership on some corridors.

APPLICATION AND USE

- Travel-side buffered bicycle lanes should be considered anywhere a conventional bike lane is used. It can also be an alternative to a protected facility if full protection is not feasible due to cost, space, access management challenges, or other issues.
- Door-side buffered bicycle lanes should be used where the bicycle lane is adjacent to a parking lane.
- The marked buffer effectively increases the width of the bicycle zone without increasing the risk that the bicycle lane will be confused for a motor vehicle travel lane or parking lane and improves bicyclist positioning for enhanced safety.

DESIGN AND OPERATION

- The minimum buffer width from through traffic should be 18 inches.
- **Buffer widths of at least 2 feet from through traffic are preferred.**
- Where 8 feet is available for a buffered bicycle lane, the preferred configuration is
    - o 5 feet of ridable surface with a 3-foot door-side buffer, when adjacent to on-street parking, or
    - o 6 feet of ridable surface with 2-foot road-side buffer where there is no on-street parking.
- Where 9 feet is available, the preferred configuration is 6 feet of ridable surface with 3 feet of physical separation.
- A 3-foot buffer is preferred when installed on the parking side of the bicycle lane.
- Where the buffer width is 3 feet or greater, hatching-style markings should be applied between the solid white lines of the buffer. Parallel longitudinal lines are an acceptable buffer below 3 feet.
- Hatching-style markings should be spaced at 10-40ft. with the spacing equal to the posted speed limit. Hatchings should form an angle of approximately 30 to 45 degrees with the longitudinal lines that they intersect.
- On intersection approaches with right turn only lanes, the bike lane should be transitioned to a through bike lane to the left of the right turn only lane.

OTHER CONSIDERATIONS

- The combined width of the buffer and the bicycle lane should be considered the total bicycle lane width.
- Where a buffer can only be installed on one side of the bicycle lane and there is on-street parking, the buffer should be placed on the parking side of the bicycle lane, particularly where there is high parking turnover.
- Green colored pavement can be used to highlight conflict areas, such as at bus pull-outs, larger driveways, and where vehicles cross the bicycle land to access a right-turn lane.

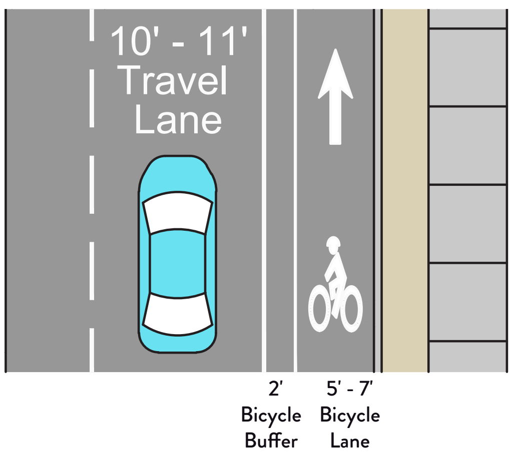


Image 4.6
Parallel Lines on Buffered Bicycle Lane

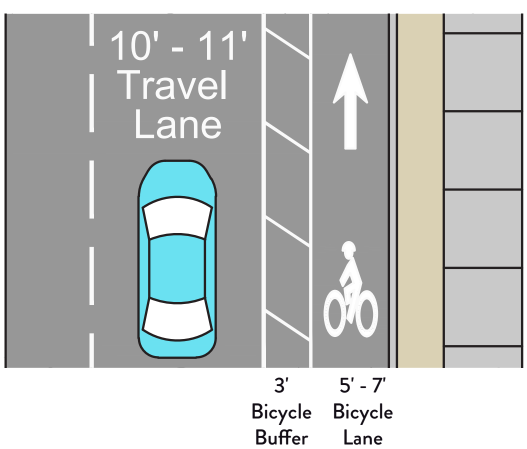


Image 4.7
Hatched markings in a 3-foot bicycle lane buffer

Conventional Bicycle Lanes

OVERVIEW

Conventional bicycle lanes are currently the most common bicycle facility type in Tucson. They are created by applying a white stripe with "BIKE LANE" text or bicycle symbol pavement markings on the side of a roadway to designate an exclusive space for bicyclists to operate.

APPLICATION AND USE

- Conventional bicycle lanes can be installed on any street type, but are uncommon on low-speed, low-volume streets where exclusive space may not be needed and maintenance of striping may be a concern.
- Conventional bicycle lanes can be created for relatively little cost during repaving projects through re-striping the roadway to allocate space to bicyclists.
- Lanes are typically located on the right side of the street between the travel lane and the curb edge.
- On higher-speed, multilane roadways, conventional bicycle lanes should only be used if not enough space is available for protected or buffered lanes (or other constraints make the more comfortable facility types infeasible). Protected or raised bicycle lanes should be the first-choice bicycle facility during reconstruction and major corridor projects.
- Conventional bicycle lanes are most appropriate on streets with 25 mph speed limits, low traffic volume, and low curbside activity.

DESIGN AND OPERATIONS

- **Bicycle lanes should be at least 5 feet wide** but 4-foot lanes may be considered in constrained conditions, particularly on lower-volume, lower speed streets, based on engineering judgment.
- Lanes 6.5 feet or wider should include a painted buffer of at least 18 inches to communicate to drivers that the bicycle lane is not a travel lane or parking lane.
- Where drainage grates or gutter pans are located adjacent to the curb in a bicycle lane, 4 feet of ridable surface should be maintained between the grate or gutter pan and the vehicle lane. When drain grates are placed in the the bicycle lane, grate openings should not be oriented parallel to the direction of travel to avoid catching narrow bicycle tires. Manhole covers may be located in the bicycle lane.

OTHER CONSIDERATIONS

- Green colored pavement can be used to highlight conflict areas, such as at bus pull-outs, larger driveways, and where vehicles cross the bicycle lane to access a right-turn lane.
- Conventional and buffered bicycle lanes may encourage higher vehicle speeds due to decreased side friction and driver perception of road width.
- Bicycle symbol must be used to communicate lane purpose to road users. Markings should be placed at least every 1/2 mile and after every major signalized intersection.
- For all bicycle lane types, parking restrictions should be strictly enforced, including for delivery and maintenance vehicles. Where parking violations in the bicycle lane continue to occur or where a bicycle lane may be confused for on-street parking, a No Parking Bike Lane (MUTCD R7-9, 9a sign) should be installed.
- In work zones, active bicycle lanes must remain clear. They cannot be closed unless documented in a Traffic Control Permit. Before a bicycle lane is closed, options for maintaining a bicycle lane through the construction zone should be explored, including narrowing travel lanes.
    - o Where bicycle lanes must be closed, advanced notification and tapers should be provided with sufficient length to allow bicyclists to merge into the adjoining travel lane. A temporary Bikes May Use Full Lane sign (MUTCD R4-11) should be installed at the start of the taper.

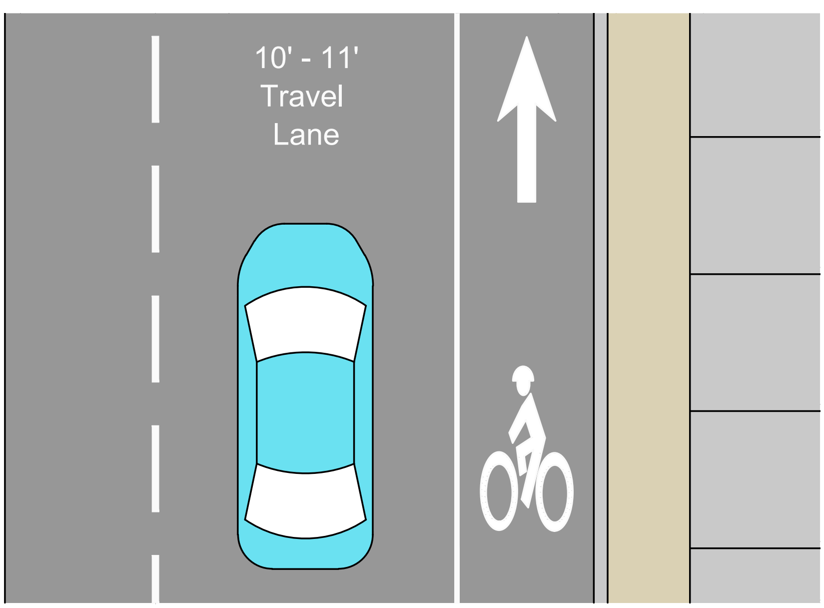


Image 4.9
Conventional
Bicycle Lane

Table 4.1
Bicycle Facility Dimensions Guidance*

Type of Bicycle Lane	Ridable Surface				Buffer/Protective Element			
	Without Gutter		With Gutter		Without On-Street Parking		With On-Street Parking	
	Minimum	Preferred	Minimum	Preferred	Minimum	Preferred	Minimum	Preferred
Protected Bicycle Lane	5' (6' if vertical elements are placed directly along the edge of	6.5'+	4'	6.5'+	1' curb protected 2' object protected	3'+	3' (parking side of bike lane)	3' (parking side of bike lane)
Raised Bicycle Lane	5'	6.5'+	X	X	1' w/ mountable curb or no street	3' w/ street furniture	3' from parked cars	3' from parked cars
Buffered Bicycle Lane	5'	6.5'+	4'	6.5'+	18"	3'+	3' (parking side of bike	3' parking side buffer and 18"+ street-side
Conventional Bicycle Lane	5'	6.5'	4'	6.5'	X	X	X	X

If a vertical eleme 1t, such as a header curb, flexibile deline ator, planter, etc. is placed along either edge of the protected bike lane, increase minimum buffer space by at least 6". I.E if a protected bike lane is bordered by two vertical curbs, the minimum rideable surface should be at least 6'. If beveled pedal-safe

Image 4.8
Conventional Bicycle Lane

Image 4.9
Buffered Bicycle Lane on Mountain Ave.

Shared Lanes

OVERVIEW

In some locations it is not feasible or practical to install exclusive bicycle lanes. In these cases, bicyclists and motor vehicles will operate in a shared lane. In some cases, it is desirable to mark shared lanes with special lane markings, known as shared lane markings, or sometimes "sharrows."

Shared lane markings help bicyclists to position themselves most safely in the travel lane, they reinforce driver expectations that bicyclists can operate in the travel lane, and they show bicyclists the correct direction of travel. Shared lane markings should not be treated as a substitute for protected, buffered, or conventional bicycle lanes.

APPLICATION AND USE

- Shared lane markings are typically installed on roadways where spatial constraints make installation of more comfortable bicycle facilities impossible. Shared lane markings should never be used as a substitute for exclusive bicycle facilities on non-neighborhood streets where space exists.
- Shared lane markings should be used on bicycle boulevards.
- Shared lane markings should not be used on streets with posted speed limits greater than 30 mph.
- On streets with on-street parking, shared lane markings should be located to keep bicyclists out of the door zone of parked vehicles.
- On multilane streets, shared lane markings should generally be placed in the outside travel lane.

DESIGN AND OPERATION

- The design of shared lane markings is covered under Section 9C.07 of the MUTCD.
- Shared lane markings may be supplemented with BIKES MAY USE FULL LANE or bicycle warning signs where appropriate.

OTHER CONSIDERATIONS

- Shared lane markings should only be considered after all other options to install exclusive bicycle lanes have been explored and deemed infeasible.
- On 25 mph streets with high parking turnover, shared lane markings should be close to the center of the travel lane to indicate full lane usage by bicyclists and to keep the travel path clear of the door zone.

Image 4.9
Shared Lane on 6th Ave.

Bicycle Boulevards

OVERVIEW

Bicycle boulevards are neighborhood streets designed to prioritize bicycling and to enhance conditions for walking. They have been modified to encourage comfortable bicycle travel by ensuring low vehicle volumes and slow travel speeds by calming traffic reducing cut-through travel. Bicycle boulevards are intended to provide safe, low-stress bicycle route alternatives to higher-volume connectors and thoroughfares. Bicycle boulevards attract riders of all ages and abilities who would not otherwise be comfortable on the busier streets. Bicycle Boulevards are one of the modal priority street types assigned to Tucson's road network.Tucson is adding 100 miles of bicycle boulevards on 31 neighborhood streets in the next years, funded through voter-approved Proposition 407.

APPLICATION AND USE

- Bicycle boulevards are created by adding traffic calming, shared lane markings, wayfinding signage, and crossing enhancements to neighborhood streets.
- Streets with vehicle volumes below 1,500 are preferred for bicycle boulevards, though up to 3,000 vehicles per day are allowed on limited sections.
- Above 3,000 vehicles per day, project teams can divert traffic on to alternate routes through the use of volume management strategies.

DESIGN AND OPERATION

- Bicycle boulevards slow traffic through the installation of traffic calming features, such as traffic circles, chicanes, curb extensions, and other features (traffic calming is addressed later in this chapter).
- Bicycle boulevards function best when installed on more direct routes. Circuitous routes can be confusing to riders.
- Visibility is a crucial element of a successful bicycle boulevard network. Appropriate signage and pavement markings alert all roadway users that they are on a street that prioritizes bicycle and pedestrian travel. Consistent branding will help to unify the network and draw attention to the special street designation.
- Safe roadway crossings must be provided where bicycle boulevards cross multilane, high-speed roadways. Installation of curb extensions, median refuge islands, bike crossing markings, and/or demand activated beacons such as BikeHAWKs or TOUCANs with bike button signal activation should be used. (more information on these crossing treatments is provided in Chapter 5 of this Guide). Bicycle crossings should be responsive to actuation to minimize wait times for bicyclists crossing major roadways. Green infrastructure can be used in these locations to cool waiting areas.

Image 4.9
4th Ave Bicycle
Boulevard

[27] City of Tucson Bicycle Boulevard Master Plan. https://www.tucsonaz.gov/files/transportation/files/BBMP-2-22-17.pdf

• For more detailed design guidance on bicycle boulevards, refer to Chapter 4 of the City of Tucson Bicycle Boulevard Master Plan.[27]

• The policy of the City of Tucson is that all bicycle boulevards will have a speed limit of 20 mph once constructed.

OTHER CONSIDERATIONS

• In the Bicycle Boulevard Master Plan, The Tucson Department of Transportation and Mobility has identified and prioritized a network of 193 total miles of future bicycle boulevards along 64 corridors.

Table 4.2
Bicycle Facility Selection Guidance*

TRAFFIC VOLUME	POSTED SPEED	DRIVEWAY FREQUENCY	1ST CHOICE BICYCLE FACILITY	2ND CHOICE BICYCLE FACILITY	3RD CHOICE BICYCLE FACILITY	4TH CHOICE BICYCLE FACILITY
>6,000	30+ mph	Infrequent	Protected Bicycle Lane†	Raised Bicycle Lane	Buffered Bicycle Lane	Conventional Bicycle Lane
>6,000	30+ mph	Frequent	Raised Bicycle Lane	Protected Bicycle Lane	Buffered Bicycle Lane	Conventional Bicycle Lane
>6,000	25 mph	All	Protected/ Raised Bicycle	Buffered Bicycle Lane	Conventional Bicycle Lane	Shared Lane
3,000-	25-30 mph	All	Buffered Bicycle Lane	Conventional Bicycle Lane‡	-	-
<3,000	25 mph	All	Shared Lane	-	-	-
<3,000	20 mph	All	Bicycle Boulevard	Shared Lane	-	-

*Table adopted and expanded from FHWA Bikeway Selection Guide, 2019.

†A shared-use path (sidepath) may be in used in place of, or in addition to, an in-street bicycle treatment where the right-of-way is available, particularly in suburban contexts.

‡In business districts or on connectors with on-street parking and high turnover, considering a parking-protected bicycle lane. Conventional bicycle lanes directly adjacent to on-street parking are discouraged.

Bicycle Facility Maintenance

In order to be comfortable, attractive, and safe all bicycle facility types should be maintained as to be free of potholes, broken glass, debris, and overgrown vegetation. Utility cuts in the bicycle lane should be backfilled to same degree of smoothness as the original surface.

Street sweeping can be considered more frequently on high-use bicycle facilities given the larger impact of debris on bicycle travel than on vehicle travel.

Bicycle Corrals

OVERVIEW

Bicycle corrals are larger in-street bicycle racks that provide secure parking for multiple bicycles. Installing corrals is beneficial to nearby businesses as they allow better access to more potential customers. Bicycle corrals provide a bicycle parking solution in areas with limited sidewalk space, high pedestrian volumes, and demand for bicycle parking.

APPLICATION AND USE

- Bicycle corrals can be installed by converting an on-street parking space, and 10-12 bicycles can be parked in a converted parking space.
- Bicycle corrals can be installed instead of other bicycle racks when bicycle parking is requested by the business and an on-street location is deemed preferable during a site review.
- Corrals should:
    - o provide at least 5 feet of clearance from utilities, loading zones, or accessible parking spaces;
    - o be at least 15 feet from a fire hydrant;
    - o be at least 60 feet from bus stops or shelters; and
    - o be at least 20 feet from a crosswalk.
- Corrals should be selected in areas with high bicycle demand and available curbside space.

DESIGN AND OPERATION

- Corrals are created by connecting multiple inverted-U bicycle racks at the base of each rack.
- As with any bicycle parking, the racks should provide enough clearance to allow for parking and retrieving bicycles – at least 3 feet of clearance between racks is preferable.
- Corrals are connected by rails and anchored into a concrete base.
- Paint, flexible bollards, parking blocks, or other elements can be used to differentiate the bike corral from the parking lane and the roadway.
- Corrals can be oriented perpendicular to the curb or at 45-degrees.

OTHER CONSIDERATIONS

- Bicycle corrals can be installed in front of local businesses by request to the Tucson Transportation Department, based on a site evaluation.

Parking

In Tucson, like most cities, parking is made available through a combination of surface parking lots, parking structures, and on-street parking. The most common type of parking on Tucson's thoroughfares and connectors is provided by surface parking lots, primarily on private property. Parking structures, both above and below ground, are largely concentrated in downtown and near the University of Arizona, with some others located at major attractors like hospitals. On-street parking is common on residential streets and in and around downtown Tucson.

On-street parking is prohibited on arterials and collectors, unless specifically authorized by Mayor and Council or the Tucson Department of Transportation and Mobility. 6th Avenue, between downtown Tucson and Speedway Blvd. is an example of a major street with on-street parking.

Surface and structured parking are outside the purview of this Guide, though it is generally recommended that where surface parking is provided in the urban area, it should be located behind or to the side of new developments with the structures built close to the sidewalk and oriented to the street. Locating large surface parking lots between the building and sidewalk creates an uncomfortable walking environment by increasing the pedestrian's sense of exposure.

Tucson residents have become used to having access to free and plentiful parking over the years. However, as demand for parking grows at major destinations the need to charge for parking has emerged as a way to manage competition for spaces and to fund construction of new structures.

This section focuses on on-street parking in the public right-of-way. It covers:

- On-street parking design and application, and
- Parking meters and pricing.

Image 4.10
Angle parking in Downtown Tucson

On-Street Parking

OVERVIEW

On-street parking is an important component of the urban environment. The presence of on-street parking can indicate to a driver that they have entered a high-activity district or neighborhood where lower travel speeds are expected. It is also an efficient use of urban space, as on-street parking occupies about half the surface area per car as off-street parking (which includes the need for driveways and aisles).On-street parking can also be provided at a significantly lower cost than structured parking, which can cost between $20,000 and $35,000 per space to construct while occupying valuable urban real estate that could be put to better uses.

On-street parking is a desirable use of space on low-speed streets and should be retained to the maximum extent practicable. On-street parking should only be considered for removal for bicycle corrals, to provide space for a protected bicycle facility, for an enhanced streetscape, to widen a sidewalk, for bus lanes, to install a parklet, or other enhancements. It should not be replaced with a general purpose travel lane.

On-street parking typically occupies the same zone in the street realm as bicycle facilities (between the vehicle travel lane and the curb), so the needs of both user groups will have to be carefully considered in the allocation of space. On-street parking can enhance walking and biking when it buffers and protects both modes from travel lanes, but it can also compete for the same piece of the roadway as cyclists in constrained rights-of-way.

Park Tucson manages Tucson's public parking supply in the highest demand areas in downtown Tucson and along the Sun Link streetcar route.

APPLICATION AND USE

- On-street parking supports the retail and service businesses that are essential to active street life.
- It improves pedestrian comfort by providing a buffer between the pedestrian realm and moving vehicles.
- On-street parking slows traffic both by introducing side friction into the street and through vehicles entering and leaving parking spaces.
- On-street parking should be:
    - o prohibited within 20 feet of fire hydrants
    - o at least 20 feet from mid-block crosswalks
    - o at least 30 feet, or more, from the corner radius of an intersection, depending on the particular sight distance needs at the intersection.

DESIGN AND OPERATION

• On-street parking lanes should be 8 feet wide on major streets and a minimum of 7 feet wide on neighborhood streets and connectors.

• Where a parallel parking lane is located next to a travel lane on a connector street, the combined width should be a minimum of 18 feet.

• The preferred combined width for a parallel parking lane adjacent to a bicycle lane is at least 15 feet (a combination of parking lane, bicycle lane, and buffer).

• On neighborhood streets, where a parking lane is adjacent to a wedge curb, the wedge curb can be included in the width of the parking lane (so where there is a 2-foot wedge curb, only 6 feet of space needs to be allocated in the street to parking to provide an 8-foot-wide parking lane).

• Angle parking can be used instead of parallel parking in walkable commercial districts and on overly-wide neighborhood streets to narrow the travel way. Depending on space available for parking, angle parking can double the inventory of on-street parking on a given street over parallel parking. Back-in parking should be considered to improve visibility and safety. The Parking angle should be approximately 60 degrees and the length of the parking stall should be 18 feet. Bicycle lanes should never be placed behind head-in angle parking.

• Curb extensions should be used at marked crosswalks in areas where on-street parking is present to improve pedestrian visibility and to increase usable space in the pedestrian realm.

OTHER CONSIDERATIONS

• On-street parking can be moved off the curb and located between the vehicle travel way and the bicycle lane to create a parking-protected bicycle lane (with a buffer between the bicycle lane and the parking lane to keep cyclists out of the door zone). Moving parking off the curb to provide a parking-protected bicycle lane is the preferred approach where there is on-street parking and traffic volumes over 6,000 ADT. This treatment may also be considered below 6,000 ADT based on engineering judgment.

• On neighborhood streets with curbs but no sidewalks, parking should be prohibited outside of the curb except on driveways (as long as the sidewalk zone is not obstructed) or in improved parking spaces. Parking in the City easement behind the curb clutters the pedestrian realm and encourages walking in the street. Where there are no curbs, parking in the easement is acceptable so long as a 5-foot wide pedestrian clear path is maintained and sidewalks are not obstructed (where present).

Parking Meters

OVERVIEW

Parking meters are a type of street furniture that facilitates payment for the use of on-street parking spaces. Metered parking encourages parking turnover in high-demand locations so that on-street spaces, which are the most desirable spots on commercial streets, are more likely to be used by patrons of the businesses, instead of employees or other longer-term parkers. Without metering, cars may occupy spots all day, thus pushing potential customers farther away from the businesses (or away from the commercial district altogether). Parking meters can be single-spaced meters, double-headed meters, or multi-space parking pay stations.

Tucson is moving towards a smart metering system that improves the collection of parking data, helps to achieve desired parking turnover rates, allows many forms of payment (including through the GoTucson Parking app), and is solar-powered.

APPLICATION AND USE

- Parking meters should be used in high-demand parking areas, like downtown and near the University of Arizona.
- Meters should be located in the planting/amenity zone, at least 18 inches from the curb and out of the sidewalk zone.
- Single-space meters should be placed at the head of the parking stall. Double-headed meters should be located between spaces. Double-headed meters are used where possible to decrease clutter in the planting/amenity zone.
- Where there is high competition for space or the planting/amenity zone is very cluttered, multi-space pay stations are preferable.
- Multi-space pay stations should be placed every 8-10 parking spaces with signage clearly directing users to the station. Signage placement must be carefully considered so as not to counteract the benefit of installing pay stations by re-cluttering the amenity zone with signs.

Image 4.11
Go Tucson App

DESIGN AND OPERATION

- Parking meters should provide multiple options for payment so as not to discourage use (cash, debit/credit, and mobile app).
- On-street parking spots are often the highest demand spots in a district. As such, they should be priced at or above the rates for garages or surface lots to encourage shorter-term parking and higher turnover. Longer-term parking, whether employees or customers/visitors, should be occurring in structures and surface lots.
- Meter prices should be set to encourage roughly 85 percent occupancy rate for on-street parking to reduce block circling in search of open parking spaces.

OTHER CONSIDERATIONS

- Another approach for managing parking demand and helping to maintain the target 85 percent occupancy rate is called variable-rate pricing. Variable pricing, or demand-based pricing, is a pricing approach that changes meter prices during different parts of the day or in higher-demand locations, allowing the cost of on-street parking to be increased at times and locations with more demand for parking.
- Variable pricing can be set up to vary pricing by location (increasing prices closer to the concentration of shops), by time of day (increasing prices on Friday and Saturday in entertainment districts), or some combination of both depending on the characteristics of demand.
- Variable pricing could be considered in Tucson if it is determined the current parking pricing schemes result in excessive block circling in high-demand areas, increasing congestion and affecting air quality.

Transit Lanes

Providing reliable, efficient, and easy-to-use public transportation is critical for ensuring that Tucson residents have access to quality transportation alternatives to personal vehicles. Transit provides a vital connection for work, doctor's visits, shopping trips, and other daily functions. High-level transit service can be achieved through a combination of improved street design and system operational decisions. When performing well, transit can compete with driving for comfort and convenience for many trip types.

Tucson's public transportation system consists of a 41-route Sun Tran bus system (29 regular routes and 12 express routes), Sun Van paratransit service, and the Sun Link Streetcar serving downtown Tucson and the University of Arizona. On an average weekday, roughly 60,000 trips are taken on Tucson's transit system.

Eleven Sun Tran routes currently comprise what is called the Frequent Transit Network (FTN). FTN routes are those that operate with frequencies of 15 minutes or less. This frequency threshold is important because at 15 minutes, a person will always have a relatively short wait time and can make convenient transfers to other FTN routes. It eliminates the need for excessive preplanning of transit trips, which is one of the factors that can discourage use.

The FTN is included as a modal priority type in this Guide to ensure that transit is a design priority on FTN corridors. Future FTN routes and operational priorities are identified in the Tucson-PAG jointly developed Long-Range Regional Transit Plan.

This section covers in-street design elements that can complement transit priorities identified in the Long-Range Regional Transit Plan. The section covers:

- Bus lanes,
- Bus bulbs,
- Bus pull-outs, and
- High-capacity transit design.

Bus Lanes

OVERVIEW

On most routes in Tucson, transit operates in mixed-traffic, subject to the same congestion and delays as all drivers. Unforeseen delays (those that aren't accounted for in route planning) can significantly hamper transit performance resulting in much lower on-time arrival rates.

On the most frequent routes (with frequencies of 15 minutes or higher), one solution to the challenge of bus delay is to dedicate a travel lane as a bus lane.

APPLICATION AND USE

- Bus lanes are an exclusive or semi-exclusive lane for the use of buses. Bus lanes improve the bus's travel time and operating efficiency by limiting the impact of roadway congestion on bus operations.
- Bus lanes can allow right-turn movements, local traffic, and bicyclists, or they can be entirely restricted to allow buses to operate entirely within their own running way.
- Where bus lanes also serve as right-turn lanes, additional right-turn bays do not need to be built at major intersections, keeping pedestrian

• Frequent Transit Network (FTN) routes that struggle to meet on-time performance targets can be prioritized for the installation of bus lanes.

• Bus lanes may be located on the curbside lane or in the median lane. Curbside lanes are more common, and usually more practical, since on-street parking is minimal on major corridors, which eliminates potential parking lane/bus conflicts on curbside lanes. If median bus lanes are used, stops must be paired with safe pedestrian crossings.

  o Median busways can be protected through the use of a median barrier where space allows.

  o Bus stops on protected-median busways are to be spaced farther apart than typical bus stops (⅓ to ½ mi. instead of ¼ mi.).

DESIGN AND OPERATION

• Bus lanes should be at least 11 feet wide with lane markings and signs indicating the preferential or exclusive use of buses.

• Red-colored pavement emphasizes the use of the bus lane for buses and reduces the enforcement burden.

• If the bus lane is exclusive, use BUS ONLY lane markings, if the bus lane also permits right turns, place Right Lane Must Turn Right markings at intersections with bus exemption signage.

• A protected median busway should be 11 feet wide with a 1-foot offset from the median barrier.

OTHER CONSIDERATIONS

• Where in-street space is limited, shared bus-bike lanes may be used, though separate facilities are preferable. Bus-bike lanes should have lane markings that indicate use by both users. Where space permits, they should be 13 to 15 feet wide, with a minimum of 12 feet wide. Bus-bike lanes should not be used at locations where buses pass at frequencies of 5 minutes or less.

• Stops serving exclusive or mixed-use bus lanes can be prioritized for sidewalk installations to ensure pedestrian access.

Bus Bulbs

OVERVIEW

Bus bulbs are curb extensions located at bus stops. They allow the bus to stay in the travel lane to make pick-ups and drop-offs instead of requiring the bus to merge out of traffic. Bus bulbs are not common in Tucson, but transit bulbs are installed at certain Sun Link streetcar stops.

APPLICATION AND USE

- Bus bulbs improve on-time performance and bus travel times by eliminating the need for buses to pull back into the flow of traffic after picking up or dropping off passengers.
- They provide additional space for street furniture, like bus shelters.
- Bus bulbs should be used in locations where there is on-street parking so the bus does not have to pull between parked vehicles. They can be on other FTN routes, but their use must consider impacts on other vehicles, the presence of bike lanes, and on-time performance.

DESIGN AND OPERATION

- Bus bulbs should be at least 30 feet long, allowing them to cover the distance from the front of the bus to the back door for safe boarding and alighting. Bulbs should be about as wide as the parking lane with the ability to accommodate an ADA-compliant landing zone. In locations where a 60-foot articulated bus or two buses may be expected to use a given stop simultaneously, the bulb can be 70 feet or longer.

OTHER CONSIDERATIONS

- Where bicycle lanes are present, cut-throughs should be used to route cyclists behind the bus bulb. Bicycle lanes should not be dropped at bus bulbs.

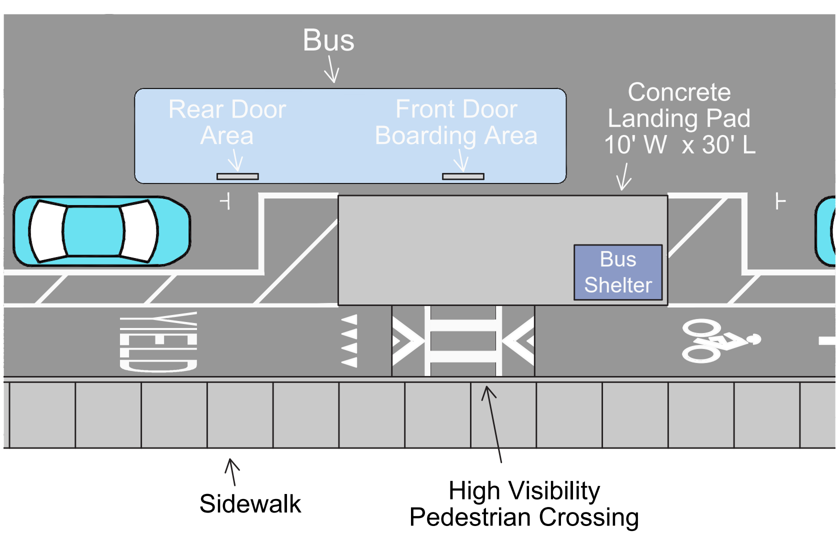


Image 4.12
Bus bulb with bike lane routed behind the platform. Raised pedestrian crossing can be considered but may present drainage challenges.

Bus Pull-Outs

OVERVIEW

Bus pull-outs are a stop type in which the bus pulls out of the travel lane to the side of the road to make pick-ups and drop-offs. Bus pull-outs increase transition time for buses to enter and leave the stop location—especially where traffic volumes are high—but they reduce delay for motorists driving behind the bus and decrease the risk of rear-end and side-swipe crashes caused by vehicles changing lanes to get around a stopped bus. Bus pull-outs are created by moving the curbline back to provide space for a taper and bus storage outside of the flow of traffic.

Since 2006, approximately 100 bus pull-outs have been installed on major corridors in Tucson, with funding support from the RTA.

APPLICATION AND USE

- Bus pull-outs can be installed on thoroughfares where traffic flow is a priority and target speeds are 35 mph or greater, such as on Regionally Significant Corridors.
- Pull-outs can be installed at major transfer points, end of routes, major intersections, or other locations with longer bus dwell times.
- Stops with at least 100 combined daily boardings and alightings on high-volume roadways can be considered for pull-outs.
- Pull-outs should be located on the far side of signalized intersections since traffic queuing at the signal will make it difficult for transit vehicles to merge back into traffic. **If a bus pull-out is installed on the near side of an intersection, it should be paired with a queue jump to better allow the bus to merge into traffic through the use of an advanced or extended bus-only green signal phase.**

DESIGN AND OPERATION

- Bus pull-outs should be long enough to accommodate 1 to 2 buses in the bus storage area, depending on the number of routes and service frequencies of buses using the pull-out. A 100-foot bus bay with a 25 to 50-foot entrance and exit taper can safely accommodate 2 buses or a 60-foot articulated bus. A 50-foot bus bay with entrance and exit tapers is sufficient to accommodate a single 40-foot bus.
- Bus pull-outs should be at least 11 feet wide to accommodate the width of the bus and its side mirrors.
- Pull-outs should be installed with bus shelters and rider amenities.
- Pull-outs should provide enough space to accommodate an ADA-compliant loading zone and should not reduce the sidewalk clear zone below the minimum dimension.

OTHER CONSIDERATIONS

- Bicycle lanes, where present, should continue straight on the left side of the pull-out. The bus dwelling area should not encroach into the bicycle lane where it can be avoided. Green conflict markings can be used where buses cross the bicycle lane.

Image 4.12
Bus Pull-Out

High-Capacity Transit Lanes

OVERVIEW

High-capacity transit is an enhanced transit service that typically operates in larger vehicles and at higher frequencies than traditional fixed-route bus service. Common types of high-capacity transit include BRT, light rail transit (LRT), and streetcar. High-capacity transit can operate in mixed traffic or in its own dedicated running way. High-capacity services tend to attract additional ridership given the enhanced nature of the vehicles and higher level of service provided. While still considered high-capacity transit, streetcars generally serve different travel purposes than LRT or BRT. Streetcars tend to operate on shorter lines in dense urban environments where there are high levels of pedestrian activity and continuous destinations along the length of the route. Streetcar service tends to operate at a lower speed.

BRT and LRT serve longer trip types more typical of commuting trips and serving crosstown mobility needs. Ensuring shorter travel times are a more important consideration on BRT and LRT service than on streetcar.

The Sun Link Streetcar is Tucson's first high-capacity transit service. Future potential high-capacity transit investments are identified in the Long-Range Regional Transit Plan.

APPLICATION AND USE

- High-capacity transit upgrades can be considered on routes with high transit demand, where regular fixed-route bus service is operating near capacity, or along routes connecting major activity centers.
- High-capacity transit routes can be center-running, two-way split side, two-way single side, or one-way single side (with the opposing direction operating on a parallel street).

DESIGN AND OPERATION

- BRT and LRT should have greater distances between stops (1/2 mile or greater) to support more reliable and faster service.
- Streetcars will have closer stop spacing to support more street activity and better access.
- BRT and LRT should have dedicated running ways where possible, though BRT is flexible and can switch between mixed-traffic and a dedicated running way along the same route.
- Where BRT runs in mixed traffic, queue jumps, signal priority, and other strategies should be used to ensure reliable, fast service.

• Streetcars typically operate in mixed traffic, but dedicated, or mixed transit-turn lanes, can be used to improve performance in congested areas.

• High-capacity transit routes should receive unique branding and enhanced stations to attract passengers. Unique vehicle design, platform-level all-door boarding, off-board payment kiosks, real-time arrival data, and other features should all be considered in the design of the service and stops.

OTHER CONSIDERATIONS

• High-capacity transit investments should be paired with increased residential and employment density at stop locations to support ridership and to put more people and destinations in close proximity to enhanced transit service (transit-oriented development).

• High-capacity transit can be used as an economic development tool as well as a mobility enhancement where land-use policies are supportive of increased densities.

o Streetcars, given their closer stop spacing and slower operating speeds can support development along the entire line.

o BRT and LRT lend themselves more to increased development activity near stops or stations, since the stops tend to be located at greater distances from each other.

• Streetcars pose a challenge for bicyclists, because narrow bicycle tires can get caught in the streetcar track flange gap. To reduce this risk, tracks should be installed to discourage bicyclists from crossing at less than 60-degree angles. Other design considerations include:

o Installing left-running tracks on a one-way street and center-running tracks on two-way streets to keep the tracks and bicycle lanes in separate areas of the street.

o Designing as close as possible to 90-degree track crossings where streetcars routes cross bicycle lanes.

Image 4.13
SunLink Streetcar

Vehicle Zone

The vehicle zone is used by private automobiles, commercial and freight vehicles, and buses and bicycles where dedicated bus and bicycle lanes are not provided. Under the complete streets approach, travel lanes should be designed to provide a safe and comfortable environment for all road users, designing for travel speeds appropriate for the roadway's function and context. Oftentimes, this will mean designing for slower vehicle speeds on many corridors.

Table 4.2 provides general guidance on target speeds for different road types. This table is only a guide, not a replacement for engineering judgment. Actual posted speed limits will need to be established based on each corridor's particular conditions.

Table 4.3
Target Speeds by Street Types*

STREET TYPES	TARGET SPEED	
STANDARD STREET TYPES		
Downtown / University	25 mph	
Neighborhood Commercial	25 mph	
Urban Thoroughfare	30 mph	
Urban Connector	25-30 mph	
Suburban Thoroughfare	35-40 mph	
Suburban Connector	30-35 mph	
Neighborhood Street	25 mph	
Shared Street†	15 mph	
Industrial Street	25 mph	
MODAL PRIORITIES		
Frequent Transit Network	Urban: Suburban:	25-35 mph 30-40 mph
Regionally Significant Corridor	Urban: Suburban:	35 mph 40-45 mph
Freight Corridor	Urban: Suburban:	25-35 mph 35-45 mph
Bicycle Priority Street	25 mph	
Bicycle Boulevard	20 mph	

*Speed limits are reduced on some Tucson streets at night to improve safety in low-light conditions.

†Arizona Revised Statute 28-701 sets the minimum speed limit at 25 mph for residential districts, though the operating environment on shared streets will most likely result in slower travel speeds.

Speed should not be equated with capacity in urban areas. It is important to avoid the perception that a high-capacity street needs a high target speed. Under interrupted flow conditions, such as on thoroughfares in urban areas, intersection design and signal operations exert a greater influence on capacity than speed.

The following section discusses the design of the vehicle travel lanes, including:

- Lane widths,
- Road redesign,
- Turn lanes, and
- Freight corridor design.

Lane Widths

OVERVIEW

Lane widths are an important consideration in the design of streets and are often a major determinant of how space is allocated. Travel lanes are striped to define the intended path of travel along the roadway.

Historically, wider travel lanes were preferred in order to provide a forgiving buffer to drivers to reduce departures from the travel lane and limit side-swipe collisions. However, wider travel lanes can affect driver perceptions which may result in an increase in operating speeds. This is not desirable in a complex urban environment with a mix of street users, where higher speeds decrease safety for everyone and reduce comfort for pedestrians and bicyclists. Wider lanes also take more space, which is at a premium in cities.

Under a complete streets approach, narrower lane widths are preferable since narrower widths have been shown to have multiple benefits for road users. Narrower travel lanes (<12 feet) may slow travel speeds while also providing more space for other elements within the right-of-way without having any impact of roadway safety or capacity below 45 mph. Preferred, minimum, and maximum lane widths by street type are provided in Table 5 of this Guide (Chapter 2).

APPLICATION AND USE

- Narrow lane widths should be the default design choice on Tucson's streets, particularly in more urban contexts. Wider outside lanes can be considered based on corridor function, target speed, and heavy vehicle share.

DESIGN AND OPERATION

- For preferred travel lane widths in a given context, refer to Table 2.4 of this document.
- **11-foot curb lanes should be provided on Regional Freight Corridors, Frequent Transit Network corridors, and most Thoroughfares.**
  - o 10-foot curb lanes can be considered on Urban Thoroughfares where heavy vehicles represent less than 5% of AADT.
  - o Curb lanes narrower than 11 feet may be considered next to a buffered or protected bicycle lane in constrained conditions.
- On Thoroughfares with target speeds above 35 mph, 11-foot travel lanes can be used on all lanes based on engineering judgment.
- On Neighborhood Streets, where lanes are not striped, narrow curb-to-curb widths should be used. Narrow streets discourage excessive speeds and reduce the need for vertical deflection, like speed humps, to slow travel speeds. The preferred minimum allowable widths are as follows:

Table 4.4 Minimum street widths on neighborhood streets[*]

PARKING CONDITION	MINIMUM CURB-TO-CURB WIDTH
WEDGE CURBS[†]	
2-way travel, parking prohibited	18 feet
2-way travel, parking on 1 side of the street	19 feet
2-way travel, parking on both sides of the street	24 feet
VERTICAL CURBS[‡]	
2-way travel, parking prohibited	20 feet
2-way travel, parking on 1 side of the street[§]	21 feet
2-way travel, parking on both sides of the street	28 feet

[*]Consideration must be given to drainage impacts on narrow neighborhood streets. Preferable street dimensions may increase flood risk to adjacent properties and may not be appropriate in all cases.

[†]Assumes 7-foot parking lane measured from the back of the 2-foot wedge curb. The curb-to-curb width is presented in the table as the distance between the innermost edge of the wedge curb, or from the edge of the asphalt roadway.

[‡]Assumes a 7-foot parking lane measured from the face of the vertical curb.

[§]Minimum street widths assume a 14-foot travel way. With the narrower travel way, 20-foot passing areas should be provided at appropriate intervals to allow passing by emergency response vehicles.

OTHER CONSIDERATIONS

• Streets with lane widths above those listed in Table 5 should be re-striped during paving projects to align with this guidance. Space can be re-allocated to other in-street elements, such as bicycle lanes or bicycle lane buffers/protected bicycle lanes.

o Re-allocating space from travel lanes to behind the curb will require a more extensive corridor reconstruction since the curbline would need to be moved. Some additional space can be provided with curb extensions.

Road Redesign

OVERVIEW

Another option for re-allocating in-street space and slowing travel speeds is a road redesign, also called a "road diet". A road redesign is a project in which roads are restriped to remove excessive travel capacity with the additional space used to create two-way left-turn lanes or new/wider bicycle lanes. The classic road redesign converts a 4-lane undivided roadway into a 3-lane roadway with a two-way left-turn lane. Five-lane configurations can be converted into 3-lane roadways by eliminating 1 travel lane in each direction and using the space for enhanced bicycle lanes or on-street parking.

Image 4.14
36th and Kramer Before the Road Redesign

Image 4.15
36th and Kramer After the Road Redesign

In addition to providing more space for other road users, 4-to-3 lane road redesigns have been shown to:

- Reduce crashes by between 19 and 47 percent,[28]
- Reduce speeding by eliminating passing opportunities (the slowest driver in the queue establishes travel speeds for those behind them),
- Reduce multi-threat pedestrian crashes at pedestrian crossings,
- Reduce left-turn crashes due to the creation of a turn lane, and
- Reduce crashes for turning vehicles due to fewer lanes to turn across.

[28] FHWA. Proven Safety Countermeasures. https://safety.fhwa.dot.gov/provencountermeasures/road_diets/. (page modified 10/18/2017)

APPLICATION AND USE

- Road redesign projects can be considered on 4 or 5 lanes roadways with the following volumes:
  - **o Less than 10,000 AADT- strong candidate for a road redesign**
  - **o 10,000-15,000 AADT- good candidate but an intersection analysis may need to be done for signal timing changes**
  - **o 15,000-20,000 AADT- good road redesign candidate in many instances, but capacity may be affected**
  - **o Greater than 20,000 AADT- site-specific, detailed review required to determine impacts on traffic and effect on nearby roadways.[29]**
- Peak hour traffic should also be considered at candidate locations:
  - **o 750 vehicles per hour (vph) per direction – feasible**
  - **o 750 – 875 vph per direction – caution**
  - **o Above 875 vph per direction – road redesign will be difficult, requiring additional study.[30]**
- Future volumes should also be considered in identifying road redesign candidates.
- Road redesigns can be done as part of repaving projects. They can also be done as standalone projects (without repaving) where there is an immediate safety issue or where it would improve bicycle connectivity.
- Project teams should look for opportunities to proactively do road redesigns during repaving on corridors that fall within the established volume thresholds.

[29] FHWA. Road Diet FAQ. https://safety.fhwa.dot.gov/road_diets/resources/pdf/fhwasa17021.pdf

[30] FHWA. Road Diet Information Guide. 2014. https://safety.fhwa.dot.gov/road_diets/guidance/info_guide/

DESIGN AND OPERATION

- Dimensions of the street after a road redesign is performed should conform with dimensions listed in Table 2.4.

OTHER CONSIDERATIONS

- If road redesigns are done separate from a pavement project, old lane markings must be fully obliterated leaving minimal pavement scars. Otherwise markings may cause confusion for road users.
- Since controlled intersections determine roadway capacity in most urban areas, road redesigns can be paired with signal timing and/or intersection improvements in order to gain the safety benefit of the road redesigns without reducing operating efficiency.
- Other road redesigns may be considered in certain circumstances. On 3-lane high-priority bicycle corridors with less than 11,000 AADT and low left-turn volumes, the two-way left-turn lane can be removed in favor of enhanced bicycle facilities, keeping left-turn pockets at locations with higher turn volumes.

Freight Corridors

OVERVIEW

A subset of Tucson's streets has been identified as Industrial Streets and Freight Corridors. These are the roadways that connect to industrial or major freight generating areas or are otherwise vital for the movement of goods into and out of the city. They are distinguished from the rest of the street network due to the relatively high share of heavy truck traffic and their importance to the city's economy.

It should be noted that Freight Corridors and Industrial Streets are distinct from truck routes. Truck routes are established in Section 20-15 of the Tucson City Code to identify where vehicles in excess of 20,000 pounds of gross vehicle weight rating (GVWR) are allowed to operate. These vehicles are prohibited from operating on non-truck routes, except for where exceptions apply. All arterials and collectors are designated as truck routes in the City of Tucson. Freight Corridor and Industrial Street designations, on the other hand, indicate where street design should specifically support the movement of heavy vehicles.

APPLICATION AND USE

- Industrial streets are low-speed, low-volume roadways located in industrial areas.
- Freight Corridors are thoroughfares and connectors that have a high share of freight traffic and/or connect major goods-producing areas to interstates or intermodal facilities.

DESIGN AND OPERATIONS

• Freight Corridors and Industrial Streets should have wider curb lanes. **11-foot outside lanes are preferred on Freight Corridors, while 12-foot curb lanes can be used on Industrial Streets.**

• Heavy vehicles are a major cause of pavement damage, with an 80,000 pound, five-axle, truck-semitrailer combination estimated to have a pavement impact equivalent to 1,400 passenger cars.[31] Thus, where high-volumes of heavily loaded vehicles are expected more robust, thicker pavement should be used. In addition to evaluating the vehicle mix, weight loads, and traffic volumes, a soil analysis should be done to understand the load-bearing capability of the underlying ground. This will help to determine the appropriate pavement thickness for the corridor.

• Skid resistance and strength should be considered when choosing pavement surfaces for routes frequented by heavy vehicles.

•Intersections with high volumes of turning movements of heavy vehicles should have a larger turning radii and adequate stacking space. More information on turning radii is provided in Chapter 5.

[31] Minnesota Department of Transportation. Office of Transportation System Management. "Assessing the Effects of Heavy Vehicles on Local Roads. 2014. https://www.dot.state.mn.us/research/TS/2014/201432.pdf

OTHER CONSIDERATIONS

• In Arizona, vehicles and their loads should not exceed 8 feet in width, 13 feet 6 inches in height, and 65 feet in length for truck-semitrailer combination. Trucks with 5 or more axles should not exceed 80,000 pounds. In some cases, vehicles carrying loads in excess of the allowed dimensions need to travel on Tucson's streets. Transportation improvements on Freight Corridors and Industrial Streets should consider overweight and over-dimensional loads when establishing vertical and horizontal clearances and designing bridges and culverts.

• Corridors that are also expected to serve bicycle travel should have protected bicycle or separated bicycle facilities (such as shared-use paths) to allow both users to safely and comfortably use the roadway.

Image 4.16 Truck on 20th Street

Median Zone

The median zone is the center area of the roadway that separates opposing directions of travel. The median zone can include a two-way left-turn lane, a raised median, and/or pedestrian refuge islands.

Designing roadways with a median zone provides safety and operational benefits for users of the roadway. In urban areas, overly wide medians should be avoided as the space required for wide medians is better allocated for bicycle and pedestrian roadway elements.

This section covers:

- Two-way left-turn lanes
- Raised medians
- Median Islands

Two-Way Left-Turn Lanes

OVERVIEW

A continuous two-way left-turn lane is a street design that provides a left-turn lane for traffic traveling in both directions. Continuous two-way left-turn lanes provide unrestricted access to driveways and local streets. They improve traffic flow and reduce rear-end crashes by allowing turning vehicles to move out of the through lane to wait for a gap in traffic.

Research has found that crash rates increase exponentially as the speed differential in the traffic stream increases. Separate turning lanes remove the turning vehicle from through traffic, which eliminates the speed differential in the main travel lanes. This reduces the frequency and severity of rear-end collisions.

Two-way left-turn lanes are typically found on urban roadways with two or four through lanes, where necessitated by travel speeds and volumes.

APPLICATION AND USE

- Continuous two-way left-turn lanes can be built where there is a history of crashes and where speeds and volumes warrant installation.
- Two-way left-turn lanes can be created by eliminating a travel lane through a road redesign project.
- A continuous two-way left-turn can be used on streets with curb-to-curb widths of 75 feet or less. A raised median with left-turn bays should be installed on roadways with curb-to-curb widths of 75 feet or greater.

DESIGN AND OPERATION

- The striping on two-way left-turn lanes should consist of a solid yellow line and a broken yellow line. Two-way left-turn lane arrow markings may be used based on engineering judgment. Turn-lane marking requirements are addressed in Chapter 3B of the MUTCD.
- **Two-way left-turn lanes should rarely be wider than 10 or 11 feet depending on context and street function, measured to the center of the broken yellow line.** 12-foot two-way left-turn lanes may be used in locations with high volumes of turning trucks.

OTHER CONSIDERATIONS

- Two-way left-turn lanes have more conflict points than directional left-turns at median openings. The benefits and risks must be weighed between better access versus more potential conflicts when considering which treatment to use.
- Caution is advised when installing or retaining two-way left-turn lanes, particularly on sections with 4 through lanes. Continuous two-way left-turn lanes pose a safety problem when drivers turning left onto the major street use the turn lane for acceleration. This can create the potential for head-on collisions. Continuous two-way left-turn lanes also increase the crossing distance for pedestrians and may result in pedestrians waiting in the turn lane to make a two-stage crossing. This is particularly common on higher-volume 5-lane roadways where sufficient bi-directional gaps in traffic are rare. To mitigate the safety issues of two-way left-turn lanes, refuge islands should be placed at intermittent intervals in combination with appropriate traffic controls on roadways that meet the following criteria:
    - o AADT at or above 12,000,
    - o significant numbers of pedestrians, and
    - o intermediate to high travel speeds.

Raised Median

OVERVIEW

Raised medians are continuous, or semi-continuous, permanent barriers located in the center of the roadway. They are typically created by installing vertical curbs surrounding a landscaped or hardscaped area.

Raised medians improve roadway safety and operations by limiting left turns and by providing a pedestrian crossing refuge on wider streets.

APPLICATION AND USE

- Raised medians should be used on all roadways with curb-to-curb widths greater than 75 feet.
- Raised medians (or pedestrian refuge islands) are also encouraged on any curbed, multi-lane roadway above 12,000 AADT with documented pedestrian activity.[32]

DESIGN AND OPERATIONS

- Medians can range in width from 4 to 20 feet. A minimum of 6 feet should be provided when the median serves as a pedestrian and bicyclist refuge. Overly wide raised medians (>14 feet) are not recommended in urban areas if they reduce the space available for preferred width for bicycle and pedestrian elements. Wider medians can be used where adequate right-of-way exists and the preferred widths of bicycle and pedestrian elements can be accommodated within the right-of-way.
- Medians should provide periodic openings for left turns. For median opening spacing, refer to Tucson's Access Management Guidelines.
- Median openings can either be designed as full openings with left-turn bays, or more restrictive directional openings. Directional median openings should be investigated as the first option over full openings because they reduce the number of conflicts.

[32] FHWA. Guidance Memorandum on Consideration and Implementation of Proven Safety Countermeasures. July 2008. https://safety.fhwa.dot.gov/intersection/other_topics/fhwasa09027/resources/FHWA%20Policy%20Memo%20Proven%20Safety%20Countermeasures.pdf

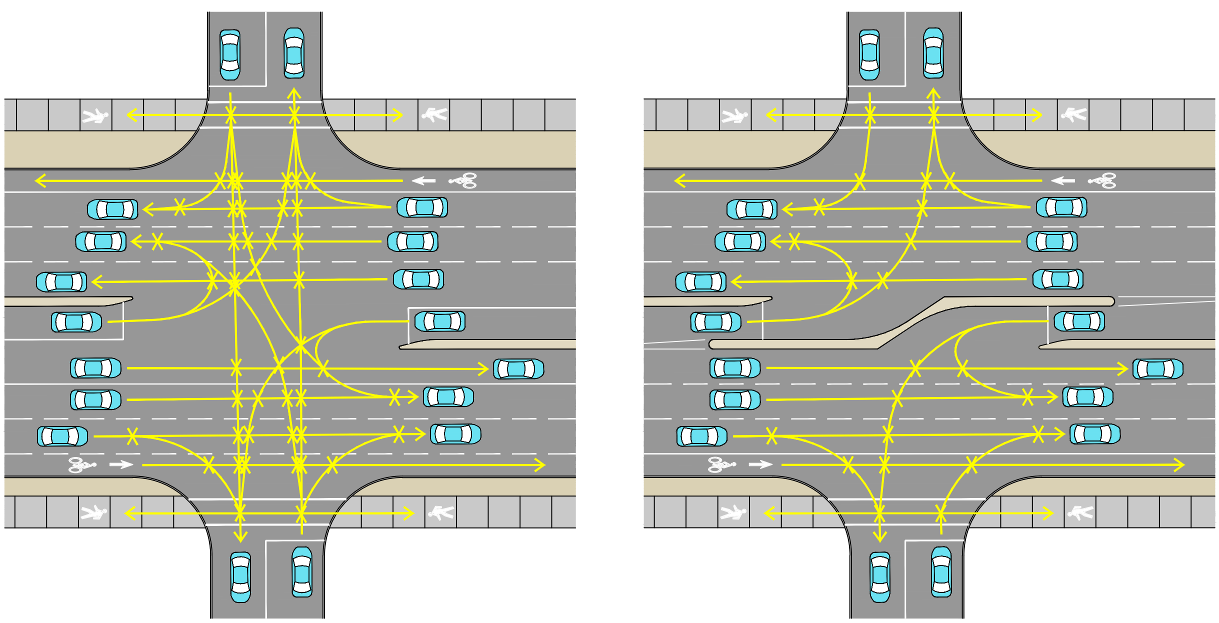
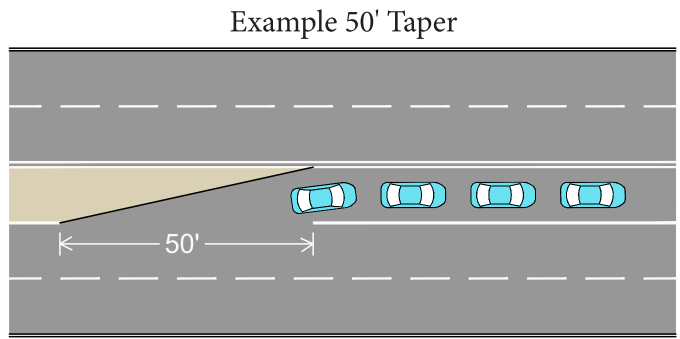


Image 4.16
Direction median openings (right) reduce the number of conflicts compared to full median openings (left)

• Openings should be designed with 50-foot to 100-foot taper to allow a left-turning vehicle to begin deceleration outside of the through-travel lane, a deceleration area, and a minimum of 110 feet of vehicle storage on roads with speeds 40 mph or less, which can accommodate up to 4 standard-sized passenger vehicles.[33]

[33] Additional storage can be provided in locations where heavy commercial vehicles represents over 10% of turning vehicles or in locations with higher volumes of turning vehicles.



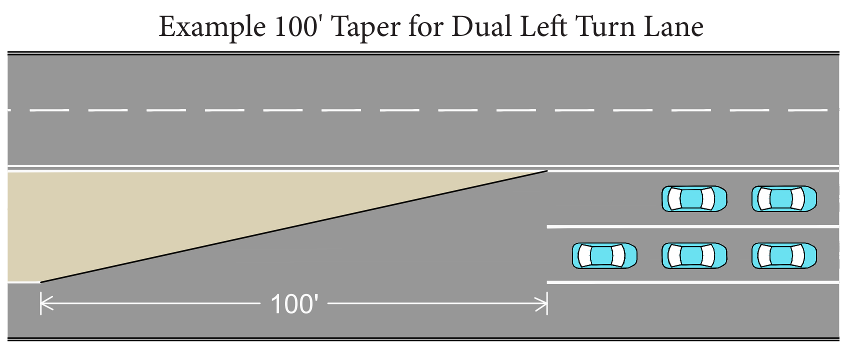


Image 4.17
Typical Taper and Multi-Lane Taper

Table 4.5
Speed per Stopping Distance

SPEED	STOPPING DISTANCE: NO DECELERATION IN THROUGH LANE	STOPPING DISTANCE: 10 MPH DECELERATION IN THROUGH LANE
25 mph	100 feet	40 feet
30 mph	160 feet	70 feet
35 mph	215 feet	110 feet
40 mph	275 feet	160 feet

• Median openings should not be placed within the functional area of a signalized intersection.

• Medians should be offset by 1 foot from the curb face to the edge of the adjacent travel lane, particularly on high-speed roadways.

• Where space allows, median openings should be designed with a 2-foot to 6-foot positive offset from the opposing turn lane to improve visibility of on-coming traffic.[34]

[34] A positive offset is created when left-turn lanes are shifted to the left to improve sight distance past opposing left-turning vehicles.

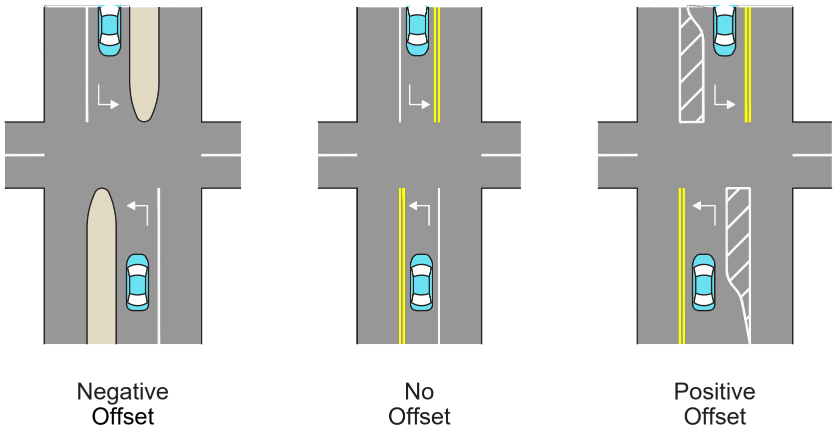


Image 4.18 Examples of Negative Offset, No Offset, and Positive Offset left turns

- Median cut-throughs, with appropriate safe crossing treatments, should be provided for pedestrians at regular intervals, particularly on high-ridership bus stops and/or other major destinations.
- Cut-throughs should be located where the median is at least 6 feet wide in order to provide pedestrian refuge. Wider refuges can be considered in areas with higher pedestrian volumes. Cut-throughs should include detectable warning strips at the border between the cut-through and vehicle travel way. The cut-through can be angled to position pedestrians to face oncoming traffic for better visibility. On roadways above 15,000 AADT, additional pedestrian safety improvements, such as pedestrian hybrid beacons (also called HAWK beacons), are strongly encouraged.[35]

[35] Federal Highway Administration. "Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations. September 2005. https://www.fhwa.dot.gov/publications/research/safety/04100/04100.pdf

RAISED MEDIAN TYPE	WIDTH*
Access control - no turn lanes	4-6 feet
Pedestrian refuge - no turn lanes	6-10 feet
Median opening without traffic separator	8-10 feet
Median opening - left turns both directions	12+ feet†
Median with trees	14+ feet‡
Median with pedestrian refuge and left-turn lanes§	16-20 feet¶

*Includes median width and turn lanes. Does not include recommended 1-foot offset between the travel lane and median curb face.

†Includes 2-foot, curbed traffic separator and 10-foot turn lane. Traffic separators can be as narrow as 2 feet in constrained conditions.

‡City of Tucson landscaping policy required at 7 feet between trees planted in the and the face of the median curb.

§Primarily applies at signalized intersections.

¶Pedestrian refuges should be at least 6 feet across, and as much as 10 feet, to accomodate waiting pedestrians, depending on pedestrian volume.

• Where there is a considerable distance to a median cut-through, pedestrian beacon, or traffic signal, raised medians should provide periodic hardscaped areas or spaces with unobstructed flat surfaces so that pedestrians can make a two-stage crossing (one stage for each direction of travel). Hardscaped areas should be kept clear of vertical obstructions to improve visibility of waiting pedestrians.

OTHER CONSIDERATIONS

• Medians may increase traffic speeds by reducing perceived friction with the separation of traffic flow directions.

• Center medians should be carefully designed to ensure proper drainage and, where appropriate, to maximize the potential for on-site stormwater detention/retention and filtration.

Image 4.18
Raised Median
with trees

Refuge Island

OVERVIEW

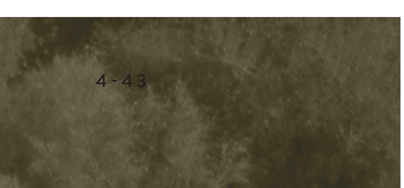
Pedestrian refuge islands—also called safety islands, or crossing islands—are non-continuous raised medians that facilitate street crossings for pedestrians, and when placed in a two-way left-turn lane, reduce the use of the turn lane for acceleration by drivers.

Pedestrian refuge islands reduce crashes and delays for people trying to cross the street by allowing them to cross one direction of traffic at a time.

APPLICATION AND USE

• Refuge islands can be installed at both intersections and at mid-block crossing locations.

[36] Federal Highway Administration. Pedestrian Safety Guide and Countermeasure Selection System. http://www.pedbikesafe.org/pedsafe/countermeasures_detail.cfm?CM_NUM=6. (Accessed 08/12/2019)



• Refuge islands can be considered at midblock locations on any roadway with 4 or more travel lanes, particularly where traffic volumes exceed 12,000 AADT.

• Refuge islands are also candidate treatment options for uncontrolled pedestrian crossings on 2-lane or 3-lane roadways with high volumes and/or high speeds in combination with other appropriate countermeasures.

• The installation of pedestrian islands can reduce pedestrian crashes by 32%.[36]

DESIGN AND OPERATION

• Refuge islands should be at least 6 feet wide and preferably 8 to 10 feet wide if space is available.

• The islands should be 20 to 40 feet long.

• Islands should be designed with cut-throughs. Pedestrian cut-through openings should be at least 5 feet wide and preferably 6 feet or more so that two wheelchairs can pass.

• Pedestrian cut-through openings can be angled to cause the pedestrian to face on-coming traffic to improve visibility. They should also have edges to orient people with visual impairments.

• Ramps should only be used on medians that are wider than 17 feet.

• Islands should be illuminated with streetlights, signs, and/or reflectors to enhance visibility for motorists. Islands can also include bollards to protect waiting pedestrians.

OTHER CONSIDERATIONS

• Islands can be enhanced with landscaping. 14-foot wide medians are required for tree planting, but shrubs and groundcover can be planted in any island wider than 4 feet.

Image 4.19
Refuge Island on 10th St.

Traffic Calming

Traffic calming is a series of measures that can be taken to slow vehicle speeds, or reduce volumes, in order to improve safety, livability, and vitality on neighborhood streets, on walkable commercial streets, and on bicycle boulevards. Traffic calming measures can help to transform streets and aid in creating a sense of place for communities.

Many of Tucson's older neighborhood streets were originally designed to be relatively wide, typically ranging from 35 to 40 feet from curb-to-curb (with some neighborhood streets near downtown wider than 50 feet). These wide streets can subconsciously encourage drivers to travel too fast for neighborhood conditions. Since it is highly unlikely that curblines will be moved to narrow most neighborhood streets, traffic calming strategies provide a comparatively low-cost means for slowing travel speeds and improving safety.

Traffic calming techniques consist of vertical deflection, horizontal deflection, street width reduction, and/or routing restriction.

- **Vertical deflection** creates a change in the height of the roadway that typically forces a motorist to slow down to maintain an acceptable level of comfort. **Vertical deflection includes speed humps, speed tables/raised crosswalks, speed cushions, and raised intersections.**
- **Horizontal deflection** prevents motorists from driving in a straight line by creating a horizontal shift in the roadway. This shift reduces the ability of a motorist to maintain speed while comfortably navigating the measure. **Horizontal deflection consists of lateral shifts, chicanes, and traffic circles.**
- **Street width reductions** narrow the width of a vehicle travel lane or roadway, so a motorist likely needs to slow the vehicle to maintain an acceptable level of comfort and safety. The measure can also reduce the distance required for pedestrian crossings, reducing exposure to vehicular conflicts. **Width reduction strategies include curb extensions and chokers** (other width reduction strategies, such as lanes widths, road redesign, and on-street parking are addressed earlier in this chapter).
- **Routing restrictions** prevent particular vehicle movements at an intersection and are intended to eliminate some portion of cut-through traffic. **Restrictions include diagonal diverters, median barriers/forced turn islands, and closures.** Routing restrictions are best saved for where other, less drastic traffic calming strategies have failed. They can also be used strategically on Bicycle Boulevards to reduce volumes to 1,500 AADT or lower.

Speed Humps

OVERVIEW

A speed hump is an elongated mound in the roadway pavement surface extending across the travel way at a right angle to the traffic flow. It is used to slow traffic on 15-25 mph residential streets where speeding is occurring. Speed humps should not be confused with speed bumps, which are exclusively found in private parking lots, apartment complexes, and other private properties to slow traffic to around 5 mph. Speed bumps are prohibited on Tucson streets.

APPLICATION AND USE

- Speed humps provide vertical deflection on neighborhood streets as a means of reducing excessive travel speeds.
- Speed humps are not appropriate on major roads, primary emergency response routes, or on bus routes.
- Speed humps should only be placed at mid-block locations and not at intersections.
- Humps should not be used where the posted speed limit is above 30 mph.
- On bicycle boulevards, speed humps should be designed to be comfortable at 20 mph.
- Humps should only be used on roadways with AADTs below 3,500.
- For speed humps to be effective, they must be installed in a series, approximately 260 feet to 500 feet apart. One speed hump alone is not advised.
- Recent speed hump studies have shown a 40-60% reduction in vehicles exceeding the speed limit.

Image 4.20
Speed Hump

DESIGN AND OPERATION

- Speed humps are typically 12 feet wide and 3 to 3 1/2 inches high.
- Speed humps should be well-marked with pavement markings. Recommended markings for speed humps can be found in the Pima County/City of Tucson Signing & Pavement Marking Manual.

OTHER CONSIDERATIONS

- Speed humps need to be designed for drainage, without providing space for motorists to go around a hump. Speed humps are not appropriate in areas where they may cause flood issues. To design for drainage, the edge of the hump can be tapered near the curb.
- A single-speed hump can delay emergency response vehicles by between 2 to 10 seconds.
- Speed humps also cause damage to fire engines when they drive over them at higher rates of speed. This can mitigated by using speed cushions in place of speed humps where desired.
- Advanced signing with a posted speed can be placed in advance of speed humps.

Speed Tables / Raised Crosswalks

OVERVIEW

Speed tables are another type of vertical deflection that are similar in many ways to speed humps. The primary difference is that instead of having a more rounded top like speed humps, speed tables have a flat top that is wide enough for the wheelbase of a passenger car to rest on top.

Speed reductions are typically less for speed tables than they are for speed humps, but they also cause less delay for emergency vehicles.

APPLICATION AND USE

- Speed tables can be used on secondary emergency streets when the Fire Department has determined that speed humps are not appropriate.
- Speed tables can be used on neighborhood streets and on some connector streets.
- Speed tables can be used on streets with posted speed limits up to 30 mph.
- Unlike speed humps, speed tables can be used at intersections when used as a raised crosswalk.
- Speed tables are more effective when used in a series.

DESIGN AND OPERATION

- A speed table is 22 feet wide and 3" to 3 ½ inches high.
- Approach ramps are typically 6 feet long with a 10-foot level area on the top.
- Speed tables should be well-marked with pavement markings (zigzag, shark's tooth, or chevron). Recommended markings for speed tables can be found in the Pima County/City of Tucson Signing & Pavement Marking Manual

OTHER CONSIDERATIONS

- The top of a speed table can be designed with a marked crosswalk to provide a raised crosswalk. Raised crosswalks increase pedestrian visibility and can communicate to the driver that they are entering a more pedestrian-oriented area.
- When installed flush with a curb, a raised crosswalk eliminates the need for curb ramps.
- The same drainage impacts must be considered with speed tables as speed humps.
- Speed tables generally cause less damage to fire equipment than speed humps.

Image 4.21
Speed Table with Raised Crosswalk at the Arizona Inn

Speed Cushions

OVERVIEW

Speed cushions are a third type of vertical deflection in which two or more raised areas are placed laterally across a roadway with gaps between the raised areas (often referred to as cutouts). The gaps enable a vehicle with a wide track (e.g., a large emergency vehicle, some trucks, some buses) to pass through the feature without any vertical deflection. The height and length of the raised areas are comparable to the dimensions of a speed hump.

APPLICATION AND USE

• Speed cushions can be used on primary emergency vehicle routes and on bus routes since the spacing of the gaps allows emergency vehicles to pass through at higher speeds and buses to clear the cushions without having to drive over the vertical deflection.

• Speed cushions can be used on neighborhood streets and some connector streets.

• Speed cushions should not be placed near intersections.

• Like speed humps and tables, cushions are more effective when used in a series and spaced 260 to 500 feet apart.

• When placed in a series, speed cushions are very effective at slowing travel speeds, though average speeds are higher than for speed humps because the design of the cushion allows for passenger cars to pass over the cushion with one wheel on and one wheel off.

DESIGN AND OPERATION

• Speed cushions are typically 12 feet long and 7 feet wide and 3 to 3 ½ inches high.

• The cutouts in the speed cushions must be positioned such that a passenger vehicle cannot pass it without traveling over a portion of the raised pavement.

OTHER CONSIDERATIONS

• Drainage is less of an issue with speed cushions because of the cutouts, but should still be considered with installation.

• Bicyclists and motorcyclists can safely pass through the cutouts in speed cushions.

Image 4.22
Speed Cushion
Credit: Jeff Gulden

Raised Intersections

OVERVIEW

A raised intersection is essentially a speed table that covers an entire intersection, including the crosswalk. It is a raised, flat area with ramps on all approaches. The purpose of a raised intersection is to slow vehicle speeds through intersections and to improve pedestrian safety. Raised intersections calm two intersecting streets at once and are typically done as part of a district-wide traffic calming strategy.

APPLICATION AND USE

- Raised intersections are most applicable in dense urban areas and walkable commercial districts, but can also be used in some residential areas.
- They should be located at signalized or 4-way stop-controlled intersections.
- Raised intersections are only appropriate on streets with curbs.
- They should not be installed on streets with posted speed limits over 30 mph.
- Raised intersections are most appropriate on intersections below 10,000 AADT total for all approaches.
- Raised intersections can be installed on bus routes and on primary emergency routes.

DESIGN AND OPERATION

- Intersections should be raised to the level of the sidewalk. Detectable warning strips should be installed where sidewalks enter the intersection for people with visual impairments.
- Chevron or shark's tooth pavement markings can be applied on the approach ramps and the use of high-visibility crosswalk markings are encouraged at stop-controlled intersections.
- Bollards may be used to delineate the sidewalk from the roadway.
- Raised intersections should be designed with a 1% slope to facilitate drainage.
- Approach ramps can be 6 feet to 10 feet long, though 6 feet is typical.

OTHER CONSIDERATIONS

- Drainage and underground utility modifications are likely necessary. Special attention must be paid to drainage issues since the grade of the entire intersection will be raised.
- Raised intersections work well with curb extensions and textured crosswalks.

Image 4.23 Raised Intersection, Credit: Google Street View

Lateral Shifts

OVERVIEW

A lateral shift is a horizontal deflection strategy in which the realignment of an otherwise straight street causes travel lanes to shift in at least one direction. The purpose of the lateral shift is to reduce speeds along the street. A lateral shift is different from a chicane (discussed below) in that a lateral shift involves only a single shift in the traveled way alignment, while a chicane involves a series of multiple shifts.

APPLICATION AND USE

- A lateral shift can be used on any street type, from neighborhood streets up to thoroughfares.
- Lateral shifts should not be used on streets with posted speed limits above 35 mph.
- Lateral shifts can be used at all traffic volumes.
- Lateral shifts should be located at mid-block locations only and should be positioned near street lights where practical.
- They can be used on bus routes and on primary emergency routes.
- Lateral shifts are a good option where travel speeds and volumes preclude other types of traffic calming measures.

DESIGN AND OPERATION

- Rightward lateral shifts work best when used in conjunction with a median island or median. Without islands, motorists can cross the centerline to maintain the straightest line possible, thus reducing the effect of the vertical deflection and posing a safety risk.
- In a leftward lateral shift, the curb or protected bicycle facility can cause the horizontal deflection.

OTHER CONSIDERATIONS

- If located in an area with on-street parking, a lateral shift could require the removal of some on-street spaces.
- Lateral shifts should likely have minimal impacts on utilities, though the effect on drainage will need to be considered.

Image 4.24
A leftward Lateral Shift on a residential street in Tucson

Chicanes

OVERVIEW

A chicane is a variation on a lateral shift that presents a series of alternating curves or lane shifts to motorists, forcing a driver to steer back and forth out of a straight path, like an "S." Chicanes are typically created by installing a series of curb extensions or edge islands that extend into the path of travel and alternate from one side of the street to the other. The amount of speed reduction depends on the length of the alignment shift and spacing.

APPLICATION AND USE

- Chicanes are most appropriate on neighborhood streets or on very low-volume connector streets.
- Chicanes should not be installed on streets over 3,500 AADT.
- Chicanes are appropriate at mid-block locations, but can also be used along the entire block if the block is relatively short.

DESIGN AND OPERATION

- Chicanes should be signed and have reflective posts or raised pavement markings to notify drivers of a bend in the roadway.
- Chicanes should be designed to cause sufficient horizontal deflection to slow motorists, but should provide adequate space for an emergency vehicle to pass through the chicane with minimal delay.
- Chicanes can be paired with small raised medians to discourage motorists from cutting across the centerline. The median can be mountable and narrow to permit emergency vehicle passage.
- A minimal clearance of 20 feet must be maintained through chicanes for fire apparatus.
- Edge islands or curb extensions may be designed with mountable curbs to be more forgiving and to permit narrower fire apparatus clearance.

OTHER CONSIDERATIONS

- Chicanes may cause drainage issues on streets with surface stormwater flows. Chicanes however, can be designed as water harvesting features to both manage stormwater and support vegetation. Chicanes function best to harvest water on crested roadways where stormwater is carried along the curb.
- Chicanes can also be offset from the curb by 1 to 2 feet, as needed, to not adversely affect drainage. They can be set further off the curb, space permitting, to allow bicycles to pass behind the chicane, but must be kept clear of debris to be usable.
- Chicanes can be created using low-cost or temporary materials, such as temporary curbs, flexible bollards or raised pavement markings, striping, or other materials.

Image 4.25 Chicanes on a BIcycle Boulevard in Tucson

Traffic Circles

OVERVIEW

A traffic circle is a raised, or delineated, round island placed within an unsignalized intersection. It should provide enough horizontal deflection to force a motorist to reduce speed when passing through the intersection. Traffic circles also break up uninterrupted street views, which may subconsciously encourage higher speeds. Traffic circles should not be confused with roundabouts, which are an alternative to signalized intersections designed to move higher volumes of traffic.

APPLICATION AND USE

- Traffic circles can be installed at intersections on neighborhood streets and bicycle boulevards.
- Traffic circles should not be placed on primary emergency routes or where buses make left turns.

Image 4.26
A landscaped traffic circle

DESIGN AND OPERATION

- The center island in the traffic circle should be large enough so that all vehicles are required to follow an indirect path to proceed through the intersection.
- A traffic circle should be designed so that the horizontal clearance is too small for a truck to circulate around the circle to make a left turn. Fire engines, garbage trucks, buses, and, infrequently, moving vans or trucks should be permitted to make left turns in front of traffic circles.
- Minimum 20-foot clearance is often provided between the corner and widest point of the traffic circle. It can be narrower in some circumstances.
- Traffic circles should be well-lit and signed.
- Traffic circles can be placed on stop-controlled, yield-controlled, or uncontrolled intersections. Along bicycle boulevards, Tucson places STOP controls on the non-bike boulevard approaches with no traffic control on the bike boulevard.

OTHER CONSIDERATIONS

- Traffic circles can incorporate green infrastructure design principles that promote water harvesting, stormwater management, native plant habitat, public art, and contribute to neighborhood beautification. Visibility and maintenance must be taken into consideration with landscaped circles.
- Special consideration must be given for impacts to street drainage. Where a raised circle may exacerbate flood issues, a depressed circle with rainwater harvesting features can be used.
- Traffic circles can be created using low-cost or temporary materials, such as temporary curbs, flexible bollards, and striping.
- If valve clusters or manholes are located in the center of the intersection, access must be maintained, limiting options for landscaping traffic circles.

Curb Extensions

OVERVIEW

A curb extension—also called a corner extension or a bulb-out—is a horizontal extension of the sidewalk into the street, which narrows the roadway section at the location of the curb extension. A curb extension, when located at an intersection, slows automobile turning speeds, shortens pedestrian crossing distance, prevents parked cars from blocking curb ramps, and increases pedestrian visibility.

APPLICATION AND USE

- Curb extensions are appropriate for all street types where on-street parking is permitted.
- Curb extensions are typically located at intersections and used to increase space in the pedestrian realm and reduce turning radii.
- Curb extensions improve pedestrian visibility where on-street parking is heavily utilized.
- Curb extensions can be placed at the entrance to neighborhoods to slow vehicle speeds as drivers transition from higher speed thoroughfares.
- Curb extensions can be located at mid-block crosswalks to reduce crossing distance and improve pedestrian visibility. These can also be called chokers (discussed below).

DESIGN AND OPERATION

• Curb extensions are created by extending the curbline out at the intersection. They can also be created through the installation of edge islands.

• Curb extensions are typically between 6 feet to 8 feet wide, roughly the width of the parking lane.

• Where an edge island is used instead of moving the curbline at an intersection, a level pedestrian access route must be provided across or through the gap between the island and the curb.

• In locations with bicycle lanes or shoulders being used as bicycle facilities, curb extensions should not extend into the bicycle lane.

• Curb extensions can be designed with mountable curbs to be comfortable by bicyclists.

OTHER CONSIDERATIONS

• A corner extension can be combined with a vertical speed control device (such as a raised crosswalk) to achieve a greater reduction in vehicle speed.

• Green infrastructure, native landscaping and street furniture, such as bike racks, can be incorporated in curb extensions so long as they are not located in the sidewalk clear zone.

• Curb extensions can be created using low-cost or temporary materials, such as flexible bollards, paint, and temporary curbs. A double white line should be used to define the edges of curb extensions when installed at street level.

• Curb extensions provide more space to install perpendicular curb ramps to better aligned with the crosswalk.

Image 4.27
A curb extension in downtown Tucson

Chokers

OVERVIEW

Chockers, or pinch-points, are mid-block curb extensions used to narrow the travel way. Chokers are created by placing two curb extensions or edge islands directly across from each other.

APPLICATION AND USE

- Chokers can be installed on all street types, but are most commonly used on neighborhood streets and on streets with on-street parking.
- When used on a commercial street, chokers support mid-block crossings and only extends into the parking lane. When used on a neighborhood street, a choker is used to narrow the traveled way.
- A midblock location near a streetlight is preferred for installation.

Image 4.28
Chokers on a residential street

DESIGN AND OPERATION

- Chokers are created by moving the curbline or installing edge islands.
- When installed on commercial streets, chokers should generally be 6 feet to 8 feet wide, extending the width of the parking lane.
- On neighborhood streets, chokers can be designed to allow two-way traffic to clear the choker, or by forcing one direction to yield to clear the choker with appropriate assignment of right-of-way. 14 feet is the narrowest recommended clearance through the choker.
- Chokers should generally be 20 feet long.

OTHER CONSIDERATIONS

- As with all in-street traffic calming features, impacts on drainage, utilities, and emergency response times need to be considered.
- Chokers can incorporate green infrastructure elements to support native vegetation and to help manage stormwater.
- Chokers can be created using low-cost or temporary materials, such as flexible bollards, paint, and temporary curbs. A double white line should be used to define the edges of chokers when installed at street level.

Diagonal Diverters

OVERVIEW

Diagonal diverters are a type of routing restriction in which barriers are placed diagonally across four-legged intersections. They block through movements of traffic, creating two unconnected intersections. They also significantly decrease traffic volumes and eliminate cut-through traffic.

APPLICATION AND USE

- Diagonal diverters can be on Neighborhood Streets, but should be used carefully so as not to simply push traffic onto adjacent roadways.
- Diverters can be used to reduce volumes on identified bicycle boulevards where AADTs are above 1,500. Diagonal diverters have been shown to reduce traffic volumes by 35% to 40%.
- Diagonal diverters are only applicable at intersections.

DESIGN AND OPERATION

- The design for a diagonal diverter should maintain full lane widths.
- They are designed for accessibility, not mobility. The radius should be the minimum needed to allow the design vehicle through.
- Appropriate signs and markings need to be in place to help the motorist be aware of and see the diagonal diverter. Painted curbs, delineation, street lights, and advance warning directional arrow sign.

OTHER CONSIDERATIONS

- A cut-out or gap should be provided for bicyclists and pedestrians to move through the intersection in all directions and safely wait for gaps in traffic.
- Diverters can be designed with flexible bollards, lockable gates, low-landscaping, or mountable curbs to allow emergency access.
- Diagonal diverters may have a considerable impact on traffic patterns and alter local access for some residents.

Image 4.29
A wide Diagonal Diverter in Baltimore, Credit: Nate Evans

Median Barrier and Forced Turn Island

OVERVIEW

Median barrier and forced turn island are two variations of routing restrictions that eliminate certain turn movements at an intersection. These route restrictions can be used to eliminate specific traffic flows (in particular, cut-through traffic) from entering or exiting a side street.

A median barrier is a raised island placed at an intersection. It prevents motorists from traveling straight through the intersection on the side street. A median barrier can be designed to allow turns to and from the main street, while preventing through traffic from the side street from crossing the main roadway.

A forced turn island is a raised traffic island, typically triangular in shape, that channels traffic to the right and blocks left-turn and through movements. It can constrain traffic entering or exiting the intersection. A variation on the forced turn island allows both left and right turns from the neighborhood street, but restricts through movements and left turns from the intersecting street.

APPLICATION AND USE

- Both median barriers and forced turn islands are typically used where neighborhood streets intersect with thoroughfares or connectors.
- Median barriers and forced turn islands can be used on bicycle boulevards to reduce traffic volumes below target numbers.

DESIGN AND OPERATION

- A median barrier should be designed with an opening that provides sufficient width for bicyclists and pedestrians to pass through but not so wide as to enable a motor vehicle to cut through. Bollards can be used to narrow opening widths to further restrict cars from passing through.
- The median barrier should extend 15 to 25 feet beyond the intersection to discourage a motorist from attempting to drive to the left of the median in order to complete a left turn to the side street.
- The forced turn island should be designed to force a turning movement, but should seek to intersect with the cross street at close to a right angle to maintain visibility and to discourage high turning speeds.

OTHER CONSIDERATIONS

- Emergency response times will be affected, particularly for left turns onto the treated neighborhood street.
- Forced turns (left and right) can also be achieved through the use of signs and enforcement. However, the lack of a forced turn island will likely result in poorer compliance.

Image 4.30
A Median Barrier with Forced Turn Island

Half / Full Closure

OVERVIEW

Half closures and full street closures are routing restriction methods that eliminate some or all vehicle access on neighborhood streets. Half closures are barriers that block travel in one direction for a short distance on otherwise two-way streets; sometimes called partial closures or one-way closures. Half-closures force a motor vehicle to turn onto the cross street and restricts entrances or exits to a street at an intersection.

Full-street closures are barriers placed across a street to completely close the street to through traffic, usually leaving open space for pedestrians and bicyclists. Cul-de-sacs and dead-end streets are common full street closures.

Half closures typically result in volume reductions of 40% to 60% on the affected street. Full closures lead to an even greater volume reduction.

DESIGN AND OPERATION

- Half closures should only be used at intersections on neighborhood streets to restrict access for one direction of travel.
- Full closures can be used at intersections or at mid-block locations also on neighborhood streets.

DESIGN AND OPERATION

- Half closures must be designed to deter illegal maneuvers. The barrier should be longer than a passenger vehicle, requiring an uncomfortable travel distance to by-pass the barrier in the wrong direction and it should extend to the street's centerline.
- Full closures should allow bicycles and pedestrians to travel through the barrier unrestricted.
- Half closures should be designed with a bicycle path running behind the barrier to not force bicyclists into oncoming traffic.
- Adequate advanced notice must be provided to motorists of street closures to allow time to re-route as needed.

OTHER CONSIDERATIONS

- For both closure types, as with all route restrictions, it is important to consider where diverted traffic will go, so that problems aren't just moved to parallel streets.
- Installation of closures may require modifications to maintain surface drainage capacity.

Image 4.31 and 4.32
A Half Closure (above) and Full Closure (below)

Experimentation and Pilot Project

Many of the traffic calming approaches discussed above—particularly the horizontal deflection, street width reduction, and routing restriction strategies—can be installed as pilot or demonstration projects using less expensive, flexible materials.

Demonstrating traffic calming projects in a real-world setting can help to build or gauge public support, allow practitioners to study traffic impacts, and let project teams test and adjust designs before committing. Piloting projects can help to lower the risk involved in capital-intensive street transformations since they are tested prior to construction, or where funding isn't immediately available, result in a semi-permanent interim design project that can improve streets more quickly and at a lower cost. These can eventually be upgraded into something more permanent. More information about demonstration/pilot projects and the "Quick-Build" approach is provided in Chapter 7.

Image 4.33
Demonstration public plaza and curb extensions on 6th Ave and 7th St in Tucson

Tucson Neighborhood Traffic Management Program

In Tucson, neighborhood traffic calming installations are overseen by the Transportation Department's Neighborhood Traffic Management Program (NTMP). The intent of the NTMP program is to protect neighborhoods and neighborhood quality of life through traffic management and control strategies. Typically, if a neighborhood is interested in pursuing traffic calming strategies on its streets, it will contact NTMP to request a petition for a traffic mitigation plan. The petition will need to be signed by 60% of the affected businesses or residents before the mitigation devices can be installed. The cost of installation and the maintenance of any landscaping (such as in chicanes or traffic circles) are the responsibility of the neighborhood. Failure to maintain landscaping in traffic calming features could result in the City removing the feature. Any street closures or route restrictions will also require approval by Tucson's Mayor and Council.

Traffic calming measures installed on bicycle boulevards, however, do not go through the neighborhood petition and approval process. The Transportation Department will develop plans for bicycle boulevards, with the input of affected neighborhoods, which will determine the appropriate traffic calming features, signage, and lane markings. All bicycle boulevard improvements will be funded by the City and its partners with the City solely responsible for maintaining all bicycle boulevard features.

For more information on the NTMP, visit the City of Tucson's Neighborhood Traffic Management Program webpage.

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INTERSECTIONS AND CROSSINGS

INTERSECTIONS AND CROSSINGS

Overview

Most roadway conflicts occur at intersections, or other crossing points, where travelers cross paths and the modes intermix in the street zone. Intersections have to accommodate vehicles turning and going straight, pedestrians and bicyclists traveling in all directions, and transit stops. Given the number of conflicts, most roadway crashes, unsurprisingly, occur at intersections. Overly long crossing distances are also a barrier for pedestrians and bicyclists, who may be exposed to both through-moving and turning motor vehicles.

With the vast majority of travel in Tucson occurring on the signalized street network, signalized intersections largely determine the vehicle capacity of the transportation system. Typically, when a driver experiences congestion in Tucson, it is almost always associated with the delay at a traffic signal.

The challenge for designing and improving intersections, particularly major signalized intersections, is striking the right balance between safety, comfort, and capacity. There are trade-offs with intersection design, with certain design elements and operational choices benefiting one user group potentially negatively affecting another. Under the Complete Streets approach, safety for all users, more than efficiency, should be the dominant consideration in intersection and crossing design. **In general, intersections should be compact, fully accessible, and designed for lower-speed turns.**

[Previous two-page spread]
Intersection with pedestrian and bicycle crossings. Source: "IMG_5499" by Joe Gilpin for NACTO under license CC BY-NC 2.0

The chapter covers intersection and crossing design, including intersection geometry, pedestrian and bicycle design elements, and traffic signals.

Intersection and Crossing Types

The following provides a brief summary of intersection and crossing types.

Mid-block Crossings – A mid-block crossing is a bicycle and/or pedestrian crossing location that is not located at an intersection. Mid-block crossing locations must be indicated with crosswalk markings.

Uncontrolled Intersections – Uncontrolled intersections are intersections where no traffic control device has been installed. In uncontrolled intersections, users yield to those who are already established in the intersection or to those approaching the intersection from the right (ARS 28-771). Uncontrolled intersections are appropriate at very low-speed, low-volume locations.

Stop-Controlled / Yield-Controlled Intersection – Stop or yield-controlled intersections are those where the right-of-way at an intersection is established through the installation of a sign at one or more approach. Stop and yield controls can be beneficial to pedestrians because the signs will require that vehicles to yield to pedestrians crossing the intersections, thus reducing wait times and ensuring low speeds. However, the use of STOP or YIELD signs must be carefully considered so as not to cause a safety issue or be overly disruptive to the flow of traffic. YIELD or STOP signs should not be used for speed control. Guidance on when to install STOP and YIELD signs is provided in Section 2B.04 of the MUTCD.

Signalized Intersection – Signalized intersections are typically larger, more complex intersections where right-of-way is assigned by electronically operated traffic signals.

To determine whether a traffic signal is required at a particular intersection, traffic engineers compare existing conditions against the standards and warrants in chapter 4 of the MUTCD. If warrants are satisfied, a new signal will generally operate effectively. If established warrants have not been met, congestion and motorist violations occur which result in more crashes.

The City of Tucson currently operates approximately 500 traffic signals.

Legal Pedestrian Crossings

Legal crosswalks can either be marked, with crosswalk paint, or unmarked. In Tucson, a pedestrian may cross the road legally at all legs of an intersection, marked or not, and at marked mid-block locations. (Pedestrians can be prohibited from crossing legs of an intersection through the installation of a No Pedestrian Crossing sign.)

Pedestrians are also legally permitted to cross the street outside of crosswalks, so long as they yield the right-of-way to motor vehicles[59], with the following exceptions:

- between adjacent traffic signals, (where there is no unsignalized intersection between signalized intersections),
- in a business district[60], or again,
- where explicitly prohibited through a sign.

[59] Arizona Revised Statutes 28-793 "Crossing at Other than a Crosswalk."

[60] According to Sec. 20-1(5) of the Tucson Code "A business district means the area contiguous to and including a street, where within any six hundred (600) feet along the street there are buildings used for business or industrial purposes which occupy at least three hundred (300) feet of frontage on one side, or three hundred (300) feet collectively on both sides of the street."

Intersection Design Elements

Since intersections are the primary transportation conflict points on the network, and they largely determine the capacity of a given roadway, well-designed intersections are essential to creating a safe, comfortable, efficient, and multimodal transportation system. Intersections must balance the needs of passenger cars, freight vehicles, pedestrians, and bicyclists. Tucson's intersections must combine well-designed geometry with efficient traffic control operations.

This section covers the major elements of intersection design. Design elements include:

- Curb radii
- Left-turn lanes
- Right-turn lanes
- Channelized right turnes
- Traffic signals
- Pedestrian design elements
- Bicycle design elements
- Transit preferential treatments
- Roundabouts

Curb Radii

OVERVIEW

Corner design has a significant impact on how safely and effectively an intersection serves roadway users. Intersections designed with large curb radii can comfortably accommodate a turning movement by larger vehicles (freight trucks, buses, etc.) but will increase the turning speed of passenger cars and make pedestrian crossings longer and reduce visibility of people crossing. This reduces the safety and comfort of pedestrians in the intersection by increasing exposure to higher-speed turning vehicles. Higher turning speeds result in longer driver reaction times, longer stopping distances, and reduced propensity to yield to pedestrians. As a result, crashes are more likely to occur at higher turning speeds, and are more likely to result in a serious injury or fatality.

In Tucson, major intersections and commercial driveways have traditionally been designed with large curb radii to allow freight traffic and buses to easily make turns—and to reduce the effect of turning vehicles on through traffic in combined lane situations—posing a challenge for more vulnerable users.

Under the Complete Streets approach, it is critical that curb radii are designed to accommodate the occasional large vehicle, but don't create a safety problem for more vulnerable users of the intersection. **To do so, the smallest feasible curb radii should be selected for corner designs, based on the turning needs of the least maneuverable vehicle that regularly uses the intersection.** Small curb radii slow vehicle speeds, decrease pedestrian crossing distance and time (allowing shorter traffic signal cycles), and permit better alignment of curb ramps and crosswalks.

Key considerations that will inform the selection of the appropriate curb radius include the following:

Curb Radius – The curb radius, or curb return radius, is the measurement of the actual curb line at the intersection.

Design Vehicle – This is the vehicle that the intersection is designed for. It is the design vehicle that ultimately determines the selection of the appropriate turn radius. The design vehicle should be chosen based on the least maneuverable vehicle that regularly uses the intersection. It should be accommodated without encroachment into opposing travel lanes.

Control Vehicle – The control vehicle is the least maneuverable vehicle that may possibly use an intersection. The control vehicle can be accommodated at an intersection through:

- allowing turns into opposing travel lanes,
- locating stop lines farther back from the intersection, or
- temporary interventions, such as flaggers or street closures.

Intersection designs should allow the control vehicle to use the full intersection to make a turn as needed. The curb radius should not be designed for the control vehicle.

Effective Curb Radius – The effective radius is the radius available for the design vehicle to complete the turn. The effective radius will be bigger than the curb radius when there is a bicycle lane and/or an on-street parking lane that separates the turn lane from the curb, or where the turning vehicle is allowed to use all receiving lanes. If the turning lane and receiving lane are directly adjacent to the curb, the curb radius and the effective turn radius will be the same.

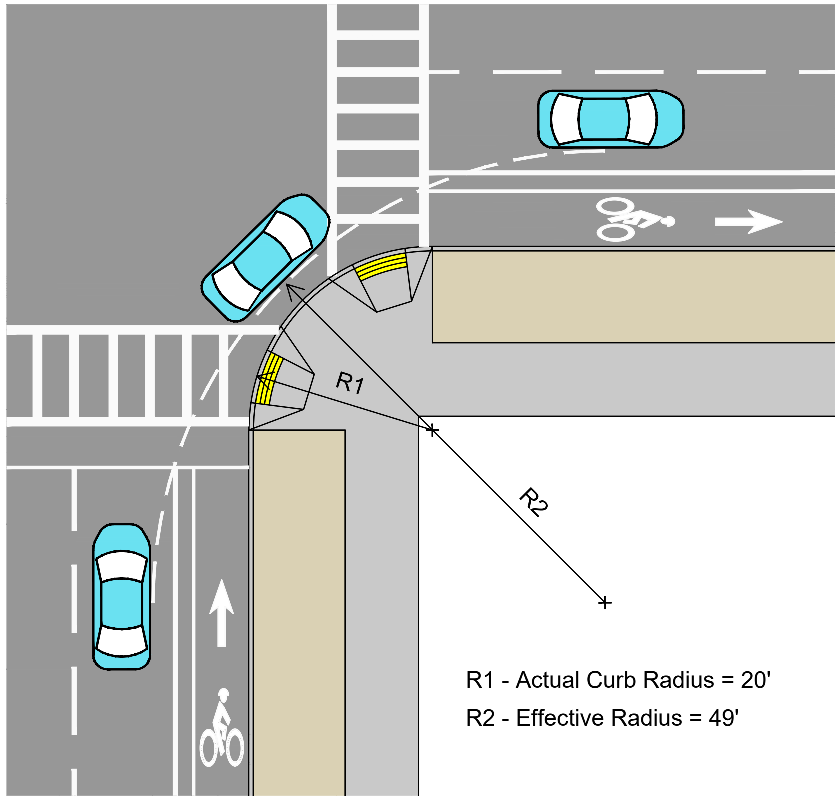

Figure 5.1
Curb Radius

APPLICATION AND USE

- The selection of a design vehicle should balance the needs of all intersection users, with particular consideration given to the most vulnerable users.
- The design vehicle should not be selected based on the largest vehicle that may occasionally use the intersection. When selecting a design vehicle, consider turning volumes. The design vehicle should be the least maneuverable vehicle that represents at least 3% of turns at the intersection, unless the intersection is on a designated freight corridor, at a designated bus turn, or on an industrial street. Intersections on these street types can be designed for larger vehicles. In all cases, the design should assume that larger vehicles make turns at very low speeds.

DESIGN AND OPERATION

- In designing the turn radius, both the curb radius and the effective turn radius should be considered (see Table 14 for general guidance on preferred curb radius by street type). The effective turn radius should be used to determine the ability of vehicles to negotiate a turn.

• At signalized intersections, where the receiving street has more than one lane in the vehicle's direction of travel, calculation of the effective turn radius may assume that large vehicles can use all receiving lanes to make the turn (not just the curb lane) at a very low speed.

• At intersections where buses make designated turns, radii should be designed for a 40-foot Sun Tran bus.

• **On all intersection types, the smallest feasible radius should be used.** It is recommended that project teams use a turn simulation software, or similar, to determine the smallest feasible radius.

• Where less maneuverable vehicles sometimes make turns, stop lines can be set back from the intersection to accommodate movement.

OTHER CONSIDERATIONS

• To get accurate information on intersection usage, classification counts should be conducted prior to design. If intersection classification counts cannot be obtained, a single unit truck (SU-30) should be selected as the design vehicle unless on a bus route, industrial street, or the intersection of freight corridors.

• A smaller corner radius shortens pedestrian crossing distance and allows for better alignment of curb ramps. When selecting a curb radius, the effect on pedestrian crossing times and ramp placement should be a key consideration.

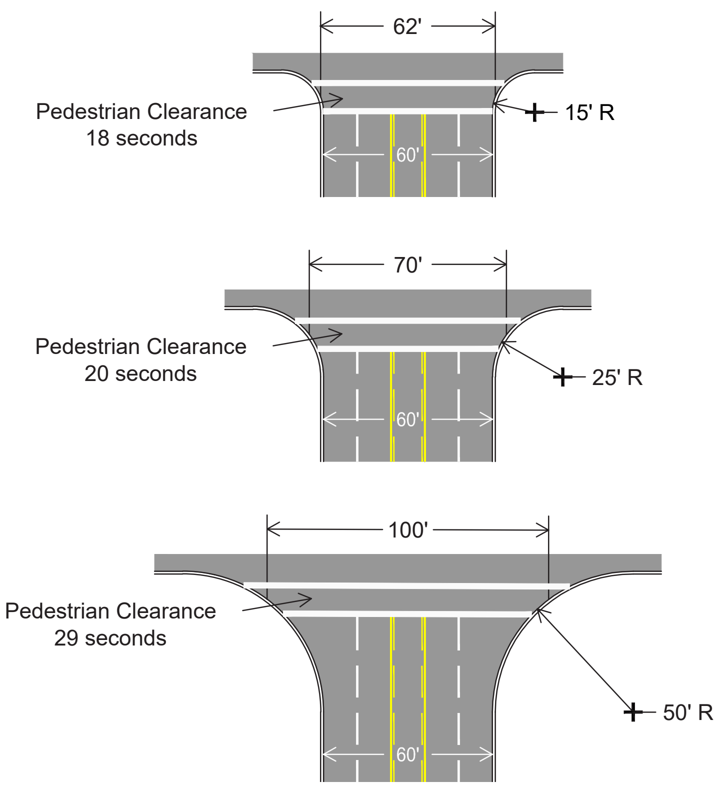

Figure 5.2 Pedestrian clearance times at different curb radii

- Where there are high volumes of large vehicles making turns, inadequate curb radii could cause large vehicles to regularly travel across the curb and into the pedestrian waiting area.
- Curb radii can be reduced through the installation of curb extensions or, where budget is limited or drainage needs constrain the installation of curb, the use of pavement markings and bollards.
- Intersections can be designed with mountable truck aprons where there is need to both accommodate large commercial vehicles while keeping turning speeds lower for passenger vehicles.[63]

[63] For more information about corner design practices, see "Corner Design for All User:: A review of geometric design practices to improve safety for pedestrians and bicyclists at intersection corners." Alta Planning + Design. 2020.

The next tables provide guidance on appropriate curb radius by street intersection type and driveway. It cannot replace engineering judgment, as curb radius design can be affected by multiple variables, including nearby freight generators, nearby trauma center, presence of a bike lane or on-street parking, large vehicle volumes, lane widths, number of lanes, drainage, placement of curb ramps, intersection skew, and other considerations. The designer may select curb radii less than or greater than those in the tables based on the characteristics of the intersection, but curb radii larger than 30 feet should generally be avoided, and the effective turn radius should not exceed 50 feet. Turn simulator software should be used during design to determine appropriate radii. **Designs with curb radii greater than 30 feet must receive approval of the City Engineer.**

Table 5.1 Guidance on Curb Radius by Street Intersection Type

STREET INTERSECTION TYPE	CURB RADIUS
Neighborhood Street to Neighborhood Street	15 feet
Connector, Thoroughfare, or Regionally Significant Corridor to Freight Corridor	25 feet
Regionally Significant Corridor to Regionally Significant Corridor	25 feet
Regionally Significant Corridor to Neighborhood Street	25 feet
Industrial Street to Industrial Street	30 feet
Industrial Street to Freight Corridor	30 feet
Freight Corridor to Freight Corridor	30 feet
All other street intersection types	**20 feet**

Table 5.2 Guidance on Curb Radius by Street / Driveway Intersection*

DRIVEWAY INTERSECTION TYPE	CURB RADIUS
Neighborhood Street / Driveway or Parking Area Access Lane (PAAL)	10 feet
Connector / Driveway or PAAL	15 feet
Thoroughfare / Driveway or PAAL	20 feet
Regionally Significant Corridor / Driveway or PAAL	25 feet

* Table 5.2 is applicable when driveways are designed with a curb return instead of a curb cut with apron.

Left-Turn Lane

OVERVIEW

Left-turn lanes improve the efficiency of signalized intersections and reduce crash risk caused by vehicles turning left from the through lane. Left-turn lanes are an important roadway safety element on most major urban streets.

APPLICATION AND USE

- Left-turn lanes are recommended at signalized intersections located on urban and suburban thoroughfares, including functional overlays.
- Left-turn lanes should be considered on connectors and other intersection types on a case-by-case basis, depending on
    - traffic volumes (both approaching and opposing),
    - approach speeds,
    - intersection capacity,
    - the proportion of left-turning volume,
    - design conditions, and
    - crash history association with left-turning vehicles.

Tucson's left turn warrants are provided in the Transportation Access Management Guidelines (Figure 5.3 below).[64]

DESIGN AND OPERATION

- Left-turn lane width should generally be 10 feet on urban corridors and 11 feet on suburban corridors (see Table 5 for turn-lane dimensions), measured from the center of the lane marking, unless there are a high volume of turning buses and/or trucks, in which case a width of 11 or 12 feet is advisable. infrastructure features can be installed in the paved planting/amenity zone to provide street trees between the sidewalk zone and the roadway where space is available.
- **Where practical, left-turn lanes should be designed to have a positive offset of 4–6 feet from the opposing left-turn lane.** Positive offsets have been shown to reduce crashes by between 32 percent and 38 percent.[65] Negative offsets should be avoided at intersections, as they limit the visibility of on-coming traffic.
- Left-turn lanes consist of an entering taper, a deceleration area, and a storage area. The length of the taper and storage area is based on the speed of the roadway and the number of vehicles that may need to be stored at peak periods.

[64] Tucson Access Management Guidelines. https://www.tucsonaz.gov/files/transportation/access_management_guidelines_update_december_2011_final.pdf

[65] Federal Highway Administration. Crash Modification Clearinghouse. "Improve left-turn lane to create a positive offset." (2009)

o Storage Length – The length of the left-turn bay should be long enough to store the number of vehicles likely to accumulate during peak hours. The storage length should be sufficient to prevent vehicles from spilling back from the turn lane into the adjacent through lane. Generally, at signalized intersections, storage length should accommodate one to two times the average number of vehicle queues per cycle. Traffic models used to develop signal timing can provide an accurate estimate on queue length.[67] At non-signalized intersections and driveways 110 feet of storage should be adequate (Pima County/City of Tucson Signing and Pavement Marking Manual).

[67] Ibid

[68] Ibid

[69] Ibid

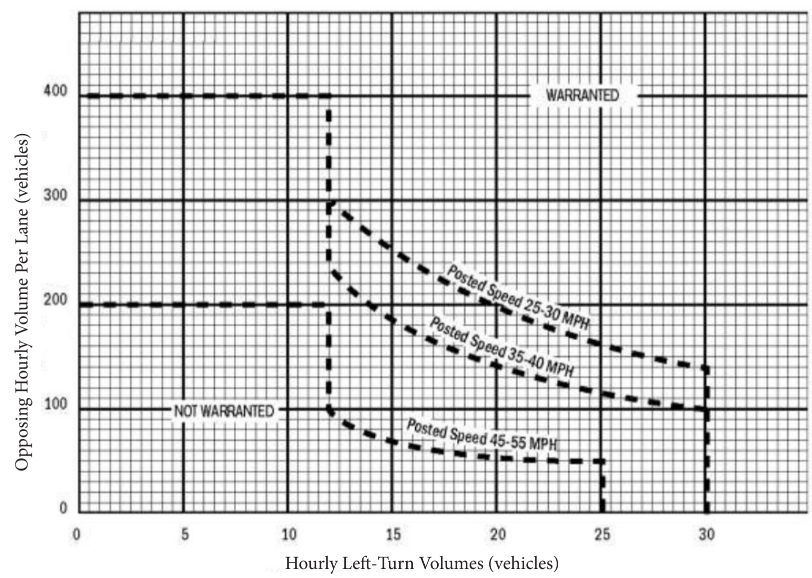

Figure 5.3
Left-Turn Guideline

OTHER CONSIDERATIONS

• Dual left-turn lanes can be considered where there are more than 300 left turns during a peak hour and opposing and adjacent traffic is moderate to heavy.[68] **Dual left-turn lanes should generally be avoided at intersections with a high numbers of pedestrian crossings at the conflicting leg of the intersection.**[69] Dual left-turns will increase intersection size, lengthening pedestrian crossing distances and increasing conflicts between left-turning vehicles and pedestrians in the parallel crosswalk.

• At dual left-turn lanes, the use of dotted lane line extensions to delineate the turn path is encouraged to help drivers determine the proper path of travel. Lane markings can also be used where the roadway alignment may be confusing.

Right-Turn Lane

OVERVIEW

Right-turn lanes provide a dedicated lane for vehicles to make right turns at intersections. As with dedicated left-turn lanes, the deceleration of right-turning vehicles creates a speed differential with through traffic. This differential can lead to delay for through vehicles and increase the risk for rear-end crashes. The benefits of right-turn lanes are not as pronounced as left-turn lanes given the absence of opposing traffic.

Where there are both significant through traffic and right-turn volumes, dedicated right-turn lanes can decrease vehicle delay and increase intersection capacity, particularly where there are high pedestrian volumes in the parallel crosswalk. However, use of right-turn lanes also increase pedestrian crossing distances at intersections and reduce comfort for bicyclists. The design should consider the trade-offs between minimizing intersection delay and comfort for people walking and biking.

APPLICATION AND USE

- Right-turn lanes can be used at both signalized and unsignalized intersections as well as at commercial driveways, depending on a number of factors, including:
    - o Peak-hour approach volume
    - o Peak-hour right-turn volume
    - o Posted speed
    - o Pedestrian activity conflicting with right-turn movement
    - o History of rear-end crashes.
- At signalized intersections, right-turn lanes assist with the optimization of signal phasing and increase intersection capacity due to the potential for right-turns-on-red.
- At non-signalized intersections and major driveways, right-turn lanes provide safe deceleration separate from higher-speed through lanes.
- Right-turn lanes will have a greater impact on traffic operations on two-lane roadways than on four-lane or six-lane roadways, because on two-lane facilities right-turning and through vehicles are restricted to a single lane.
- Right-turn lane guidelines for two-lane and four-lane roadways are shown in Figures 5.5 and 5.6 at the end of this section. **Where volumes are lower than those shown in the figures, a traffic analysis can be conducted to demonstrate the impact of a right-turn lane on intersection operation to determine if a turn-lane may still be appropriate.**

o In addition to the locations meeting the criteria in Figures 5.5 and 5.6, right-turn lanes may also be considered:

- at locations where high pedestrian volumes cause delay to right-turning vehicles,
- where there is a history of right-turn related rear-end crashes,
- where a right-turn lane can also serve as a queue jump for buses, and
- where it is otherwise determined necessary based on engineering judgment.

o Conversely, some intersections meeting the right-turn lane criteria presented in Figures 5.8 and 5.9 may not be appropriate for the installation of a right-turn lane, particularly where rights-of-way are limited and installation of a right-turn lane would reduce space available for the pedestrian realm.

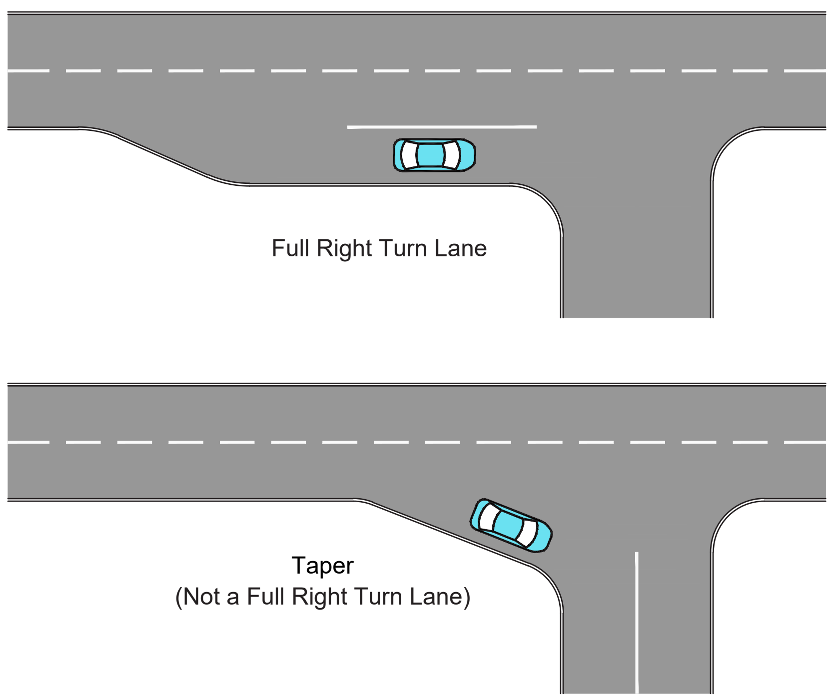

Figure 5.4
Right-Turn Lane and Taper

DESIGN AND OPERATION

· **A right-turn lane should generally have a width of 10 to 11 feet.** Appropriate lane width should be determined based on engineering judgment considering the corner radius, effective turn radius, available right-of-way, and the needs of the design vehicle. **12-foot turn lanes may be appropriate at designated bus route turns or where there are frequent turns of large trucks.**

• Similar to left-turn lanes, right-turn lanes consist of an entering taper, deceleration area, and storage area. The length of the taper/deceleration and storage area is based on roadway speed and the number of vehicles that may need to be stored during the peak period.

o Taper length and deceleration – Design guidelines for turn-lane entering tapers are provided in the Pima County/City of Tucson Signing and Pavement Marking Manual. In general, the entering taper should be designed to allow vehicles to depart the through travel lane with minimum braking; and provide adequate length to decelerate.[70]

o Storage Length – The length of the right-turn bay should be long enough to store the number of vehicles likely to accumulate during peak hours. The storage length should be sufficient to prevent vehicles from spilling back from the auxiliary lane into the adjacent through lane. Generally, storage length at signalized intersections should be long enough to accommodate one to two times the average number of vehicle queues per cycle. At unsignalized intersections and driveways 110 feet should be adequate to allow for deceleration and storage (Pima County/City of Tucson Signing and Pavement Marking Manual).

• **At unsignalized locations, a right-turn taper or pocket may be considered as alternatives to a full right-turn lane.** These can be used where it can be demonstrated that the shorter storage length won't result in significant deceleration or queuing in the through travel lane (up to 10 mph of deceleration in the through lane is acceptable).

OTHER CONSIDERATIONS

• **Dedicated right-turn lanes are not recommended on six-lane roadways.** The decision to construct dedicated right-turn lanes at signalized intersections on six-lane roadways should be weighed carefully against other considerations and justified with a traffic analysis. Adding right-turn lanes to an already-wide six-lane intersection will add more asphalt and increase pedestrian crossing distances and clearance times, requiring longer signal phases. This is particularly true at intersections with dual left-turn lanes.

• Additionally, the operational benefits of right-turn lanes on six-lane roadways are diminished since through traffic can travel in the other two travel lanes and the curb lane can largely serve as a local access lane. **Right-turn lanes may be appropriate on six-lane Regionally Significant Corridors given how those corridors function within the Tucson's street network or where they provide a bus by-pass lane.**

[70] Federal Highway Administration. Signalized Intersections: Information Guide. https://safety.fhwa.dot.gov/intersection/conventional/signalized/fhwasa13027/

• At intersections with a dedicated right-turn lane, bicycle lanes should be provided to the left of the right-turn-only lane, unless there is a bicycle signal with dedicated phasing or a protected bicycle lane.

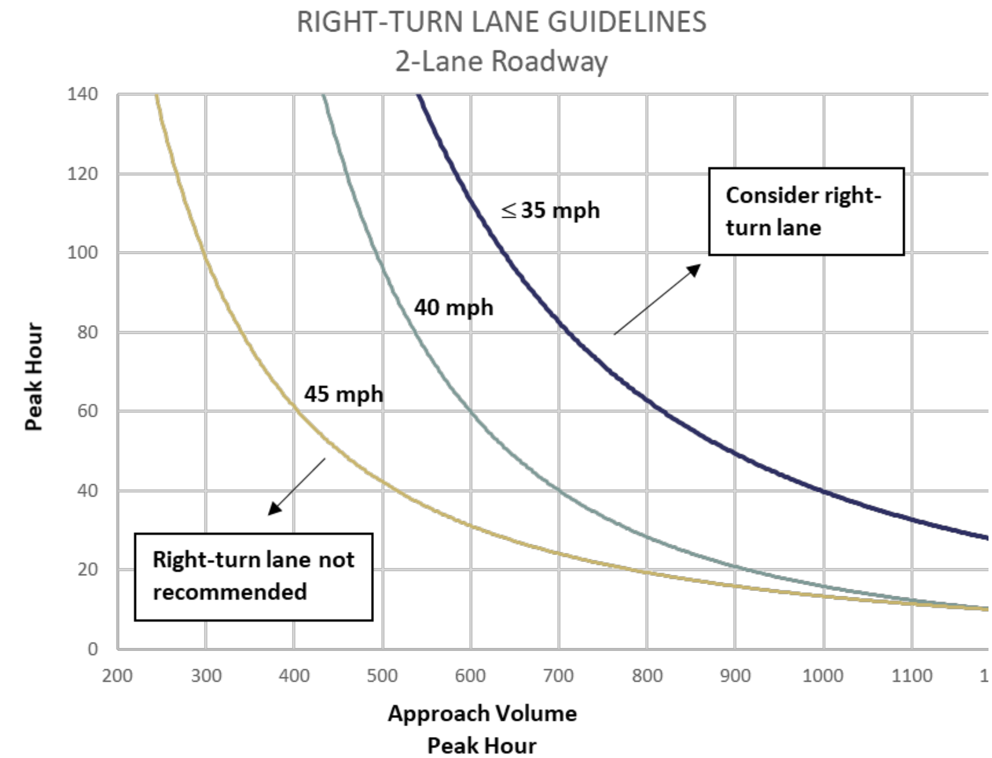

Figure 5.5
Right-Turn Lane Guidelines 2-Lane Roadway [71]

[71] Guidelines for 40 and 45 mph right-turn lanes adopted from MoDOT. Engineering Policy Guide. Sheet 940.9.8 "Right Turn Lane Guidelines for Two-Lane Roadways," 2007. 35 mph and below adopted from VTrans Right-Turn Auxiliary Lanes Traffic Volume Warrants, accessed via "Turn Lane Warrants: Concepts, Standards, Application in Review" from the ITE District 1 meeting. 2004. Existing roadway constraints may restrict the ability or need to install turning lanes. Traffic Engineering may require a traffic engineering analysis to support alternative recommendations for the installation of turning lanes.

[72] Guidelines for 40 and 45 mph right-turn lanes adopted from MoDOT. Engineering Policy Guide. Sheet 940.9.8 "Right Turn Lane Guidelines for Two-Lane Roadways," 2007. 35 mph and below criteria created using a factor applied to the 2-lane guidelines adopted from VTrans. Existing roadway constraints may restrict the ability or need to install turning lanes. Traffic Engineering may require a traffic engineering analysis to support alternative recommendations for the installation of turning lanes.

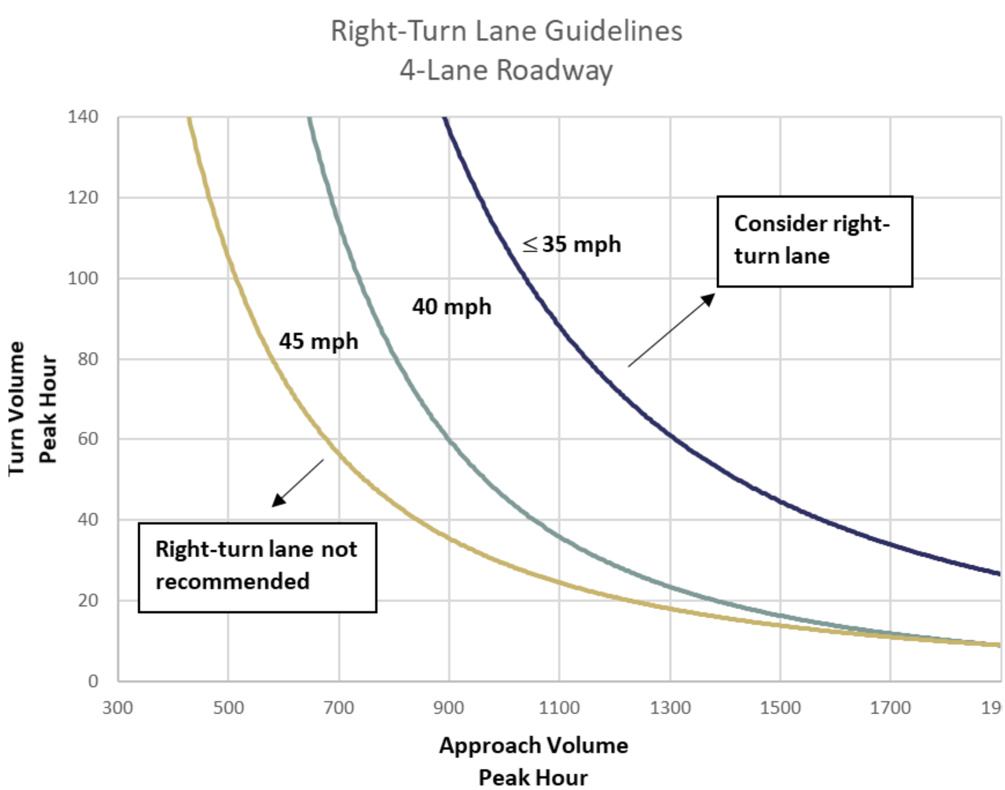

Figure 5.6
Right-Turn Lane Guidelines 4-Lane Roadway [72]

Channelized Right Turn

OVERVIEW

A channelized right-turn lane is a right-turn lane that is separated from through traffic by a raised island, also called a "porkchop." A channelized right-turn lane is a good option at intersections in which an overly large turning radius is required or where pedestrian crossing distances are long. If well designed, a channelized right-turn will reduce the number of lanes a pedestrian has to cross at one time, balance vehicle turning needs with pedestrian safety, and improve signal timing.

APPLICATION AND USE

- Channelized right-turn lanes can be used at multi-lane signalized intersections where accommodation of the design vehicle will substantially increase pedestrian crossing distances. These would be most appropriate on thoroughfares, particularly on Freight Corridors, Regionally Significant Corridors, designated bus route turns, or where the intersection is skewed.

DESIGN AND OPERATION

- An angle of 55 to 70 degrees should be provided between intersection vehicle flows. This allows turning drivers to better see pedestrians and approaching vehicles. "Head turners," in which the angle of the turn forces the right-turning driver to look back over their left shoulder to see on-coming traffic must be avoided.

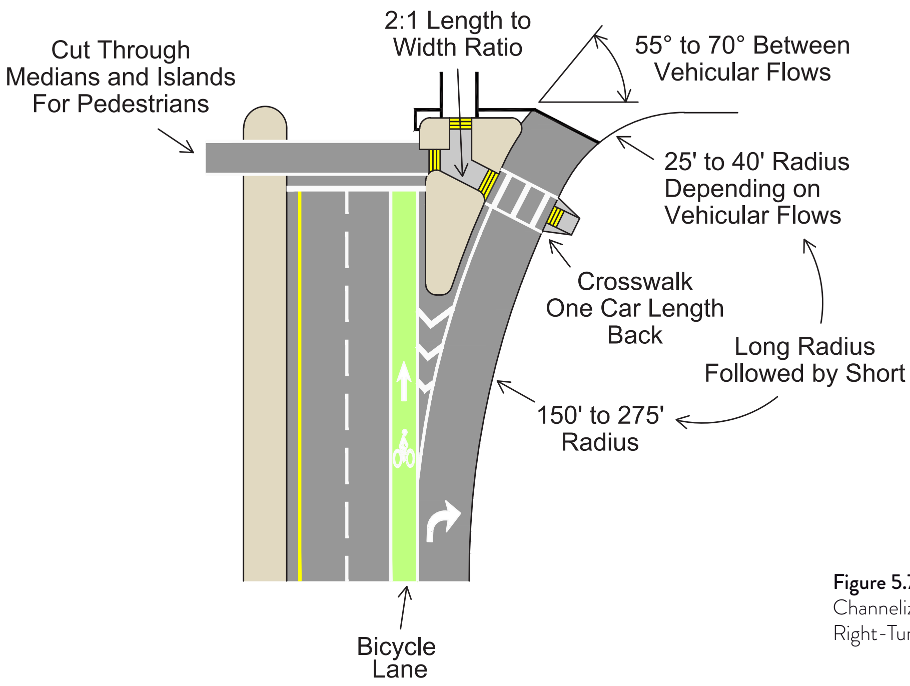

Figure 5.7
Channelized
Right-Turn

• Acceleration lanes should not be provided on the receiving street. Acceleration lanes allow drivers to take the right-turn at higher speeds without stopping. This significantly reduces the likelihood of drivers yielding to pedestrians trying to cross to the island.

• The channelized right-turn lane should be kept to as narrow as possible depending on the requirements of the design vehicle. Gore areas should be marked along the curb return - not adjacent to the channelizing island - to support the accommodation of large vehicles while guiding passenger vehicles to slow down and approach the intersecting street at the most acute possible angle.

• Mountable truck aprons can be used to narrow the pedestrian crossing distance, while still allowing larger vehicles to make the right turn.

• The crosswalk should cross the turn lane at 90 degrees. High-visibility crosswalk striping and good lighting should be used.

• One car length of distance should be provided between the crosswalk and the intersecting street to allow drivers to wait for a gap in traffic after clearing the crosswalk.

• A "STOP FOR PEDESTRIANS IN CROSSWALK" sign should be placed in front of the crosswalk.

• The raised island should be twice as long as it is wide and be designed with a cut-through for pedestrians. Detectable warning strips should be installed at all crossing locations.

OTHER CONSIDERATIONS

• Raised crosswalks can be installed at channelized right-turn lanes in order to further slow turning vehicles and to increase pedestrian visibility.

• Rectangular Rapid-Flashing Beacons (RRFB) can be considered at locations with high-pedestrian volumes and low yielding compliance at the right-turn crosswalk.

Traffic Signal Timing

OVERVIEW

Traffic signals allow the shared use of road space by separating conflicting movements in time and allocating delay. The goal of effective signal timing is to minimize cycle lengths and coordinate signals to reduce delay for all users.

A shorter signal cycle improves pedestrian convenience and compliance by decreasing wait times at intersections. Coordinated signals allow vehicles to progress along a corridor at a set speed in order to hit green lights; this is known as the "green wave."

Because so much of Tucson's traffic is carried on the signalized road network, effective operation and coordination of traffic signals can considerably improve traffic flow on the city's streets.

Maintaining a coordinated signal network is a high priority for the city of Tucson given the large potential impact of upgrading signals on improving mobility and safety for the traveling public. Signal upgrades should be explored as a first option to meet capacity needs on Tucson's streets, particularly as the City looks to incorporate the multimodal focus of these Guidelines into street design.

APPLICATION AND USE

- Traffic signals are appropriate at intersections on major roadways where traffic volumes are beyond the capabilities of other traffic controls, such as stop signs.
- Traffic signal warrants are provided in Chapter 4C of the MUTCD.

DESIGN AND OPERATION

- Traffic signals consist of signal controllers, signal heads, detectors, poles, and supports. Communications technology is also essential for ensuring that traffic signals are "talking" to each other.
- The time it takes for a traffic signal to go through all of the different traffic movements (left turns, through traffic, pedestrian signals) is called the cycle length. How the time is allocated within the cycle to each of the traffic movements is called the phase length. Signal timing is the number of seconds given to each phase.
- In Tucson, most major intersections operate on a protected-permissive left-turn phasing approach with a "lagging" protected left turn. Under this approach, left-turning vehicles are permitted to make left turns during gaps in opposing through traffic prior to receiving the protected green left-turn arrow. An alternative to protective-permissive left-turn phasing is protected-only left turns. Protected-only left-turn phasing typically has a lower crash rate than permissive-protected phasing (due to reduction of both angle crash risk at intersections and conflicts between pedestrians and left-turning vehicles,) but the trade-off is a decrease in intersection capacity. Signal phasing decisions must strike a balance between these two considerations. **Intersections with a high number of left-turn crashes should be considered for protected-only phasing or for time-of-day protected-only phasing.**

[72] FHWA. CMF Clearinghouse. Safety Effects of Flashing Yellow Arrows Used in Protected Permitted Phasing: Comparison of Full Bayes And Empirical Bayes Results. 2018. http://www.cmfclearinghouse.org/study_detail.cfm?stid=535

[73] FHWA. Center for Accelerating Innovation. Adaptive Signal Control FAQs. https://www.fhwa.dot.gov/innovation/everydaycounts/edc-1/asct-faqs.cfm#t2_imp

- The City of Tucson is working on a program to convert left-turn signal phases to a flashing yellow arrow (FYA) operation when allowing permissive turning. FYA better alert drivers to the need to yield to oncoming traffic and likely presence of pedestrians. **Flashing yellow arrows must be supplemented with signage indicating left-turn drivers must yield during the flashing phase.** Flashing yellow arrows can switch to a solid red arrow at certain times of day. Converting permissive-protected left-turns to flashing yellow arrow operation, in combination with appropriate signage, has been shown to reduce intersection crashes by approximately 12 percent.[72] In Tucson, the signals operating on flashing-yellow arrow phasing also switch to full protected phasing with actuation of the conflicting pedestrian signal, providing extra protection to pedestrians in the crosswalk.
- **At intersections with dual left turns, that have not yet been converted to flashing yellow arrow operation, it is recommended that protected-only left-turn phasing is considered due to reduced visibility for the right-most left-turn lane.** Protected-only phasing can also be considered at certain times of day when crash risk is highest. The decision to convert to protected-only operation must be made on a case-by-case basis following engineering judgement.
- Coordinating traffic signals can be an effective means of managing speed on urban corridors. The signals can be timed to provide a green wave for drivers traveling at, or just below, the posted speed limit. This strategy, if drivers are aware of it, reduces the incentive to travel at high speed between signals without impacting travel times.

OTHER CONSIDERATIONS

- In recent years, the Tucson region has constructed a number of indirect left-turn intersections on select corridors, such as Grant Road. The indirect left-turn improves intersection safety and capacity by eliminating left-turn phases on one or more approaches. A three-year before and after review conducted by the City of Tucson has shown that the indirect-left turn, in conjunction with the installation of a raised median, was able to reduce intersection crashes by nearly 50 percent while also reducing intersection delay.
- Tucson should explore transit signal priority treatments at key intersections of the frequent transit network. Transit signal priority operates through a transmitter on the bus communicating with the traffic signal. The traffic signal then dynamically adjusts its signal timing to better accommodate the movement of the transit vehicle through the intersection.

• The City of Tucson is continuing to explore ways to improve the performance of traffic signals. One technology that holds promise is Adaptive Signal Control Technology (ASCT). ASCT are technologies that sense traffic demand in order to dynamically adjust signal timing to optimize traffic flow. Unlike traditionally timed signals, ASCT signals are able to automatically respond to changing traffic conditions caused by special events, crashes, inclement weather, or other events, to optimize the allocation of green time. ASCT can improve the performance of signalized intersections by 10 percent or more (depending on base conditions) for common metrics (travel time, delay, emissions and fuel consumption). [73]

• Signal technology will continue to evolve, particularly as wireless communications technology improves and makes innovations like vehicle-to-infrastructure communication possible. Tucson should continue to look for opportunities to invest in appropriate technological improvements to get the best possible performance out of traffic signals.

Pedestrian Signals

OVERVIEW

Pedestrian signals provide specific traffic signal indications aimed exclusively at pedestrians. Pedestrian signals typically consist of pedestrian signal heads and pedestrian detectors, such as push buttons. The pedestrian signal phase at intersections is separated into the three following intervals:

• The Walk Interval – this is signified by the WALK indication, the walking person, and it alerts the pedestrian to begin their crossing.

• The Pedestrian Change Interval – this is signified by the flashing DON'T WALK indication, which is symbolized by the flashing UPRAISED HAND and countdown display. The change interval alerts pedestrians that they should not begin crossing the street and the countdown lets them know how much time remains for the crossing. All new pedestrian heads should include a countdown display.

• The Don't Walk Interval, which is symbolized by the steady UPRAISED HAND, indicates to the pedestrian that they should not enter the roadway. A buffer interval should also be provided at the beginning of the Don't Walk Interval. The buffer interval is a 3-second period in which the pedestrian sees the steady UPRAISED HAND but in which no conflicting vehicle movements have begun.

APPLICATION AND USE

• Pedestrian signal heads should be provided at all signalized intersections where there are legal crosswalks.

DESIGN AND OPERATION

- Design guidance for pedestrian signal heads and accessible pushbuttons is located in Chapter 4E of the MUTCD.
- Pedestrian signals are timed based on the following considerations:
    - o The Walk Interval should be a minimum of 7 seconds. To provide more convenience for pedestrians, it is recommended that the Walk Interval is maximized within the green signal phase.
    - o The Pedestrian Clearance is the sum of the pedestrian change interval and the buffer interval. The pedestrian clearance is timed so that a pedestrian who left the curb at the end of the Walk Interval can travel the entire length of the crosswalk at a walking speed of 3.5 feet per second (or 3 feet per second where slower walking pedestrians are frequent). **Longer clearance times should be used near senior centers or where there are a high number of people who may walk at a slower speed.**
    - o At larger intersections, the combined Walk and Pedestrian Clearance Intervals can be the major determinant of traffic signal timing, limiting the ability to provide shorter signal cycles.

Image 5.1
Pedestrian Countdown

OTHER CONSIDERATIONS

- Pedestrian phases can be actuated (pushbutton) or automatic (providing a Walk Interval automatically with each signal cycle). Automatic pedestrian phasing should be used in areas with heavy pedestrian activity, such as downtown Tucson and near the University of Arizona. Actuated signals can be used where pedestrian activity is intermittent and where including the full pedestrian phase automatically in every signal cycle would result in overly long signal cycles across the network. **Automatic pedestrian phasing can be considered at any intersection in which pedestrians crossings occur during at least 50 percent of signal cycles at peak hours, though engineering judgment should be used.**

- Accessible Pedestrian Signals (APS) are pedestrian signals that communicate information in non-visual formats for pedestrians with visual disabilities. APS and detectors may include features such as audible tones, speech messages, detectable arrow indications and/or vibrating surfaces. The City of Tucson's policy is to install APS at all newly constructed traffic signals. APS will also be installed on request based on a priority ranking and funding availability. The audible tones on APS signals can be adjusted with traffic noise so that they are not overly loud during overnight hours.

- In locations with a high number of conflicts between pedestrians and right-turning vehicles, project engineers should consider the use of the Leading Pedestrian Interval (LPI). LPI is a signal phasing technique in which pedestrians are given the Walk Interval 3 to 7 seconds before the conflicting green interval is given for motorists. This provides sufficient time for a pedestrian to cross one lane of traffic in order to be fully established in the crosswalk. LPIs have been shown to reduce vehicle-pedestrian crashes by 13 percent at intersections.[74] LPIs work best when paired with no right-turn on red restrictions to improve effectiveness.

- LPIs can be paired with a leading bicycle interval (LBI), where appropriate. The LBI operates in the same way as the LPI, with bicycles receiving a 3 to 7-second lead before the conflicting right-turn green phase. To permit the LBI, signals can be installed with a BIKES USE PEDESTRIAN SIGNAL supplemental plaque. [75]

- At intersections installed with flashing yellow arrows, switching to a red arrow when the pedestrian signal is actuated reduces pedestrian crash risk with left-turning vehicles.

[74] FHWA. Proven Safety Countermeasures. https://safety.fhwa.dot.gov/provencountermeasures/fhwasa18029/ch13.cfm

[75] NACTO. Don't Give Up the Intersection. Designing All Ages and Abilities Bicycle Crossings. 2019

Curb Ramps

OVERVIEW

A curb ramp provides a transition from the sidewalk to the street. Ramps are critical for allowing people with mobility or visual impairments to safely access intersections and travel along the pedestrian route from one side of the street to the other. Curb ramps also make it easier for people pushing strollers, rolling luggage, or pushing their bicycles to access the sidewalk.

APPLICATION AND USE

- Ramps are required along pedestrian access routes anywhere there is a change in level greater than 1/2 inch. Most typically, ramps are found on curbed streets where the sidewalk has to drop down to meet the level of the street.
- Curb ramps must be installed on a pedestrian access route as part of any alteration to the roadway that spans from one intersection to another. Alterations include construction, reconstruction, overlays, and others. Ramps do not need to be installed as part of routine pavement maintenance. [76]

[76] Department of Justice/Department of Transportation: Department of Justice/Department of Transportation Joint Technical Assistance on the Title II of the Americans with Disabilities Act Requirements to Provide Curb Ramps when Streets, Roads, or Highways are Altered through Resurfacing. 2013. https://www.ada.gov/doj-fhwa-ta.htm

DESIGN AND OPERATION

- Ramps and landings should be designed in compliance with ADA requirements.
- Curb ramps should be aligned with crosswalks at the intersection and placed in line with the pedestrian's path of travel, where feasible. **Diagonal curb ramps (in which a single ramp is placed at the apex of the corner to provide ramp access to two perpendicular crosswalks) should be avoided.**
- Ramps should be located so they direct pedestrians to cross the intersection at the location with the shortest possible crossing distance and still maintain good sightlines between motorists and pedestrians.
- Detectable warning strips should be placed at the transition from the sidewalk to the street. Detectable warnings should be as wide as the ramp and have a color contrast of at least 70 percent with the adjacent walking surface, either dark-on-light, or light-on-dark. "Safety yellow" is a common color choice for detectable warning strips, though Terracotta or Colonial Red may be used in its place to better blend with the surrounding context. The strips should consist of truncated domes in a square or radial grid pattern. Detectable warning strips should be at least 2 feet long and as wide as the curb ramp. Detectable warnings should not cover the entire ramp surface because the truncated domes present a vibration-causing surface for pedestrians in wheelchairs.

OTHER CONSIDERATIONS

- Smaller curb radii allow for better placement and more direct alignment of curb ramps.
- Ramps should be designed to avoid ponding and collection of debris at their base.
- Ramp flares are required when the surface adjacent to the ramp is walkable, but they are unnecessary when the surface next to the ramp is occupied by planters or other street furniture and not part of the access way. Curb ramps that have vertical sides can provide a useful directional cue for pedestrians with visual impairments so long as they are aligned with the crosswalk.

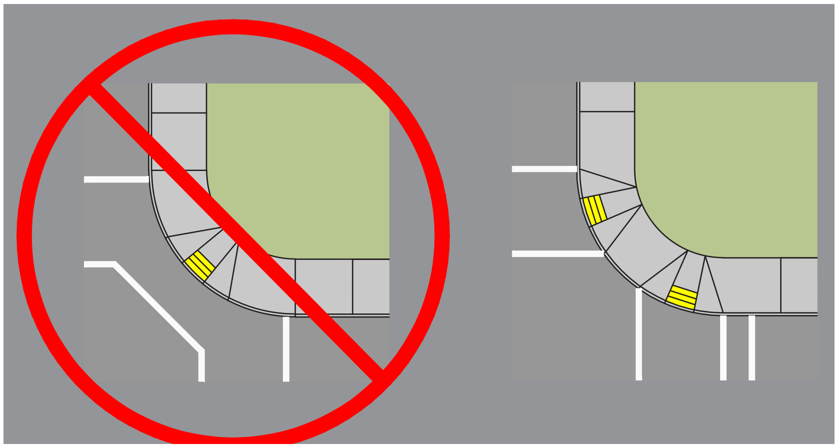

Figure 5.8
Diagonal curb ramps (left) should be avoided at intersections. Directional curb ramps (right) are preferred

Image 5.2
A new curb ramp in downtown Tucson

Designing for Bicycles at Intersections

OVERVIEW

In order to build a complete and safe bicycle network, it is critical that the needs of bicyclists are considered in the design and operation of intersections. In general, intersection design should observe the following principles for bicyclists:

- Provide a clear, direct, and continuous bicycle route through intersections,
- Reduce and manage conflicts with turning vehicles,
- Reduce vehicle turning speed,
- Consider bicycle needs in signal timing and design,
- Provide access to off-street destinations, and
- Raise visibility and awareness of the presence of bicyclists.

APPLICATION AND USE

- Bicyclist needs should be considered at signalized and unsignalized intersections, as well as where bicycle lanes cross in front of driveways.

DESIGN AND OPERATION

- In general, where there is an exclusive right-turn lane, a standard bicycle lane should be located on the left side of the turn lane. At intersections with a high number of conflicts between bicyclists and merging vehicles, or where there are other risk factors, a green surface treatment can be applied to the pavement where motor vehicles merge across the bicycle lane into the right-turn bay. Green colored pavement should be applied in a dashed pattern and made of durable, skid-resistant, retro-reflective materials.
    - o The bicycle lane can be located to the right of the right-turn lane if 1) a bicycle signal is provided with a dedicated phase or 2) the intersection is designed as a protected bicycle intersection, as described in NACTO's Don't Give Up at the Intersection guide.
- Green colored pavement can also be used where protected bicycle lanes cross busy driveways or intersect with local streets to enhance the conspicuity of the bicycle lane.
- **Protected intersections should be considered anywhere Bicycle Priority Streets or raised or protected bicycle lane intersect a cross street at a signalized intersection.**
- Protected intersections allow bicyclists to proceed into a curb-protected queue area ahead of motor vehicles to improve the visibility of bicyclists and reduce crossing distances. Protected intersections also facilitate two-stage left turns at intersections. A similar treatment, called dedicated intersection, can be used where full protected intersections are not feasible.

• At signalized intersections without a dedicated right-turn lane, a green bike box may be installed to allow bicyclists to move ahead of queued motor vehicle traffic at the intersection. This can prevent right-hook conflicts at the start of the green phase and allow traffic to clear the intersection more quickly.

o A bike box is a designated area at the head of a traffic lane at a signalized intersection that provides bicyclists with a safe and visible way to get ahead of queuing traffic during the red signal phase. Bike boxes are not recommended for left turns.

• A green two-stage turn queue box can be installed at multilane signalized intersections to facilitate more comfortable left-turns for bicyclists. The two-stage queue box is a green bicycle box with a left-turn arrow, typically located between the front of the crosswalk and the bicycle through lane. The left-turn queue box allows a bicyclist to safely make a left-turn from the right-side bicycle lane, though it does increase bicycle delay (having to wait for two green phases) and the location of the bicycle box (in front of the crosswalk) can be uncomfortable for some bicyclists.

• A leading bike interval (LBI) can also be considered to reduce right-hook crashes.

• At lower-volume T-intesections with roughly equal turn volumes, the bicycle lane can be dropped at the intersection approach to allow bicyclists to position themselves in the appropriate turn lane. At higher-volume T-intersections, a right-turn bicycle lane can be placed to the right of the right-turn lane and the left-turn bicycle lane can be located to the right of the left-turn lane.

• More detailed bicycle facility design guidance for intersections can be found in the MUTCD, the NACTO Urban Street and Bicycle Design Guides, the NACTO Don't Give Up at the Intersection guidelines, the FHWA Separated Bicycle Lane Planning and Design Guide, and AASHTO Guide for the Development of Bicycle Facilities.

OTHER CONSIDERATIONS

• At detection-equipped traffic signals, signals should be able to detect the presence of bicyclists in order to provide a green phase. Where the signal is not equipped with bicycle detection and the bicycle lane is curb adjacent, a bicycle push button can be placed next to the bike lane to allow bicyclists to activate the signal without dismounting.

• On corridors with closely spaced signals and high bicycle volumes, bicycle travel speeds and operating characteristics should be considered in signal timing plans in order to provide signal progression that meets the needs of all users.

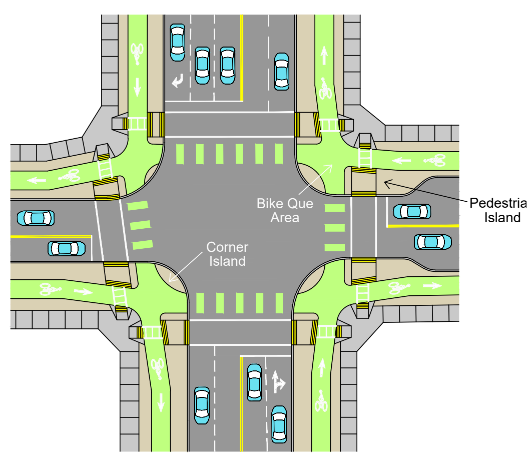

Figure 5.9
Protected
Intersection

Transit Preferential Treatments at Intersections

OVERVIEW

Prioritizing transit at signalized intersections makes transit more reliable and competitive with private automobiles. Transit can be prioritized both through signal operations and/or the provision of transit by-pass lanes.

Signals can prioritize transit in two primary ways: 1) through the coordination of signal timing on transit routes to provide signal progression based on transit vehicle travel characteristics or 2) through the use of transit signal priority (TSP). Providing signal progression that aligns with the operating characteristics of a city bus can be difficult given the boarding and alighting of passengers near signals. TSP, which enables transit vehicles to shorten or extend traffic signal phases (extra green time or less red time when buses are present) without changing the phase sequence, can better account for variation in operations, but does require that buses and signal controllers be outfitted with vehicle location and wireless technologies to allow communication between transit vehicles and traffic signals.

Transit by-pass lanes provide a lane for transit vehicles to go around queued traffic at the intersection. The transit lane can be exclusive for buses or it can be shared with right-turning vehicles. Under certain conditions, by-pass lanes can be combined with an exclusive transit signal phase to allow transit vehicles to easily re-enter travel lanes.

Transit signal priority and intersection transit lanes allow buses that don't operate in a fully dedicated transit lane to stay on schedule during peak hours when congestion causes traffic back-ups at major intersections.

APPLICATION AND USE

- Transit prioritization strategies can be considered at signalized intersections on the Frequent Transit Network or on high-capacity transit routes that operate with mixed traffic.

DESIGN AND OPERATION

- In order to allow the bus to access the transit lane, the transit lane must be longer than the average peak-hour traffic queue. The goal is to ensure that buses can clear the intersection within a single signal cycle at every signalized intersection during peak hours.
- Where the transit lane also serves as a right-turn lane, appropriate signage or pavement markings are required to show RIGHT LANE MUST TURN RIGHT, EXCEPT BUSES.

• Exclusive bus signal phasing can be considered under the following bus stop conditions:

o **With a near-side stop located in an exclusive transit by-pass lane,** with or without a transit merge lane on the far side of the intersection.

o **With a near-side stop in a shared transit lane/right-turn lane.** The stop should be located far enough back from the intersection to permit passenger loading behind queued right-turning vehicles. The exclusive signal phase can then clear right-turning vehicles and allow the transit vehicle to proceed through the intersection.

o **With a near-side bus by-pass lane and a far side in-lane stop.** This allows the bus to get ahead of traffic for passenger loading and then proceed without having to merge back into traffic.

• There is little benefit in pairing an exclusive signal phase with a far side stop in a bus pull-out or pull-through, since the bus will be delayed by through traffic as soon as through traffic receives the green phase.

• When an exclusive transit signal phase is provided, separate signals must be used to indicate when transit proceeds and when general traffic proceeds. Transit signals can be either a transit specific signal head or a louvered or visibility-limited green indication, making it visible only to the right-most lane. The Sun Link Streetcar currently uses an exclusive green phase at Broadway and 5th Ave. to allow it to crossover travel lanes to make a left turn.

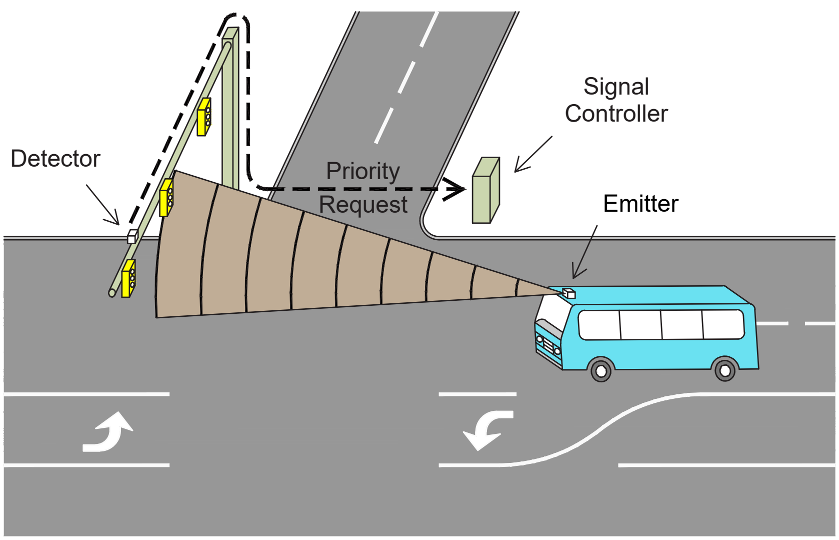

Figure 5.9
Signal Priority detection technology

OTHER CONSIDERATIONS

- Transit lanes shared with right-turn lanes provide less benefit where pedestrian volumes are heavy and where there are a high number of right turns. The pedestrians prevent vehicles from turning right thereby eliminating the bus benefits of the shared lane. This delay can be eliminated by providing an exclusive green phase for right-turning vehicles and transit when a bus is present.
- Transit signal priority can be active at all times, or can be restricted to times in which the bus is behind schedule.
- Transit lanes and transit signal priority are most beneficial when congestion at the intersection is high.

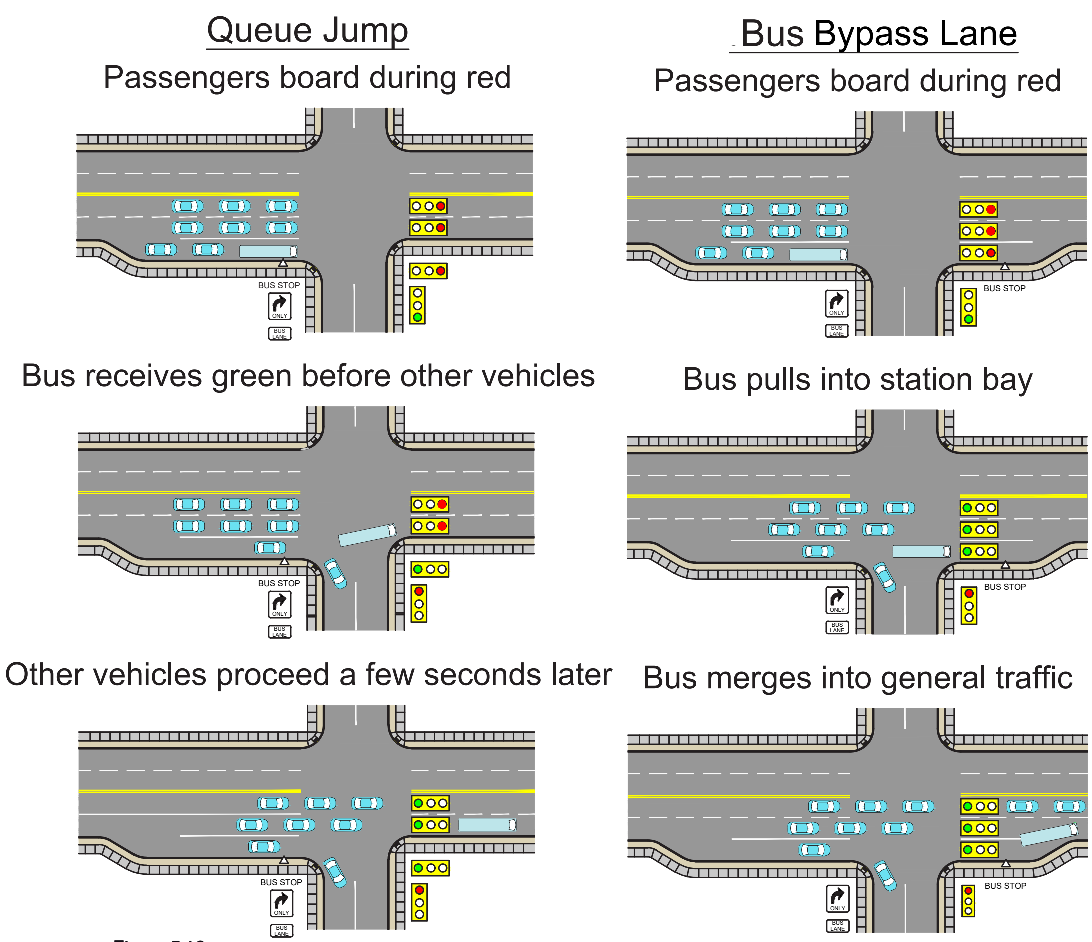

Figure 5.10
Queue Jump and Bus Bypass Lane

Roundabouts

OVERVIEW

Roundabouts are circular intersections designed to eliminate left turns by requiring traffic to exit to the right of the circle. They provide an alternative to other intersection traffic controls. Roundabouts are intended to allow traffic to merge into and flow through the intersection without having to stop. Roundabouts have been shown to reduce vehicular speeds, improve safety at intersections through eliminating left-turn crashes, help traffic flow more efficiently, and reduce operating costs when compared to signalized intersections.

At roundabouts, entering traffic yields to vehicles already circulating, leading to improved operational performance. Roundabouts have been shown to result in a 78 percent reduction in severe crashes from signalized intersections.[77] Roundabouts should not be confused with traffic circles, which are traffic calming devices used on neighborhood streets.

[77] FHWA. Proven Safety Countermeasures. https://safety.fhwa.dot.gov/provencountermeasures/roundabouts/

[78] NCHRP Report 672: Roundabouts: An Informational Guide. Second Edition. 2010

APPLICATION AND USE

- Roundabouts generally work best where approach volumes are balanced.
- A single-lane roundabout provides adequate capacity at intersections with total traffic volumes below 17,000 AADT and fewer than 20 percent of volumes making left turns. A dual-lane roundabout would be needed at intersections with AADTs up to 25,000 and where the left turn percentage is greater than 20 percent.[87] Above these volumes, additional analysis would be needed to determine the appropriateness of a roundabout. Maximum traffic volumes for single lane and multilane roundabouts are approximately 25,000 and 45,000 AADT respectively.
- Single-lane roundabouts are generally preferable to double-lane roundabouts because they are easier for pedestrians to cross.
- **Multilane roundabouts should not be installed in areas with high levels of pedestrian and bicycle activity.** Multilane roundabouts pose a safety concern of multiple threat crashes for pedestrians, especially those with visual impairments, and for bicyclists. Multilane roundabouts should also be avoided at intersections with more than four legs.
- Roundabouts work well in new residential subdivisions, commercial centers, and as gateway treatments. They can be used in urban, suburban, and rural contexts.

DESIGN AND OPERATION

- Roundabouts should provide a pedestrian island and crosswalk at least 20 feet prior to the entrance. Channelization islands at the approaches are recommended to slow traffic and to provide a pedestrian refuge. preferred travel lane widths in a given context, refer to Table 5 of this document.
- Bicyclists should be given the option of proceeding through the roundabout as either a vehicle or a pedestrian. Bicycle lanes should not be provided in roundabouts. While proceeding as a vehicle, bicyclists should ride in the vehicle lane. To accommodate bicyclists as pedestrians, provide a bicycle path adjacent to the sidewalk and wider crosswalks to allow a pedestrian and bicyclists to cross the street at the same time.
- Yield lines should be provided at the entry to the roundabout.

OTHER CONSIDERATIONS

- New multilane roundabouts should include accessible pedestrian signals at all crosswalks, in accordance with policy guidance provided in the PROWAG. Installation of pedestrian signals does reduce the cost effectiveness of roundabouts.

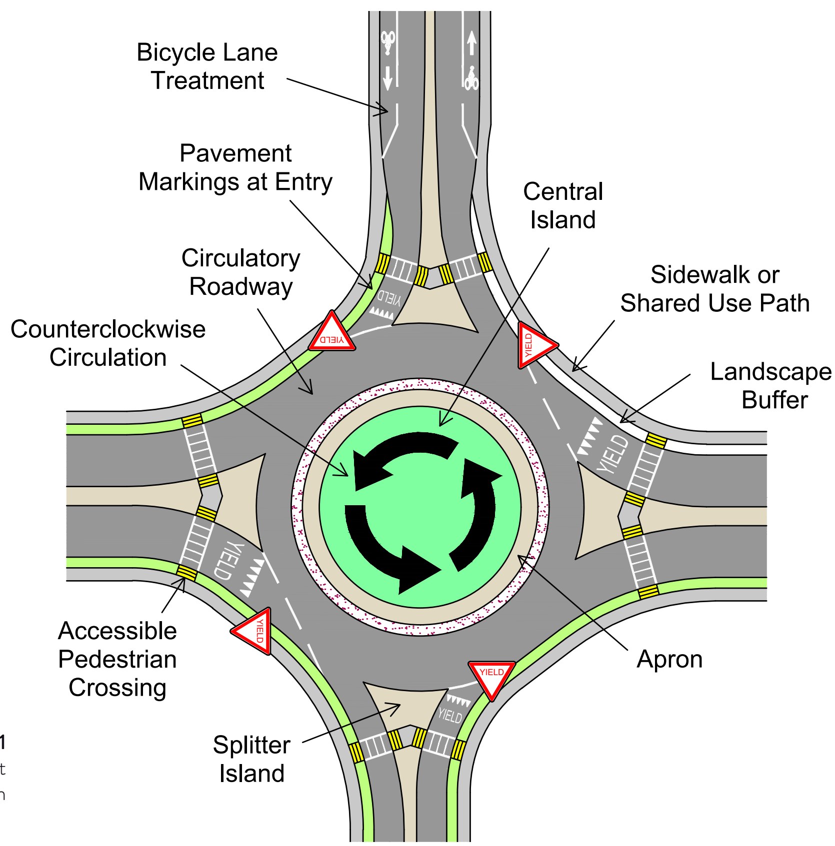

Figure 5.11
Roundabout Diagram

Crosswalks

OVERVIEW

Marked crosswalks are used to indicate the optimal, or preferred, locations for pedestrians to cross. They help designate right-of-way at midblock crossings and encourage motorists to yield to pedestrians, since oftentimes, driver yielding rates at unmarked legal crosswalks can be low. When not located at an intersection, a marked crosswalk also establishes a legal mid-block crossing location.

Crosswalk markings should not be used indiscriminately. On high-volume, multilane roadways, marking a crosswalk without installing additional pedestrian countermeasures has the potential to increase the risk of pedestrian crashes.

APPLICATION AND USE

- Crosswalks should be marked at all four legs of signalized intersections, unless specific intersection conditions make it impossible or unsafe to permit pedestrian crossings on one or more intersection legs.
- Crosswalks should be marked near schools at appropriate locations to establish school crossings.
- Marked crosswalks can also be considered in the following locations based on engineering judgment:
  - o at four-way stop-controlled intersections in walkable commercial districts and other high pedestrian volume locations where marking a crosswalk may improve driver awareness of likely pedestrian activity;
  - o at the uncontrolled leg of a 2-way stop-controlled intersection, such as where a neighborhood street intersects with a major street;
  - o at mid-block locations near pedestrian generators such as transit stops, shopping centers, social service providers, libraries, cultural sites, and others;
  - o at "T" intersections to emphasize a legal crossing location; and
  - o where shared-use paths cross major or minor roadways.
- Tucson's crosswalk installation warrants must be met before a marked crosswalk can be installed. Considerations for marking a crosswalk can include traffic volumes, travel speed, crossing distances, crash history, distance from other marked crosswalks or traffic signals, crossing demand, sight distance, street lighting, and drainage.

• **Generally, marked crosswalks alone are insufficient where traffic volumes exceed 12,000 AADT or posted speeds are 40 mph or higher.**.[65] Installing a marked crosswalk under these conditions without additional countermeasures, even at a legal crossing location, can increase pedestrian crash risk. Crosswalks should be paired with appropriate, complementary safety countermeasures at high-speed and high-volume locations.

  o Where crosswalks are currently marked on high-speed, high-volume roadways, appropriate supplemental countermeasures should be installed as funding allows. If appropriate countermeasures cannot be installed when the roadway is resurfaced, the crosswalk should be removed. These crossings should be prioritized for appropriate countermeasures as funding allows.

• Marked crosswalks are generally not necessary at locations where the AADT is below 1,500, unless it is otherwise determined to be needed based on engineering judgment.

• Marked crosswalks should be located at least 20 feet from existing driveways and on-street parking.

DESIGN AND OPERATION

• The City of Tucson uses two primary crosswalk styles:

  o The transverse marking style, consisting of two parallel 12-inch lines usually spaced 10-feet apart, and

  o The high-visibility ladder style which consists of 2-foot wide lines oriented parallel to the vehicle direction of travel and enclosed by two transverse 12-inch lines (giving the appearance of a ladder.) The parallel lines should be spaced to avoid the wheel path for longevity. White diagonal lines striped at a 45-degree angle may be used instead of perpendicular lines.

• The transverse crosswalk marking is typically used at signalized intersections.

• High-visibility markings should be used under these conditions:

  o to establish uncontrolled mid-block crosswalks;

  o to emphasize a legal crossing at an uncontrolled leg of an unsignalized intersection in combination with appropriate countermeasures;

  o in combination with High Intensity Activated Crosswalks (HAWKs), BikeHAWKs, Two Groups Can Cross (TOUCANs), RRFBs, or pedestrian signals; and

  o at school crossings (yellow-colored crossings are used in these locations).

• High-visibility crosswalk markings should also be considered in the following circumstances:

o at stop or yield-controlled intersections with high pedestrian volumes and moderate to high vehicular traffic;

o at signalized intersections in high-pedestrian activity areas, such as downtown Tucson or in other walkable commercial districts;

o at other signalized intersections with significant pedestrian volumes, based on engineering judgment; and

o at the entrances to neighborhoods where neighborhood streets intersect with major streets.

• Crosswalks should provide 10 feet of space between the inside edges of the transverse markings. Crosswalks may be narrower in some circumstances, but a minimum width of 6 feet must be provided.[66] The crosswalk should extend the full width of the pavement edge.

• Crosswalk markings should be located so that the curb ramps are within the extension of the crosswalk markings.

• A 12 to 24-inch wide stop line should be marked at least 4 feet in front of crosswalks at signalized intersections.

o Stop lines can be set farther back from intersections as needed in order to provide more space for larger vehicles to turn at compact intersections.

• Pedestrian crossing warning signs and crossing signs can be used in conjunction with marked uncontrolled crosswalks (W11-2 MUTCD).

OTHER CONSIDERATIONS

• Textured crosswalks (such as textured asphalt) may be considered in more walkable districts to complement and enhance the character of the surroundings; however, high visibility crosswalks are preferable.

o Textured crosswalks should be marked with reflective lines to improve visibility since textured crosswalks are difficult to see at night or when wet

o Materials that cause excessive vibration for pedestrians in wheelchairs, such as brick or cobblestone, should generally be avoided unless vibration can be minimized.

The next sections of this chapter discuss the application of additional pedestrian safety countermeasures necessary to make sure marked crosswalks are safe for pedestrians. [67]

[65] The City of Tucson follows the guidance provided under the FHWA publication Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations (2005) when determining where to install marked crosswalks.

[66] FHWA. MUTCD. Section 3B.17

[67] For a full list and appropriate use of pedestrian safety countermeasures, refer to Table 1 in the FHWA's Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations. (2018)

Enhanced Crossings

Regular, safe crossing opportunities must be provided for bicyclists and pedestrians. Street crossings are often the most challenging, and important, element of pedestrian and bicycle design.

Multilane roadway crossings present major barriers to pedestrians and bicyclists, particularly where there can be a 1/2 mile or more between signalized intersections, a considerable distance to travel out of one's way on a short walking or biking trip. Where there are long distances between traffic controls, pedestrians and bicyclists will look to cross the road at uncontrolled locations, both at intersections or at mid-block locations.

Drivers are legally required to yield the right-of-way to pedestrians at crosswalks, whether or not it is marked. However, many motorists are unaware of this, or simply may not see approaching pedestrians on higher speed, multilane roadways. Additionally, drivers who do yield the right-of-way in the curb lane present another risk by blocking the view of drivers in inside lanes creating the potential for a multi-threat crash.[68]

In urban areas, where there is more pedestrian or bicycle activity, enhanced pedestrian crossings should be provided at frequent intervals. In suburban contexts, crossings can be less frequent but should still be located at regular intervals near generators of bicycle and pedestrian traffic.

What constitutes an enhanced pedestrian crossing varies by location. It depends on selecting an appropriate countermeasure based on traffic volumes, travel speeds, number of lanes, and the presence of a raised median or refuge island. [69]

Table 15 provides general guidance on the recommended spacing of enhanced crossing locations. Site-specific factors, such as proximity to schools, transit stops, shopping centers and convenience stores, and libraries, among others, such as crash histories, must be considered in determining where to prioritize and install enhanced crossing treatments based on engineering judgment.

[68] Multi-threat pedestrian crashes occur when the first vehicle stops or slows for the pedestrian, but a vehicle on the inside lane in the same direction does not yield and strikes the pedestrian as they proceed into the second lanePedestrian Safety at Uncontrolled Crossing Locations. (2018)

[69] Specific recommendations for safe crossing types can be found in NCHRP Report 562: Improving Pedestrian Safety at Unsignalized Crossings (2006) and FHWA's Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations. (2018)

Table 5.3 Guidance on the spacing of enhanced pedestrian crossings

CONTEXT	ENHANCED CROSSING FREQUENCY
Downtown / University / Neighborhood Commercial Street	Every block
Urban Connector / Thoroughfare	1/8 mile - 1/4 mile
Suburban Connector / Thoroughfare	1/4 mile - 1/2 mile

Where local streets cross major roadways, bicyclists can have difficulty crossing without the assistance of a traffic control device.

Enhanced bicycle crossings should be provided where Bicycle Boulevards or other high-use bicycle routes cross high-volume, multilane roadways (four or more lanes).

More information on specific enhanced crossing treatments is provided in the following sections.

Advanced Yield Here To (Stop Here For) Pedestrian and Yield (Stop) Line

OVERVIEW

An advanced yield or stop sign and line is a combination pavement marking and sign that is placed 20 to 50 feet in advance of the crosswalk to improve driver awareness of potential pedestrians and reduce the risk of a multi-threat crash.

Arizona law requires that vehicles yield to pedestrians in the crosswalk. Therefore, advanced warning signs and pavement markings use yield indications unless advanced signs/markings are used in combination with a HAWK beacon or pedestrian signal (where drivers are required to come to a full stop).

APPLICATION AND USE

- Advanced yield signs and lines can always be considered at any unsignalized multilane roadway where there is a risk of multi-threat pedestrian crashes.
- **Generally, on 3 or 4-lane roadways with AADTs over 9,000 and posted speeds over 30 mph, advanced yield signs are insufficient on their own as a safety enhancement at marked crosswalks and should be used in conjunction with other safety countermeasures.**
- Advanced yield signs and lines can be used in combination with RRFBs on multi-lane roadways.
- HAWKs and TOUCANs should always be installed in combination with an advanced stop line, placed approximately 50 feet in front of the crosswalk.

DESIGN AND OPERATION

- Advanced yield lines are marked in the "sharks teeth" pattern – a row of white isosceles triangles pointing towards approaching vehicles.
- Advanced stop lines are 12 to 24-inch wide solid white lines that extend across the approach lanes.
- YIELD HERE TO PEDESTRIANS signs should be used where yield lines are marked in advance of a crosswalk (R1-5 and R1-5a in the MUTCD). Yield signs may also be used on their own, without the yield pavement marking. Yield pavement markings must always be accompanied by the sign.

OTHER CONSIDERATIONS

- Parking should be restricted between the stop or yield line and the crosswalk to not obstruct visibility.

In-Street Pedestrian Crossing Signs

OVERVIEW

In-street pedestrian crossings signs are plastic signs placed in the roadway at unsignalized crosswalk locations. The purpose of the sign is to increase the visibility of the crosswalk and make motorists aware of their responsibilities to Yield to Pedestrians.

Image 5.3 In-Street Crossing Signs increase visibility of crosswalks

APPLICATION AND USE

- In-street signs can be used on 2 or 3-lane roadways with posted speeds up to 30 mph. In-street signs should not be used on roadways with 4+ lanes or any roadway with a posted speed above 30 mph.
- In-street signs should be placed at the crosswalk on a lane line between travel lanes, or on a refuge island, where present. Since in-street signs are occasionally struck by passing motorists, placement on the refuge island increases the lifespan of the sign.

DESIGN AND OPERATION

- In-street crossing signs can be permanently installed in the roadway or mounted on a portable base to allow them to be taken in and out of the street for special needs.
- The design of in-street pedestrian signs is described in Section 2B.12 of the MUTCD.

OTHER CONSIDERATIONS

- Given the potential for a high replacement rate, the City of Tucson requires that an outside entity "adopt a sign" to pay for the sign's replacement at the end of its useful life.
- In-street signs are primarily used in the downtown area and on the 4th Avenue commercial district. They may be considered outside of these areas on a case-by-case basis.

Rectangular Rapid-Flashing Beacon

OVERVIEW

The rectangular rapid-flashing beacon (RRFB), is a traffic control device designed to increase driver awareness of pedestrians and remind them of their obligation to yield to pedestrian crossing roadways at marked midblock crossings or uncontrolled intersections.

RRFBs are a lower-cost alternative to traffic signals and HAWK beacons that are shown to increase driver yielding behavior at crosswalks significantly when supplementing standard pedestrian crossing warning signs and markings.[70]

[70] FHWA. Proven Safety Countermeasures. https://safety.fhwa.dot.gov/intersection/conventional/unsignalized/tech_sum/fhwasa09009/

Image 5.4 RRFBs improve driver compliance at crossings. Credit: Toole Design Group

APPLICATION AND USE

- RRFBs can generally be considered in the following locations:
    - o 3-lane roadways without a raised median, AADTs below 15,000 and posted speeds up to 35 mph,
    - o 3-lane roadways with a raised median, AADTs over 15,000 and posted speeds limits up to 35 mph,
    - o 4-lane roadways with raised medians or pedestrian refuge islands, AADTs below 15,000 and posted speed limits up to 35 mph,
    - o 4-lane roadways with a raised median, AADTs above 15,000 and posted speed limits up to 30 mph
    - o RRFBs are not recommended on 4-lane roadways without a raised median or in locations where the speed limit is 40 mph or greater.
- Engineering judgment should be used in determining whether to install a HAWK beacon or RRFB in locations where both treatments could be considered.

[88] Arizona Department of Transportation. Evaluation of Pedestrian Hybrid Beacons on Arizona Highways. SPR-756. September 2019.

DESIGN AND OPERATION

- The beacons consist of rectangular-shaped amber light-emitting diodes (LEDs) installed below pedestrian warning signs. The beacons remain "dark" until a pedestrian desiring to cross the street pushes the call button to activate the flashing lights. The flashing lights are intended to attract the driver's attention and reinforce the driver's duty to yield to pedestrians in the marked crosswalk.

OTHER CONSIDERATIONS

- Solar power panels can be used to eliminate the need for a power source.

HAWK / Bike HAWK

OVERVIEW

The HAWK beacon, also called the Pedestrian Hybrid Beacon (PHB), are pushbutton activated beacons that facilitate crossings of busy streets at marked crosswalks by requiring that motorists come to a full stop.

The Bike HAWK is a variation on the traditional HAWK that has alterations to be more useful for bicyclists.

APPLICATION AND USE

- The HAWK beacon can be considered at uncontrolled crossing locations that meet the warrants provided in Chapter 4F of the MUTCD.
- HAWK beacons are the recommended countermeasure, at appropriate intervals, on 4+ lane roadways with posted speeds of 35 mph or greater and AADTs greater than 15,000.
- HAWK beacons can be considered at any other crossing location with posted speed limits of 40 mph or greater.
- HAWKs are typically located 600 feet from traffic signals or other beacons, but can be located closer than 600 feet from traffic signals in some instances based on engineering judgment. [88]
- BikeHAWKs (or TOUCANs) should be considered as part of the design toolbox where bicycle boulevards cross high-volume, multi-lane roadways.

DESIGN AND OPERATION

- The design of HAWK beacons is described in Chapter 4F of the MUTCD.
- The beacon head consists of two red lenses above a single yellow lens. The beacon remains off until a pedestrian activates the system by pressing a button. First, a FLASHING YELLOW light warns motorists that a pedestrian is present. The signal then changes to SOLID YELLOW, alerting drivers to prepare to stop. The signal then turns SOLID RED and shows the pedestrian a "WALK" symbol. The signal then begins FLASHING RED, and the pedestrian is shown a flashing "DON'T WALK" symbol with a countdown timer. During the FLASHING RED drivers are to make a full stop to ensure that the crosswalk is free of pedestrians, and then proceed.
- BikeHAWKs begin with the standard HAWK design, but also have features for the safety and convenience of cyclists, including:
    - o a short two-way protected bike lane as a lead-up to the crossing
    - o a designated bike crossing area (usually dashed green) adjacent to the crosswalk
    - o signs indicating that cyclists should use the pedestrian signal
    - o illuminated signs indicating when cyclists should wait and when they may proceed
    - o a pushbutton within easy reach by bicyclists.

OTHER CONSIDERATIONS

- On 6-lane roadways with a raised median, HAWKs can be designed to provide a 2-stage crossing for pedestrians.[89] This minimizes disruption to traffic flow on the major roadway.
    - o In these cases, the pedestrian activates the pushbutton on one side of the roadway and crosses to the median. The pedestrian then walks a short distance in the median (parallel with traffic) to a second pushbutton, which the pedestrian then actuates to complete the crossing.
- BikeHAWKs can also be timed to provide a two-stage bicycle crossing, but only where space is provided in the median to off-set the bicyclist's direction of travel. Where a two-stage crossing is not possible, the BikeHAWK should be timed to permit a single-stage pedestrian crossing.

[89] At two-stage crossings, PEdestrian LIght Control ActivatioN (PELICAN) can also be considered. A PELICAN is placed mid-block on major streets to provide a two-stage crossing for pedestrians. The PELICAN uses two, standard Red-Yellow-Green signals. The signals remain green for motorists until a pedestrian activates them using a push button. When a pedestrian presses the button, the signal turns YELLOW, then RED, alerting oncoming motorized traffic to stop. A "WALK" symbol prompts the pedestrian to proceed across half of the road to the median.

Image 5.5
A BikeHAWK near the University of Arizona

TOUCAN

OVERVIEW

TOUCANs, which stands for TwO groUps CAN cross, is another system designed to provide a safe crossing for two groups, pedestrians and bicyclists. Unlike HAWKs, TOUCANs also function as a volume control measure by restricting motor vehicle cut-through traffic, since at a TOUCAN signal, motorized traffic on the minor street must turn right at the intersection.

APPLICATION AND USE

- TOUCANs are placed along roadways that are prioritized for non-motorized uses, such as where Bicycle Boulevards intersect with multi-lane, high-volume roadways.

DESIGN AND OPERATION

- TOUCANs use a standard red-yellow-green signal head for motorists.
- A TOUCAN rests on green for the major road. A bicyclist or pedestrian activates the signal by pressing a push-button. Bicyclists respond to a bicycle signal and use a special lane (dashed green pavement) when crossing. Pedestrians get a standard WALK indication and have a separate, adjacent crosswalk. The system uses a standard signal for motorists.

For the complete list of when and where to consider specific pedestrian safety countermeasures, refer to Table 1 in FHWA's Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations (recreated in the next page).

Image 5.6
Pedestrians and cyclists use a TOUCAN on Euclid Ave in Tucson

Roadway Configuration	Posted Speed Limit and AADT								
	Vehicle AADT <9,000			Vehicle AADT 9,000–15,000			Vehicle AADT >15,000		
	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph
2 lanes (1 lane in each direction)	❶ 2 4 5 6	❶ 5 6 7 9	① 5 6 ❼ ❾	❶ 4 5 6	❶ 5 6 7 9	① 5 6 ❼ ❾	❶ 4 5 6 7 9	① 5 6 7 9	① 5 6 ❾
3 lanes with raised median (1 lane in each direction)	❶ 2 3 4 5	❶ ❸ 5 7 9	① ❸ 5 ❼ ❾	① 3 4 5 7 9	① ❸ 5 ❼ ❾	① ❸ 5 ❼ ❾	① ❸ 4 5 7 9	① ❸ 5 ❼ ❾	① ❸ 5 ❾
3 lanes w/o raised median (1 lane in each direction with a two-way left-turn lane)	❶ 2 3 4 5 6 7 9	❶ ❸ 5 6 7 9	① ❸ 5 6 ❾	① 3 4 5 6 7 9	① ❸ 5 6 ❼ ❾	① ❸ 5 6 ❾	① ❸ 4 5 6 7 9	① ❸ 5 6 ❾	① ❸ 5 6 ❾
4+ lanes with raised median (2 or more lanes in each direction)	❶ ❸ 5 7 8 9	❶ ❸ 5 7 8 9	① ❸ 5 8 ❾	① ❸ 5 7 8 9	① ❸ 5 ❼ 8 ❾	① ❸ 5 8 ❾	① ❸ 5 ❼ 8 ❾	① ❸ 5 8 ❾	① ❸ 5 8 ❾
4+ lanes w/o raised median (2 or more lanes in each direction)	❶ ❸ 5 6 7 8 9	① ❸ 5 ❻ 7 8 9	① ❸ 5 ❻ 8 ❾	① ❸ 5 ❻ 7 8 9	① ❸ 5 ❻ ❼ 8 ❾	① ❸ 5 ❻ 8 ❾	① ❸ 5 ❻ ❼ 8 ❾	① ❸ 5 ❻ 8 ❾	① ❸ 5 ❻ 8 ❾

Given the set of conditions in a cell,

- \# Signifies that the countermeasure is a candidate treatment at a marked uncontrolled crossing location.
- ● Signifies that the countermeasure should always be considered, but not mandated or required, based upon engineering judgment at a marked uncontrolled crossing location.
- ○ Signifies that crosswalk visibility enhancements should always occur in conjunction with other identified countermeasures.*

The absence of a number signifies that the countermeasure is generally not an appropriate treatment, but exceptions may be considered following engineering judgment.

1 High-visibility crosswalk markings, parking restrictions on crosswalk approach, adequate nighttime lighting levels, and crossing warning signs
2 Raised crosswalk
3 Advance Yield Here To (Stop Here For) Pedestrians sign and yield (stop) line
4 In-Street Pedestrian Crossing sign
5 Curb extension
6 Pedestrian refuge island
7 Rectangular Rapid-Flashing Beacon (RRFB)**
8 Road Diet
9 Pedestrian Hybrid Beacon (PHB)**

Source: FHWA. Pedestrian Safety Countermeasures. https://safety.fhwa.dot.gov/

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6

GREEN STREETS

GREEN STREETS

Overview

Complete streets should be green streets. Street improvements offer an opportunity to incorporate natural elements, such as street trees and other vegetation into the public right-of-way. Green elements should be considered an essential component of a complete streets approach given the myriad benefits they provide, particularly in the desert Southwest. Green elements and native landscaping play an important role in making streets inviting, comfortable, shaded, and sustainable. They are critical to building a sense of place that anchors the city in the Sonoran Desert and differentiates the community from other parts of the world. Vegetating the streets can cool the air and mitigate against the heat island effect, increase absorption of greenhouse gases, help manage stormwater, improve community aesthetics, and contribute to native wildlife systems.

This chapter is organized into two main sections. The first section addresses how Tucson manages stormwater on its street system. The second provides guidance on street trees and vegetation.

Principles of Streetscape Ecosystem Design

[Previous two-page spread]
Green infrastructure on the streets of Tucson. Source: "IMG_5479" by Joe Gilpin for NACTO under license CC BY-NC 2.0

Streetscape improvements are a standard element of most transportation projects in Tucson. When undertaking streetscape improvements, design teams should adhere to the following principles:

- **Coordinate streetscape elements in project design to maximize green street benefits.** All street improvements should continue to incorporate landscape enhancements and green infrastructure. Medians, roundabouts, planting/amenity strips, curb extensions, traffic circles and other street elements should be designed to support landscape elements. This should be a consideration early in project development. Areas with greatest risks of heat exposure or that would benefit greatest from the approach due to low shade canopy should be prioritized.

- **Create a context-appropriate sense of place.** Streetscape elements should be selected that reflect the context and character of the location. Native plants are a critical component of connecting the built environment to the natural surroundings. Plants should be low water use/drought tolerant to enhance resiliency and ease maintenance.

Streetwater Management

Drainage and streetwater management are key considerations in the design of transportation improvements. Tucson is faced with a number of unique challenges in managing water within the right-of-way.

Firstly, Tucson's climate is such that the city experiences periods of drought punctuated by bursts of intense rainfall, particularly during the summer monsoon season (June-September). Tucson receives an average of 12 inches of rain per year, which is more than many desert areas. Approximately eight inches fall in the summer, while the remaining four inches coming during the winter rains. Common stormwater risks identified within the City of Tucson are flooding, erosion, sediment transport, and flash flood events. [90]

Secondly, much of the city developed without a robust storm drain system, meaning that many of Tucson's streets are designed both for transportation and also to convey stormwater. During larger rain events, particularly during the monsoon, Tucson's streets can flood, becoming impassible for hours after the rain has stopped.

The City of Tucson requires the following design criteria for all newly constructed or substantially improved roadways:

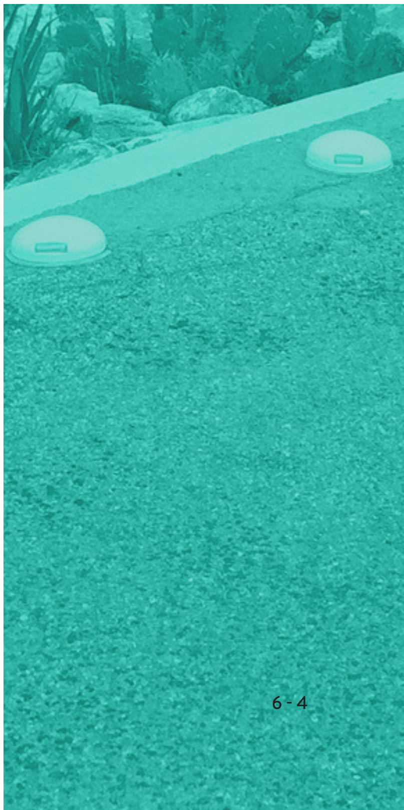
- Runoff from a ten-year storm must be contained within the curbs of the street.
- On multilane roadways, at least one travel lane in each direction shall be free from flooding during a 10-year flood. Otherwise storm drains, drainage channels, or other acceptable infrastructure shall be provided to comply with all-weather access requirements. [91]

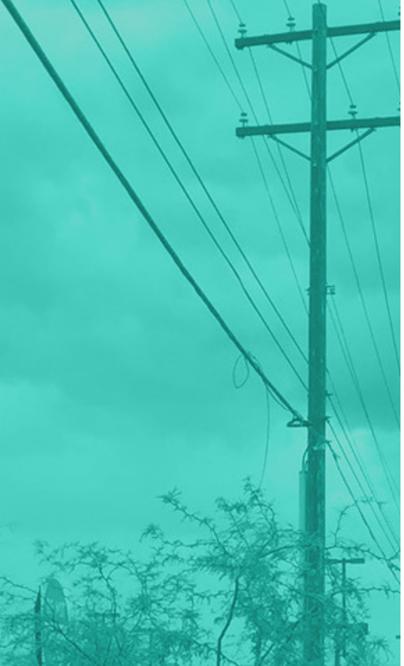
In order to meet the above design criteria, Tucson employs a mix of traditional drainage practices and water harvesting/ green infrastructure methods.

As Southern Arizona's weather becomes more extreme with the changing climate, continuing to manage streetwater in a sustainable manner will make the City more resilient in the face of uncertain climatological challenges.

[90] City of Tucson. Floodplain Management Plan. TSMS Phase V. August 2016.

[91] City of Tucson. Standard Manual for Drainage Design and Floodplain Management in Tucson, Arizona. Section 12.2. Revised July, 1998





Green Infrastructure

Tucson has long been a leader among desert communities at incorporating green infrastructure into transportation projects. In 2013, the Tucson Transportation Department established a Green Streets Active Practice Guideline (APG).[92] The guidelines require the incorporation of green infrastructure features into Tucson roadways wherever possible. The guidelines apply to new construction and street reconstruction of publicly funded roadways or drainage projects.

Tucson's Green Streets APG includes the following performance goals:

- Landscape planting criteria should be as follows:
  - o The bottom of basins are planted with at least 25% groundcover
  - o Mature tree canopy covers at least 25% of tree canopy area
  - o Within 5 years, vegetation survives on harvested water
  - o Trees are located to provide shade on sidewalks
  - o All basin areas should be ripped to a minimum depth of 12" prior to planting

The key concept of the green street is to retain, detain, infiltrate, and/or filter runoff from the street and sidewalk in landscaped areas behind existing or proposed curbs (either in the median or outside of the street). This approach treats stormwater as a resource, encouraging the capture and use of the water as near to the source as possible.

Green infrastructure serves multiple purposes beyond just helping to move water off the street. When combined with traffic calming (see chapter 4) it can slow traffic, it can capture stormwater runoff and remove pollutants from the water, it cools and beautifies the street, and provides habitat.

Vegetation can reduce ground-level ozone by reducing air temperatures, reducing energy emissions associated with air conditioning, and removing air pollutants. Green infrastructure features can reduce particulate air pollution (dust, chemicals, and metals suspended in the air we breathe) by absorbing and filtering particulate matter.

Image 6.1 Newly-planted green infrastructure in Sugar Hill Credit: Watershed Management Group

[92] City of Tucson Department of Transportation and Mobility Engineering Division. Green Streets Active Practice Guidelines. https://www.tucsonaz.gov/files/transportation/Green_Streets_APG_Signed_by_Director.pdf

Drainage Conveyance Structures

The street flow can be conveyed to the storm drain, the water harvesting feature, or the drainage way via the following structures:

Curb inlets – a curb inlet is a general term for an opening in the curb face that allows water to be conveyed off the street into a drainage or water harvesting structure.

Image 6.2
A curb inlet conveys water off the street

Curb cuts – a curb cut is created by sawing an 18”–24” opening in the curb face, typically with 45-degree sloped sides.

Image 6.3
A curb cut with public art in Rincon Heights
Credit: Watershed Management Group

Curb cores – Curb cores are 3” – 4” diameter openings made at street level in the face of the curb. Cores can become blocked by debris given their smaller size and so they should be used advisedly.

Image 6.4
A curb core with flowing water
Credit: Watershed Management Group

Sidewalk scuppers – A scupper is a covered opening in a curb that allows water to cross under the sidewalk area to a basin or storm drain while maintaining level pedestrian access on the sidewalk.

Image 6.5
A sidewalk scupper in a curb bulbout
Credit: Watershed Management Group

Grate inlets – A grate inlet is a curb inlet with a metal grate covering. The covering is used to catch debris to prevent it from clogging drain pipes.

Green Infrastructure Design

OVERVIEW

Green infrastructure practices can be used both on the side of the street, behind the curb, or in the street located within traffic calming features, like chicanes, traffic circles, and medians.

Streetside – Streetside green infrastructure and water harvesting are most appropriate on crowned streets, where water is conveyed along the curb. Most streetside practices involve the installation of a drainage conveyance structure to move water off to collect and infiltrate in a basin or swale.

Basins and swales are areas located behind the curb that are excavated to be lower than the level of the street. Basins capture and infiltrate the water on-site, while swales are designed with a longer linear shape and gently sloping sides that can be used to both capture stormwater or transport it downhill for detention or drainage.

Image 6.6
Green infrastructure basin behind curb
Credit: Watershed Management Group

Image 6.7
A green, pervious alley being constructed in Sugar Hill
Credit: Watershed Management Group

In-Street – In-street green infrastructure involves adapting streetside practices to function within in-street traffic calming features, such as chicanes, curb extensions, and traffic circles. In-street installations can be more complex than streetside, requiring greater coordination among partners and often coming at a greater cost. The advantage of in-street practices is that they have the additional benefits of narrowing and beautifying streets and slowing traffic.

Image 6.8
Green infrastructure in a chicane

APPLICATION AND USE

- Green infrastructure practices should be incorporated into Tucson roadways wherever possible.
- Green infrastructure can be used on all street types to complement and support other drainage practices.
- Green infrastructure installations must maintain required setbacks from underground and above ground utilities (table 17). Water harvesting features should not be installed directly above water or wastewater lines.
- Streetside basins and swales are typically located between the curb and the sidewalk. Green infrastructure features should not reduce the width of the sidewalk below the minimum dimension.
- Where a retention basin is located behind the sidewalk, a sidewalk scupper can be used to convey the water to the appropriate location without impacting the pedestrians.

DESIGN AND OPERATION

- Green infrastructure features must be designed so as to cause no adverse impacts to infrastructure or nearby properties.
- Curb inlets must be regularly maintained and kept clear of debris.
- Trees and other plants must be trimmed at periodic intervals to ensure that basins and swales are not becoming overgrown and obstructing sightlines, travel lanes, bicycle lanes, or the sidewalk zone. Proper developmental pruning around the second year can help shape the tree to create less obstructions and maintenance later.

• Sediment must be removed to ensure optimum functionality. Placement of sediment traps at the inlet allows ease of maintenance.

• Green infrastructure features must be designed to avoid extended ponding of water (which may result in mosquitos and associated diseases). The maximum drain-down time should be 24 hours or less.

• A healthy understory of desired plants will aid infiltration and alleviate ponding risks. Over trimming of trees may create additional weed growth.

Image 6.9
Plantings in a curb bumpout
Credit: Watershed Management Group

OTHER CONSIDERATIONS

• Green infrastructure sites typically can help reduce flood peaks downstream. Site placement and contours must be carefully selected so as to not increase the flood risk of nearby properties.

• Planning for green infrastructure improvements should begin early in the design process.

For more information about Green Infrastructure practices in the Tucson region, refer to the following resources:

• *Green Streets Active Practice Guidelines.* City of Tucson. 2013.

• *Sonoran Desert Green Infrastructure Resource Library: A Playbook for Transportation Projects in Pima County Communities.* American Rivers and Pima Association of Governments. 2020.

• *Low Impact Development and Green Infrastructure Guidance Manual.* Pima County and the City of Tucson. 2015.

• *Green Infrastructure for Desert Communities.* Watershed Management Group. 2016.

• *Water Harvesting Guidance Manual.* City of Tucson. 2006.

Street Trees and Vegetation

OVERVIEW

Trees and other vegetation have a variety of functions in the street landscape. They can provide shade, buffer pedestrians from passing vehicles, help to decrease the urban heat island effect, and provide aesthetic enhancements to otherwise unattractive streets. Trees also provide "vertical friction", prompting vehicles to self-regulate and drive with more awareness.

Trees, shrubs, bunch grasses, and other vegetation, play an important role in making streets comfortable, human-scaled, sustainable, and memorable. When planted and placed properly, they can provide shade and cooling, improve air quality, help define place, reduce energy consumption, and infiltrate and help clean stormwater.

Healthy street landscape systems can provide environmental, social, and psychological benefits to the community. People are naturally attracted to places that have well-maintained landscapes. Healthy street landscapes improve city life and are good for business. A tree-lined street in Tucson can increase the pedestrian street experience and usability year-round. By providing a connection with nature, plants can help reduce stress and restore a sense of calm and focus.

Maintaining healthy landscape plantings on Tucson's streets presents challenges. Sidewalk space is often at a premium and concrete and pavers can be restrictive to trees and other plantings. Soil compaction, lack of rooting space, poor soils, extreme temperature fluctuations near hardscape, physical damage from pedestrians, and even air pollution and litter all put stress on plants. These guidelines seek to balance the benefits of a healthy street landscape with the realities of limited space and the ongoing need for care and maintenance.

The information in this section is intended to enable street trees and other vegetation to thrive, and to utilize stormwater as a supplemental resource to support plant life and replenish groundwater.

Image 6.10
Street trees

APPLICATION AND USE

The following ideas guide the selection of trees and vegetation and healthy practices for the Complete Street design.

Space for Trees and Vegetation – The Complete Street design often creates areas that can be opportunities for landscaping.

- Beyond the dedicated Planting /Amenity Zone, other street elements including; medians, chicanes, traffic circles, channelization islands, and curb extensions provide possible space to plant trees and other vegetation.

Right Tree / Right Place – Placement of trees and other vegetation requires careful consideration of many factors to ensure that the right tree is planted in the right place to avoid future conflicts, infrastructure damage, and increased maintenance costs.

- Knowledge of the mature height and width of trees and other vegetation is perhaps the most important factor. When designing the street landscape, knowing these dimensions assures that the tree and or other vegetation will not interfere with above-ground elements such as overhead utilities, pedestrian ways, travel lanes, bike lanes, parking spaces, sight visibility requirements, pedestrian and street lighting and signage, and access to site furnishings.
- Trees and other vegetation should always be shown at mature size on any landscape plan to ensure they will fit in the proposed location.
- Information on the growth pattern of trees roots systems is also an important consideration. Typically roots of trees used in the Tucson region do not grow deeper than three (3) feet in depth, though some species can be more aggressive than others. Also, larger structural roots of most trees do not extend beyond the drip edge of the canopy; this is an imaginary line on the ground at the furthest edge of a tree's canopy.
- A space of at least 4 feet wide by 8 feet long is required for planting a tree in the ROW.
- Knowing the location and depth of underground utilities is imperative when placing trees on a street landscape plan so that the tree root systems do not interfere or damage above-ground and underground infrastructure.
- An understanding of a plant's tolerance of sunlight and water requirements also ensures proper placement and health of the plant.

- Trees for use in the ROW can be selected from the latest version of the Arizona Department of Water Resources (ADWR) Tucson Active Management Area Low Water Use / Drought Tolerant Plant List.[93] Selections will require approval from Tucson Transportation Department's Landscape Architect.
- A selection from The ADWR list that is frequently used within the City is attached in the Appendix.

[93] Arizona Department of Water Resources. Tucson Active Management Area Low Water Use / Drought Tolerant Plant List. http://infoshare.azwater.gov/docushare/dsweb/Get/Document-10085/TAMA_LWUPL%20_2015%20for%20Web%20(Final).pdf

Large-Stature Trees

Used for: Larger scale streets (Especially Urban Thoroughfare and Suburban Thoroughfare,) and plazas with no overhead utilities.
Sample species: Ghostgum, Arizona Ash, and Chinese Elm.

Medium-Stature Trees

Used for: Smaller scale streets (Especially Urban Connector, Suburban Connector, Downtown/University District, and Neighborhood Streets. Can be used under high utility lines (45' and up)
Sample species: Palo Brea, Red Push Pistache, and Netleaf Hackberry.

Short-Stature and Ornamental Trees

U Used for: Any street landscape with limited planting area, planters, plazas, and areas with lower overhead utilities.
Sample species: Foothills Palo verde, Mulga, and Screwbean Mesquite.

Create Ideal Conditions for Health and Growth – The ROW can be a harsh environment for vegetation to thrive in. Some best practices can help to improve plant health and longevity.

- Constrained space for root growth is the greatest cause of poor health in urban trees. Landscape buffer areas are a minimum of 4 feet wide with no maximum width designated. Ideal conditions would be that the root system of the trees is open to air and water for the full area of the mature tree canopy. This however is not always realistic within the constraints of the ROW widths.
- The soil in designated landscape areas should remain uncompacted to a minimum 3-foot depth. Where landscape areas are 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. This can be achieved using structural soils or structural cells.

Use Healthy Nursery Stock and Provide Proper Maintenance – Start with healthy trees and vegetation and maintain them properly.

- When installing plant material ensure that selections meet the criteria set forth in the "The American Standard for Nursery Stock" (ANSI Z60.1).
- Generally, trees should have a complete single leader, should not be root bound, and have good form.
- Tree species that are naturally multi-trunked can be used in areas where natural growth will not be impeded and the tree will not impact its surroundings or visibility.
- A watering schedule for landscape establishment and beyond should be based on the time of year of planting, and requirements of the mature tree.
- Pruning should only be done when necessary and should follow ISA Pruning Standards (ANSI A300) to ensure years of healthy growth.
- Do not prune ROW trees for the first year of growth unless approved by the Tucson Transportation Department Landscape Architect.

Minimize Exposure to Concentrated Levels of Pollutants – The City of Tucson has been at the forefront of incorporating green infrastructure into its Development Code as well as new road construction.

- In line with Tucson's commitment to integrating green infrastructure in street projects, trees and other vegetation should be integrated into stormwater management practices when possible.

• Green infrastructure should incorporate elements that filter pollutants from “first flush” water. This will prevent toxic buildup of street pollutants in planting areas and extend the life of the vegetation. Since roads are designed to be the drainage system, oil and grease leaked on roads get picked up by stormwater and flow into watercourses. This pollutes the environment in desert watercourses which the majority of wildlife depend on for their survival and which has greater connectivity to our aquifer and water supply. It only takes 4 quarts, or one oil change, of used motor oil to foul 1 million gallons of water. GI filters and breaks down pollutants, like pathogens and hydrocarbons, and reduces excess discharge to water courses.

• Use Right Tree–Right Place principles when selecting planting location.

DESIGN AND OPERATION

• Always call in an Arizona 811 before any digging is started to plant in the ROW.

• Obtain a Right of Way permit. [94]

• Follow utility setback requirements (Table 17). [95]

• Check for proper drainage before planting. Most desert-adapted trees and shrubs can drown if planted in areas that retains too much water. Dig the planting hole, fill it with water, and check back in 24 hours to see if the water has percolated. If it has, you can plant. If not, you may need to move your hole or dig deeper to where the soils do percolate and then backfill to root ball depth.

• Dig the hole no deeper than the root ball (not the top of the container) and 2-3 times as wide. Foot-stamp the bottom of the hole to minimize settling. The crown must not settle below the soil line.

• Scarify the hole edges so roots don’t circle within the planting hole.

• When planting trees in a water harvesting basin ensure that the tree root crown is a minimum of 4” above the bottom of the basin or planted on a shelf in the basin. Trees also benefit from harvested water when planted directly adjacent to a basin or drainage way.

• Shrubs should not be planted directly in the flow line of a drainage or basin. Ensure that this plant selected can tolerate inundation for 24 hours if planting in basin bottom.

• If an irrigation system is used in the ROW that is not City maintained, no mainlines or equipment under constant pressure is allowed in the ROW without prior review by the DTM's Landscape Architect

• Organic matter should be used as mulch when possible and approved

[94] Right of Way Permit Application, https://www.tucsonaz.gov/files/transportation/files/ROW_Application_2018i.pdf

[95] https://www.tucsonaz.gov/files/transportation/files/setbacks.pdf

Table 17.
Utility Setback Requirements

REQUIRED PLANT SETBACKS FROM UNDERGROUND UTILITIES			
UNDERGROUND UTILITY	LARGE TREE OVER 20 FEET	PLANTS UNDER 20 FEET TALL	PLANTS UNDER 3 FEET
SW Gas	8 feet	5 feet	3 feet
Pima C. Sewer	16 feet; 10 feet if sewer line is deeper than 8 feet	10 feet	5 feet
Electric Underground	3 feet	3 feet	3 feet
Tucson Water	10 feet	5 feet	3 feet
Cable / Fiber Optic	5 feet	5 feet	3 feet
*No planting in El Paso Gas easements.			

OTHER CONSIDERATIONS

• The minimum 4-foot wide by 8-foot long planting area can be achieved using tree grates or other ADA compliant permeable products in the sidewalk, as long as the minimum pedestrian width is maintained.

• The use of green infrastructure to harvest stormwater to replace or supplement plant water needs is encouraged wherever possible. Use of native trees will minimize supplemental water needs as they are adapted to the our bimodal precipitation seasons and in particular, our dry and hot springs.

• Products such as Drywater can extend the period between waterings.

• Till the dirt and ensure that heavy equipment has not created compacted soils in the tree root area.

• Root growth space can be enlarged by incorporating structural soils or cell systems under sidewalks in the pedestrian realm. These systems also help minimize the negative impact of tree roots on hardscape features.

• All street landscape elements in the public right-of-way must be approved by the City of Tucson Transportation Department Landscape Architect. Enhanced and pilot treatments will require special maintenance agreements.

• Trees and plants must not obstruct sight visibility triangles.

Structural Soils

OVERVIEW

Structural Soil is a medium that can be compacted to pavement design and installation requirements while permitting root growth. It is a mixture of gap-graded gravels (mostly made of crushed stone) and soil (mineral content and organic content). It provides an integrated, root penetrable, high strength pavement system that shifts design away from individual tree pits.

APPLICATION AND USE

- The use of Structural Soil in the ROW is used to increase the area that tree roots have to grow where open planting areas are limited.
- Structural Soil is a narrowly graded rock (typically 1-1/2"-2" with no fines) used to support pavement without compression of the voids thus protecting roots growing within the voids. The voids are partially filled with soil to provide nutrients and to hold moisture for root growth.

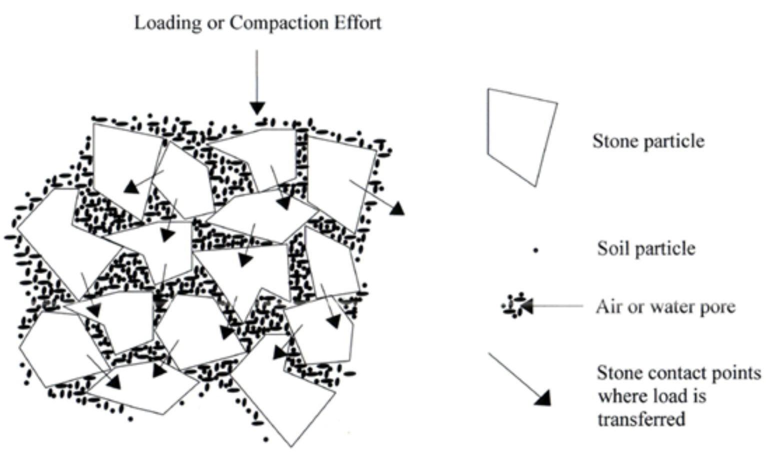


Image 6.11
A cross-section of structural soil

- **The minimum required width of a planting area for trees is 4'. This is often adjacent to a 5' sidewalk.** The use of Structural Soils under a sidewalk or asphalt pedestrian path can more than double the area roots have to grow; while minimizing hardscape damage from roots normally associated with small planting areas.
- The Structural Soils can be compacted to the required densities for sidewalk and asphalt path construction without compromising the spaces between the rock for root growth.

DESIGN AND OPERATION

- Follow approved Plans, Details and Specifications when constructing with Structural Soils.
- Do not begin the installation of structural soil materials until all walls, curbs, footings, and utility work in the area have been completed.
- Subsurface drains must be in place prior to installation.
- The typical depth of the Structural Soils is 36 inches.
- Installation should take place in 6-inch lifts, compacting to an appropriate density between each lift.

OTHER CONSIDERATIONS

- Structural soil is not typically stockpiled; it should be mixed and installed soon after delivery.
- If a stockpile is required, the soil needs to be protected from the elements so it does not become contaminated.
- Installation typically calls for two cubic feet of soil is needed for every square foot of crown projected.
- It is also recommended for irrigated trees to have low-volume drip irrigation.

Structural Cells

OVERVIEW

Soil cells are suspended pavement systems that create an uncompacted soil volume beneath pavements to provide suitable conditions for tree root growth and structural stability for pavements.

APPLICATION AND USE

The use of Structural Cells in the ROW increases the area that tree roots have to grow where open planting areas are limited.

- There are several structural cell systems on the market, and though not all exactly the same they all are constructed of plastic and reinforcing steel covered in plastic and achieve similar results, healthier, larger trees.
- In the ROW trees are often planted in cramped planting areas with poor subsoil, resulting in stunted growth, and roots that spread underneath the adjacent paved surface in search of air and water, causing pavement damage. Structural Cells offer load-bearing soil cells to create structurally adequate soil systems that are also conducive to root growth.

• These subsurface structures can be stacked and configured to various heights and shapes during construction, as required to achieve the desired depth. The load-bearing modules form a skeletal matrix that is filled with uncompacted soil to provide a healthier soil environment for the tree's roots.

• The weight of the paving and any surface loading is transferred downward through the structure to the compacted base at the bottom of the tree pit while the soil within the cell structure remains uncompacted to allow for healthy tree root establishment.

• Utilizing soil cells for tree planting can also provide a stormwater treatment function. Rainwater runoff can enter the system through pervious paving, drains, catch basins, and the opening around the tree trunk.

• Structural cell systems support paved surfaces of any kind and most can meet AASHTO H-20 loading requirements with proper engineered surfaces above. Irrigation and aeration systems, as well as local utility ducts, can be integrated into the soil cell layout.

DESIGN AND OPERATION

• Follow approved Plans, Details and Specifications when constructing with Structural Cells.

• The size of the cell pits is associated with the area for root growth.

• Subsurface drains must be in place prior to installation, per manufacturer's specifications.

• The typical depth of the Structural Cells is 36 inches. The bottom of the cell pit must be compacted to manufacture's recommended density.

• Different systems have varied construction requirements and directions.

• Soil mixture for the cells can vary for native and drought-tolerant trees; follow current City Standard Specifications for topsoil, prepared soil, and mulching.

Image 6.12
Structural cells to support street trees. Source: greenblue.com

7

IMPLEMENTATION

IMPLEMENTATION

Overview

As stated in the City of Tucson's Complete Streets vision, all transportation improvements are opportunities to foster a vibrant, healthy, equitable, interconnected, accessible, environmentally sustainable, and more livable city where everyone can move about safely, comfortably, and with dignity. Every time an improvement is made to the public right-of-way, there is an opportunity to execute on that vision by applying the guidance provided in this document. The ability to do so will be informed by the constraints and prospects of working within Tucson's established urban fabric, a commitment to the Complete Streets design principles, and meaningful community engagement.

This chapter provides:

- examples of how the Complete Streets approach can be implemented through different types of transportation improvements, and
- a general overview of community engagement strategies for transportation improvements.

Implementation Opportunities

Transportation projects vary in scope, complexity, funding source, and intent. They can range from major corridor widening or modernization projects down to roadway resurfacing projects, spot improvements, or quick-build projects. Regardless of project scale, Complete Streets design principles should be reflected in design decisions for all project types. The extent to which specific design elements can be incorporated into a given project will depend on resource availability.

Corridor-Scale Capital Improvements

The design guidance provided in this manual is most clearly applicable to major corridor improvement projects, that is, on projects that improve an entire roadway, including changing roadway geometry, realigning curblines, upgrading drainage infrastructure, installing traffic control devices, adding green infrastructure features and landscaping, and potentially acquiring additional right-of-way. The two major types of corridor-scale capital improvements typically seen in Tucson include corridor widening projects and corridor modernization projects.

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Ward 1 Block Party. Source: Monica Landgrave-Serrano, 2020.

CORRIDOR WIDENINGS

Corridor widenings are major roadway projects in which vehicular capacity is added in the form of additional travel lanes. Corridor widenings present an opportunity for incorporating Complete Streets design guidance, because within a given project budget, corridor widenings allow designers to re-allocate space across the entire right-of-way. Additional right-of-way is almost always required in widening projects, so spatial constraints are not as challenging as in other project types (widening projects should still seek, to the extent feasible, to minimize takings of private property, both in order to not overly disrupt the structure of the existing community and to reduce project costs).

With fewer spatial constraints, corridor widening projects can likely be built close to the preferred dimensions shown in Table 5 and incorporate recommended design elements, such as refuge islands/raised medians, protected or raised bicycle lanes, wider sidewalks, safe crossings, consolidated driveways, and other features.

However, although corridor widenings offer opportunities to incorporate many Complete Streets elements, overly-wide roads can also be a barrier in the city. **Road widenings should only be pursued in limited circumstances after all other options for improvements have been explored, with consideration of a variety of impacts beyond vehicle delay and congestion, such as safety and crossing times.**

An alternative capital improvement to a corridor widening project is a corridor modernization project.

CORRIDOR MODERNIZATION

Depending on project budget, corridor modernization projects are transportation improvements that upgrade infrastructure, re-align curblines, improve drainage, and re-allocate space in the right-of-way; basically, everything that is done in a corridor widening, but without adding additional travel lanes.

Because these projects require less right-of-way than corridor widening projects, they can often be done at a lower cost, but the trade-off is that spatial constraint will be much more a determinant of design options.

Where space is highly constrained in modernization projects, it is recommended that project teams apply the outside-in design approach described in Chapter 1 of this document and refer to the prioritization chart in Table 6 when determining how to use the right-of-way.

Other Complete Street Implementation Opportunities

Corridor-scale projects are always going to provide the greatest opportunity to reconfigure Tucson's streets, but since projects of that scale are relatively infrequent, other opportunities must be pursued to implement elements of this Guide. Roadway repaving, private development projects, retrofit and spot improvement projects, and Quick-Build projects all present opportunities to re-allocate space in the roadway or make improvements behind the curb.

ROADWAY REPAVING

Any repaving project that involves removing lane markings and restriping the roadway presents a chance to reallocate space between the curbs. Depending on the prior lane configuration, traffic volumes, pavement width, and vehicle mix, repaving projects may allow project teams to narrow travel lanes, install new bicycle lanes or enhance existing lanes by widening the ridable surface, adding lane buffering, or installing protective elements. On four or five-lane roadways, where traffic volumes are projected to remain below 20,000 AADT, the potential to perform a road redesign should be evaluated. Striping plans should be consistent with the guidance in this document.

PRIVATE DEVELOPMENT/PRIVATE IMPROVEMENT AGREEMENTS

Private developers often make improvements in the public right-of-way as part of their development agreements with the City. Private improvements to the public right-of-way may include installing or upgrading sidewalks, adding landscaping and other streetscape enhancements along the frontage of the development, and making other enhancements, such as improving bicycle connectivity, and addressing access challenges, to name a few. During the development process, the developer, the city of Tucson, and the community should work together to look for opportunities to improve the public realm. Privately developed streets, such as those constructed in new subdivisions, must comply with the Tucson's Unified Development Code (UDC).

RETROFIT OR SPOT IMPROVEMENT PROJECTS

Retrofit and spot improvement projects are smaller-scale, less-intensive improvements to the right-of-way that typically involve minimal moving of curblines or acquisitions of property. These types of projects can include installation of sidewalks and/or ADA-compliant curb ramps, location-specific safety enhancements, such as neighborhood traffic calming, and other improvements. Retrofit projects tend to be very constrained, but they do improve safety and accessibility, addressing trouble locations in the transportation system.

QUICK-BUILD PROJECTS

Quick-build project delivery is a practice that has emerged nationally over the preceding decade, and in Tucson over the past few years. In essence, the quick-build approach is one in which street space is realigned and reassigned using a combination of paint and low-cost physical objects, such as flexible bollards and planters.

Quick-build techniques can be used in many different types of projects, from reducing turn radii at challenging intersections and creating new neighborhood traffic circles, chicanes, or refuge islands, to installing protected bicycle lanes, and creating public plazas from reclaimed street space.

One of the primary benefits of the quick-build approach is that it allows public improvements to be built on much shorter timelines and at much lower levels of investment, and therefore risk. It permits greater experimentation in street configurations and allows for adjustment after installation, something that can only be done at great cost on more permanent improvements. Quick-build projects require a commitment of staff resources and time to implement well.

Quick-build projects provide a real-life demonstration of the types of changes that are possible in the street. This can help to allay concerns among stakeholders and permit the testing of concepts that may not have otherwise been accepted. Moreover, engaging community members in the design and installation of quick-build projects—for example in creating pavement art—has been shown to be an effective means of bringing communities together, building excitement and ownership for public improvements, and revitalizing public spaces.

Image 7.1
Neighborhood
Quick Build
Traffic Circle

In October 2018, Living Streets Alliance (LSA), in partnership with the Tucson Department of Transportation and Mobility and area businesses, led a team of volunteers to transform the intersection of 6th Ave. and 7th St., just north of downtown Tucson, using nothing more than planters, paint, and flexible bollards. This was Tucson's first major quick-build project. The project, known as the Corbett Porch, resulted in a more compact intersection and a more usable public space in an area with considerable bicycle and pedestrian activity.

Tucson Transportation and Mobility will continue pursuing quick-build project opportunities as another tool that can be used to implement complete streets across the entire city.

Image 7.2
Complete Streets Demo Project: Corbett Porch

Community Involvement

As the City of Tucson pursues reconfiguration of city streets there is a need to explore new ways of engaging people in the design process. One of the major efforts of implementing the Complete Streets Policy will involve developing a Complete Streets Community Engagement Plan. This plan will have a particular emphasis on engaging communities who have traditionally been underrepresented in city planning and decision-making processes. The plan shall include specific strategies for overcoming barriers to engagement associated with race/ethnicity, income, age, disability, English language proficiency, vehicle access, and other factors linked to historical disenfranchisement.

Public Meetings

Transportation projects should be guided by extensive, open, and well-advertised community processes. Public meetings should be held at each major step in the project development process, from planning to construction.

Public meetings provide an opportunity to:

- inform the public about the project's purpose and need,
- solicit public comments, and
- review comments and adjust project design to address concerns to the extent feasible within the constraints of safety and cost.

Public meetings provide an opportunity to collaboratively develop the transportation projects with the communities they are intended to serve.

Committees

Tucson Transportation and Mobility works through a public committee structure to inform project design.

CITIZENS ADVISORY COMMITTEE

For complex projects, a Citizens Advisory Committee (CAC) may be established. The CAC works with the project team to provide comments on project design. The CAC typically consists of those who are most directly affected by the project.

COMPLETE STREETS COORDINATING COUNCIL

The project team will meet with the City of Tucson's Complete Streets Coordinating Council (CSCC) at key milestones in project development to ensure that designs are consistent with the intent of the Complete Streets Policy. The CSCC will make formal recommendations to the Transportation Director.

OTHER CITY BOARDS, COMMITTEES, AND COMMISSIONS

The Tucson City Charter gives the Mayor and Council the authority to establish boards, committees, and commissions, collectively known as BCCs. The strength of the BCC system is its ability to bring expertise and information from the community to bear on the policies and operations of city government. BCCs that have a nexus with the design of transportation projects include the Pedestrian Advisory Committee, the Tucson-Pima County Bicycle Advisory Committee, the Park Tucson Commission, the Commission on Disability Issues, and the Transit Task Force.

Each of these BCCs will be engaged in project development to provide valuable guidance on design elements related to their relevant advisory and advocacy roles. The guidance provided by the BCCs should be shared with the CSCC prior to the CSCC making a formal recommendation on project designs.

Other Community Outreach Efforts

In addition to public meetings and committees, DTM will continue to engage with the public in multiple ways. This will enable DTM to connect with the greatest number of people, particularly those who have not traditionally participated in public processes. Strategies that may be explored include:

- Pop-Up Events / Street Ambassadors
- Community Workshops
- Online Engagement / Social Media Campaigns
- Press Releases and Mailers.

An emphasis in this outreach will be to reduce barriers to participation by meeting people where they already are.

Image 7.3
Activity at the Move Tucson Launch Event

POP-UP EVENTS / STREET AMBASSADORS

Pop-up engagement is a strategy for meeting people as they go about their daily lives. The idea is to set up opportunities for the public to participate in planning and design efforts at high-volume community locations, such as bus stations, supermarkets, libraries, parks, public events, and other places. This strategy has been effective at encountering people who wouldn't necessarily hear about or attend workshops or open houses, giving them an opportunity to weigh-in without having to commit significant resources.

Pop-up engagement and other outreach initiatives can be supported by a street ambassador program. Streets ambassadors work as intermediaries between the Department of Transportation and Mobility and members of the public. Ambassadors are people who are able to lead engagement efforts on weekends, evenings, mornings and are anchored within the communities where they are working. They are able to speak the language residents are comfortable with and are familiar with community dynamics. Ambassadors can also be used to lead targeted outreach to specific neighborhoods where barriers to participation are particularly high. Living Streets Alliance used the Pop-up engagement model to great success in the development of the City of Tucson's Complete Streets Policy.

COMMUNITY WORKSHOPS

Community workshops provide an opportunity for residents to be more actively engaged in plans or project design than traditional open houses.

Depending on the scope of the effort, workshops can be organized in different ways. One option would be to work through existing organizations, associations, or community groups to schedule and plan workshops that would be convenient for their members.

ONLINE ENGAGEMENT

Tucson Transportation and Mobility is committed to using an array of online tools as a means of supporting public input. Online tools can include surveys, project identification, scenario evaluation, and other formats.

For those who may not have ready access to this information, mobile input stations can be brought to residents by street ambassadors through pop-up events, or one-on-one with neighbors and friends. Online engagement platforms should always be available in both English and Spanish.

SOCIAL MEDIA

Tucson Transportation and Mobility will continue to use social media as a means of getting information to the community and notifying the public of opportunities for participation. The department should explore strategies for keeping its social media presence fresh and engaging for a variety of audiences.

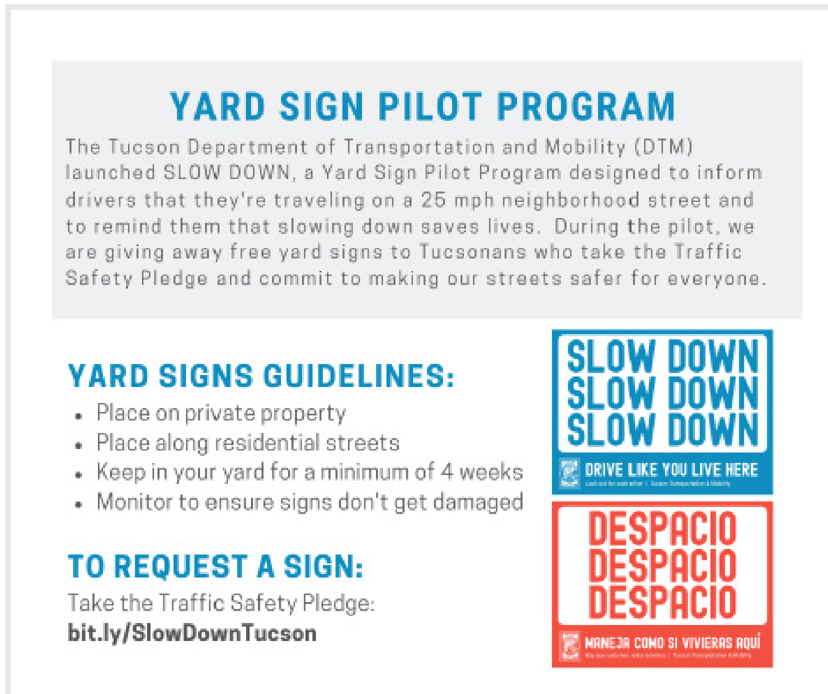

Image 7.4
Online Information of the Yard Sign Pilot

PRESS RELEASES AND MAILERS

While exploring new opportunities to reach members of the public, the department will also continue to use more traditional methods, such as direct mailers to those most affected by a given project and press releases.

Using a range of techniques ensures that the department is providing information through channels most likely to reach the widest possible cross-section of the Tucson community.

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WOLVERTON MOUNTAIN OVERL

APPENDICES

GLOSSARY

A

AASHTO

The American Association of State Highway and Transportation Officials. AASHTO publishes design guidelines for roadways that most cities, including Tucson, follow.

AADT or ADT

Annual average daily traffic. This is the most common way that cities measure the number of cars using a roadway, and is an important measure used when determining the level of traffic congestion. This measurement is the average number of cars using a roadway in a 24 hour period.

Accessibility

A measure of how easily destinations can be reached using the existing or proposed transportation infrastructure. The term is also used to refer to how well transportation infrastructure meets the needs of people with disabilities.

B

[Previous two-page spread]
Horse-drawn stagecoach in the Tucson Rodeo Parade. Source: "Stagecoach" by Flickr user Erin under license CC BY-NC-ND 2.0

Bicycle Lane

A section of roadway separated by pavement markings for exclusive use by bicyclists.

Bike Lane (buffered)

Bicycle lanes that are separated from the adjacent motor vehicle travel lane and/or parking lane by an 18 inch or greater buffer (typically 2-3') indicated by pavement markings.

Bike Lane (protected)

Bicycle lanes that are separated from adjacent motor vehicle travel lanes by physical objects, such as curbs, bollards, medians, planters, parked cars, or other items. Also called separated bicycle lanes or cycle tracks.

Bike Lane (raised)

Bicycle lanes that are vertically separated from adjacent motor vehicle travel lanes, either the level of the adjacent sidewalk or at an intermediate level between the roadway and the sidewalk.

Bollard
A short post used to divert traffic from an area or from parts of the roadway. Bollards can be fixed or flexible. Flexible bollards are also known as flex-posts or flexible delineators.

Built Environment
Our man-made surroundings, including buildings, parks, streets and supporting infrastructure.

Bus Bulb
A bus stop where the waiting area is extended out into to the street to allow the bus to board passengers without exiting the travel lane.

Bus Pullout
A bus stop where the bus pulls out of the flow of traffic to board passengers.

Bus Rapid Transit
A higher quality form of bus service, that includes many features commonly found on rail transit systems such as enhanced stations, dedicated lanes, and traffic signal priority. Explored in this document under the umbrella term “High Capacity Transit”.

C

Context-Sensitive Design
An approach to transportation projects that considers the existing conditions, history, plans, and populations of a place when designing new or improved facilities.

Cross-Section
A representation of the roadway shown from the level of the road, indicating the width and location of various elements of the roadway, such as travel lanes, sidewalks, bicycle lanes, etc.

Crosswalk
That part of a roadway at an intersection included within the prolongations or connections of the lateral lines of the sidewalks on opposite sides of the highway measured from the curbs or, in absence of curbs, from the edges of the traversable roadway.

E

Equity

Considering historical inequalities in transportation planning. This includes investing in underserved communities, involving people who have traditionally been excluded from planning processes, and prioritizing those who are most vulnerable to poor roadway design.

F

Federal Functional Classification System

The way in which roads are divided into classes based on their use. The Federal Highway Administration has three main classes of road: arterial, collector, and local.

Federal Highway Administration (FHWA)

The Federal Highway Administration (FHWA) is an agency within the U.S. Department of Transportation that supports State and local governments in the design, construction, and maintenance of the Nation's highway system (Federal Aid Highway Program) and various federally and tribal owned lands (Federal Lands Highway Program).

Frontage Zone

The area in the pedestrian realm located between the sidewalk and structures lining the public right of way.

G

General Plan

A document outlining the vision for how a city will grow. In Arizona, these plans are required to contain certain elements relating to transportation, land use, and the environment, and must be voted on every ten years.

Green Infrastructure

Systems used to manage storm water through plantings, bioswales, or other natural features without the use of storm sewers. Green infrastructure can often save money, reduce flooding, and help water native plants.

H

Highway Capacity Manual

A federal document used to calculate the capacity and levels of service provided by different types of roadways. This document focuses largely on automobile level of service at the expense of other roadway users.

I

ITE

The Institute of Transportation Engineers. This organization does research and sets standards for transportation planning in the United States and Canada.

L

Light Rail

A form of public transportation using trains that can run in either the street or their own right of way. Light rail is usually differentiated from streetcars (such as Tucson's SunLink) by having longer trains, larger stations, and exclusive lanes or tracks. Valley Metro is currently the only existing example of light rail in the Southwest.

Long Range Transportation Plan

A 20 year document that outlines a city or region's long term transportation goals. This plan influences what types of projects can be eligible for federal funding.

M

Major Streets and Routes Plan

A City of Tucson document that outlines roadway classifications, expected right of way needs, and guide land use decisions. This document impacts the types of changes that can be made to different roadways within the city, as well as how close to the roadway new buildings can be built.

Mixed-use Development

A type of development that blends residential, commercial, and other uses within a single building or block. This form of development is most commonly found in older neighborhoods and tends to lead to higher rates of walking, bicycling, and transit use.

Mode

The different ways in which people or goods are transported. This can include driving, walking, transit, biking, and other means.

Multimodal

A project that aims to accommodate more than one mode of transportation.

Mobility

The movement of people or goods.

MUTCD
Manual on Uniform Traffic Control Devices – a set of standards for roadway design issued by the Federal Highway Administration. All traffic control devices in the United States (signs, signals, pavement markings, etc.) must follow these standards according to federal law.

N

NACTO
National Association of City Transportation Officials – a coalition of city departments of transportation in North America that issues street and transit design guidelines.

P

Parking Lane
The curbside lane on a roadway used for parking vehicles. This lane can also be used for pedestrian and traffic calming amenities, such as parklet or curb bump outs.

Parklet
A small seating area or green space created as a public amenity on or alongside a sidewalk, especially in a former roadside parking space.

Planting / Amenity Zone
The area located between the sidewalk and the curb used to locate landscaping, street furniture, signs, and utilities.

Plaza
A public square, marketplace, or similar open space in a built-up area, often hardscaped.

Pocket Park
Small parks created on vacant or irregular parcels, usually in more urban areas.

Policy
A set of high-level government guidelines or directives that influence how government business is carried out. Policies are generally adopted by the mayor and city council. The Complete Streets Policy adopted by mayor and council led to the creation of the Street Design Guide.

Public Rights-of-Way Accessibility Guidelines (PROWAG)

Guidelines developed by the United States Access Board for public rights-of-way that address various issues, including access for blind pedestrians at street crossings, wheelchair access to on-street parking, and various constraints posed by space limitations, roadway design practices, slope, and terrain.

R

Raised Median

Is the curbed and elevated area between opposing lanes of traffic. Medians in urban areas typically include openings at regular intervals to allow left turns and U-turns.

Refuge Island

Protected spaces placed in the center of the street to facilitate bicycle and pedestrian crossings. Crossings of two-way streets are facilitated by allowing bicyclists and pedestrians to navigate only one direction of traffic at a time.

Right-of-Way (ROW)

The easement or property used for a roadway or other form of transportation. This is the entire area between property lines on each side of the street. The right of way may include additional land outside of the roadway for plantings or future expansion.

Road Redesign

Sometimes known as road diets, road redesigns involve eliminating one or more travel lanes from a roadway with excess capacity to use the right-of-way for other purposes.

Road Typology

A system of classifying different types of roadways by their intended uses and characteristics.

S

Shared Mobility

Services such as bikesharing, carsharing, and ride-hailing apps that allow people to gain short-term access to a mode of transportation without owning their vehicle.

Shared-Lane Marking
Sometimes called a “sharrow,” a shared lane marking is a lane marking placed in the travel lane to indicate where people should preferably ride their bicycle and to notify drivers to the likely presence of bicyclists.

Shared-Use Path
A path for walking, bicycling, and other recreational uses. Shared-use paths can have their right-of-way or they can be located in the right-of-way of a roadway.

Shy Distance
The space between vehicles and pedestrians or vehicles and fixed objects within the right of way. The distance required tends to increase as vehicle speed increases.

Sidewalk Zone
The area within the pedestrian realm that is dedicated to supporting the movement of pedestrians. The sidewalk zone should be kept clear of street furniture, signs, and other obstructions.

Street Typology
A form of classifying streets based on sets of similar characteristics such as elements of roadway function, location, and adjacent development patterns.

Streetscape
The collective appearance of all the different elements along a street such as buildings, bus stops, lighting, landscaping, roadway materials, etc. Streetscaping projects involve improving the appearance of a street, often via landscaping or improved pedestrian amenities.

T

Traffic Calming
Physical road design that is used to deliberately slow travel speeds and improve roadway safety. Specific traffic calming measures are described in Chapter 4.

Transit By-pass Lane
Short transit lanes on the approach to major intersections, sometimes paired to allow transit vehicles to bypass long queues that form at traffic signals.

Transit Queue Jump

Transit priority treatments that combine transit by-pass lanes with signal operational improvements that allow buses to easily enter traffic flow in a priority position at traffic signals.

Transit Signal Priority (TSP)

Is a general term for a set of operational improvements that use technology to reduce dwell time at traffic signals for transit vehicles by holding green lights longer or shortening red lights when transit vehicles are present.

Travel Way

The portion of the roadway used for the movement of vehicles, not including shoulder areas.

U

United States Access Board

Federal agency that sets standards to ensure that public streets and facilities are accessible to people with disabilities.

Urban Heat Island

The effect by which a metropolitan area is generally hotter than its surroundings due to the large amount of impervious surfaces such as buildings and roads which absorb heat during the day and release it at night. This can be combatted through increased shade and vegetation.

V

Vertical Curb

A small concrete barrier used to define the edge of the road use to discourage motor vehicles from exiting the roadway.

W

Warrant

A condition that must be met in order for certain traffic control devices, such as traffic signals, to be installed.

Wedge Curb

Sometimes called a roll curb, or mountable curb, a wedge curb has a sloping face that allows vehicles to encroach on them, either for on-street parking or to access driveways.

URBAN STREET TREE SELECTION

Botanical Name	**Common Name**	Tree Canopy Height	Tree Canopy Width	Water Use	Root Damage Potential	Sonoran / Chihuahuan Desert Native
Acacia aneura	Mulga	15-20'	12-15'	Low	Low	No
Acacia constricta	Whitethorn Acacia	10-20'	10-20'	Low	Low	Yes
Acacia farnesiana	Desert Sweet Acacia	20-30'	20-30'	Moderate	Low	Yes
Acacia rigidula	Black Brush Acacia	10-15'	10-15'	Low	Low	No
Acacia willardiana	Palo Blanco	10-20'	15-20'	Low	Low	Yes
Bauhinia lunarioides	Anacacho Orchid Tree	6-10'	8'	Low	Low	No
Bauhinia macranthera	Chihuahuan Orchid Tree	15'	15'	Low	Low	Yes
Brachychiton populneus	Australian Bottletree	30-50'	30'	Low	Moderate	No
Caesalpinia cacalaco	Cascalote	10-20'	10-20'	Low	Low	No
Caesalpinia mexicana	Mexican Bird of Paradise Tree	15-25'	12-18'	Moderate	Low	No
Callistemon viminalis	Red Bottlebrush	15-20'	15-20'	Low	Low	No

Height Overhead Utility Friendly

Water Use: Low · Moderate · High

Root Damage Potential: Low · Moderate · High

Common Name	Tree Canopy Height	Tree Canopy Width	Water Use	Root Damage Potential	Sonoran / Chihuahuan Desert Native
Netleaf Hackberry	25-35'	25-30'	Low	Low	Yes
Mexican Redbud	15-25'	15-20'	Low	Low	No
Desert Willow	15-30'	10-20'	Low	Low	Yes
Sissoo, Indian Rosewood	45-65'	30-40'	Moderate	High	No
Texas Ebony	30-40'	30-40'	Low	High	No
Ghost Gum	35-50'	20-35'	Low	Moderate	No
Little Leaf Ash	15-18'	10-18'	Low	Low	Yes
Bonita Ash	25-30'	25-30'	Moderate	Moderate	No
Rio Grande Ash	35-45'	25-35'	Moderate	Moderate	No
Modesto Ash	30-50'	30-40'	Moderate	High	No
Raywood Ash	25-30'	20-30'	Moderate	Moderate	No
Arizona Ash or Velvet Ash	30-50'	30-40'	Moderate	Moderate	Yes

Height Overhead Utility Friendly

Water Use: Low | Moderate | High

Root Damage Potential: Low | Moderate | High

Botanical Name	**Common Name**	Tree Canopy Height	Tree Canopy Width	Water Use	Root Damage Potential	Sonoran / Chihuahuan Desert Native
Jacaranda mimosifolia	Jacaranda	25-40'	20-30'	Moderate	Low	No
Lysiloma watsonii	Feather Bush or Desert Fern	12-15'	12-15'	Low	Low	Yes
Olea europaea	Fruitless Olive	25-30'	25-30'	Low	Moderate	Yes
Olneya tesota	Desert Ironwood	15-30'	15-30'	Low	Low	Yes
Parkinsonia florida	Blue Palo Verde	25'	15-20'	Low	Low	Yes
Parkinsonia X 'Desert Museum'	Desert Museum Palo Verde	25'	25'	Low	Low	Yes
Parkinsonia Microphylla	Foothills Palo Verde	10-20'	10-20'	Low	Low	Yes
Parkinsonia praecox	Sonoran Palo Verde or Palo Brea	20'	20'	Low	Low	Yes
Pistacia chinensis	Chinese Pistache	25-40'	20-30'	Moderate	Low	No
Pistacia lentiscus	Mastic Tree	12-25'	15-25'	Low	Low	No
Pistacia x 'Red Push'	Red Push Pistacia	25-40'	20-40'	Moderate	Low	No
Platanus mexicana	Mexican Sycamore	50'	30'	Moderate	Moderate	No

Height Overhead Utility Friendly

Water Use: Low Moderate High

Root Damage Potential: Low Moderate High

Botanical Name	Common Name	Tree Canopy Height	Tree Canopy Width	Water Use	Root Damage Potential	Sonoran / Chihuahuan Desert Native
Platanus wrightii	Arizona Sycamore	50'	50'	Moderate	Moderate	Yes
Populus fremontii	Western Cottonwood	40-50'+	20-40'	Moderate	High	Yes
Prosopis glandulosa	Texas Honey Mesquite	25-35'	25-35'	Low	Low	No
Prosopis hybrid	Hybrid Mesquite	30'	30'	Low	Low	No
Prosopis pubescens	Screwbean Mesquite	20'	15'	Low	Low	Yes
Prosopis velutina	Velvet Mesquite	30'	30'	Low	Low	Yes
Quercus buckleyi	Texas Red Oak	30'	25'	Moderate	Low	No
Quercus virginiana	Virginia Live Oak	40-60'	40-60'	Moderate	Moderate	No
Sophora secundiflora	Texas Mountain Laurel	15-25'	10-15'	Low	Low	No
Vauquelinia californica	Arizona Rosewood	5-25'	4-15'	Low	Low	Yes
Vitex agnus-castus	Monk's Pepper or Chaste Tree	15-20'	15-20'	Moderate	Low	No

Height Overhead Utility Friendly

Water Use: Low / Moderate / High

Root Damage Potential: Low / Moderate / High

COMPLETE STREETS PROJECT CHECKLIST

Introduction

The City of Tucson views all transportation improvements as opportunities to foster a vibrant, healthy, equitable, interconnected, accessible, environmentally-sustainable, and more livable city where everyone can move about safely, comfortably, and with dignity. The City's Complete Streets Policy shall guide the development of a safe, connected, and equitable transportation network that promotes enhanced mobility for people of all ages and abilities including, but not limited to, people walking, biking, using transit, driving, using wheelchairs or other mobility devices.

The purpose of project checklist is to ensure that project teams, staff, and project reviewing bodies are incorporating the Complete Streets Policy into project design through the application of the Tucson Street Design Guide. The checklist should be used on transportation improvements that cost over $500,000. It should be used early in the design process to guide project development.

Overview

Project Name (if project is listed in the Transportation Improvement Program (TIP), use the same name):

Project Manager:

Project Extent (project termini to nearest cross streets):

Project Description:

Number of travel lanes before:

Number of travel lanes after:

Current Right of Way (range within project extent):

Future Right of Way (range within project extent):

Project Cost Estimate:

Will acquisition of property be required for this project?

- [ ] Yes
- [ ] No

Federal Functional Classification (note: the Street Design Guide is not applicable to Interstates or Freeways):

- [ ] Principal Arterial
- [ ] Minor Arterial
- [ ] Major Collector
- [ ] Minor Collector
- [ ] Local Road

Street Type (refer to Move Tucson for map of Street Types):

- [ ] Downtown/Univ. District
- [ ] Neighborhood Commercial
- [ ] Urban Thoroughfare
- [ ] Urban Connector
- [ ] Suburban Thoroughfare
- [ ] Suburban Connector
- [ ] Neighborhood Street
- [ ] Shared Street
- [ ] Industrial Street

Modal Priority (if applicable):

- [ ] Frequent Transit Network
- [ ] Regionally Significant Corridor
- [ ] Freight Corridor
- [ ] Bicycle Priority Street
- [ ] Bicycle Boulevard

AADT (list each segment for which data are available):

Bike Counts (list each segment for which data are available):

Pedestrian Counts (list each segment for which data are available):

Are there significant project constraints that require deviation from preferred dimensions in Street Design Guide? (refer to the dimensions table and priority tables in the design guide) If so, please identify.

Safety

Current posted speed:

85th percentile (list for each segment of the project extent):

What is the target speed after improvements?

If the current 85th percentile speed is at least 5 mph over the posted speed how does this project seek to slow traffic?

Are any street segments or intersections at Level of Safety Service (LOSS) 4? Refer to the Pima Association of Governments for LOSS performance. (https://gismaps.pagnet.org/PAGSafety/)

☐ Yes ☐ No

If yes, what safety improvements will this project make at those locations?

Does the project contain segments on the Pedestrian High Injury Network (refer to the Pedestrian Safety Action Plan for locations)?

☐ Yes ☐ No

If yes, pedestrian safety improvements should be a priority consideration in this project. How is pedestrian safety being addressed?

Is the project street a candidate for a road diet (four or more lanes, AADT 20,000 or below, peak hour vph below 875 per direction)?

☐ Yes ☐ No

If yes, is a road diet being proposed as part of this project? If not, why?

Will the project upgrade lighting along the corridor?

☐ Yes ☐ No

During construction, how will bicycle and pedestrian access be maintained through the work zone?

Pedestrian Realm

Will this project install or upgrade sidewalks?

☐ Yes ☐ No

If no, why are sidewalks not being installed or upgraded?

If sidewalks are being installed/upgraded, are there project constraints that require deviation from preferred sidewalk dimensions (see table 2.4 in the Street Design Guide for preferred sidewalk zone width)?

☐ Yes ☐ No

If yes, what is the proposed sidewalk width in the project area?

If sidewalks are being installed/upgraded, are sidewalks setback from curb (see table 2.4 in the Street Design Guide for preferred planting/amenity zone width)?

☐ Yes ☐ No

If no, why not?

Where sidewalks cross driveways, are the level, material, running slope, and cross slope of the sidewalks being maintained through driveway areas?

☐ Yes ☐ No

-Note: Sidewalks should be dominant across driveways and driveways should be designed to slow turning speeds, especially on urban corridors. Aproned driveways are preferred over curb returned driveways on urban facilities. See the driveway section in the Street Design Guide.

Are curb ramps being installed or brought into compliance with the requirements of the American Disabilities Act (diagonal curb ramp placement should be avoided where new curb ramps are installed, see curb ramps section of the Street Design Guide)?

☐ Yes ☐ No

What is the frequency of enhanced pedestrian crossings along the project area (refer to the Street Design Guide for preferred spacing of enhanced crossing by street type)?

Are there other pedestrian design elements incorporated into the project? Please identify.

Bicycle Facilities

Will this project upgrade or add bicycle lanes?

☐ Yes ☐ No

If yes, what type of bicycle facility will be installed? (refer to the Street Design guide for preferred bicycle facility type by AADT). Please describe. If no, describe existing bicycle facility.

Are there project constraints that require deviation from the 1st choice bicycle facility (refer to the Street Design Guide for preferred bicycle facility type by AADT)?

☐ Yes ☐ No

If yes, please list the constraints.

Are there project constraints or other considerations that require deviation from preferred bicycle facility dimensions (refer to Table 2.4 in the Street Design Guide)?

☐ Yes ☐ No

If yes, what bicycle facility dimensions are being used (including buffers or protective elements)?

Does this project include any enhanced bicycle treatments at signalized intersections?

☐ Yes ☐ No

If yes, please describe.

Does the project intersect with any planned Bicycle Boulevards (only applicable for Thoroughfare or Connector streets)?

☐ Yes ☐ No

If yes, are enhanced bicycle crossings being installed (bike HAWK or TOUCAN)?

☐ Yes ☐ No

Street Realm

What is the width of travel lanes after the project (refer to table 2.4 for preferred widths: typical widths are 10 feet for most travel lanes and 11-foot curb lanes should be used on Frequent Transit Network routes, Freight Corridors, and Thoroughfares with at least 5% heavy vehicle traffic)?

Curb lane:

Inside lane(s):

Does the project include a two-way left-turn lane?

☐ Yes ☐ No

Will medians or refuge islands be installed as part of the project (refuge islands or medians are encouraged on multilane roadways with AADTs greater than 12,000)?

☐ Yes ☐ No

Pavement condition – are there any segments of the project area with an overall condition index (OCI) below 60 (see Map Tucson https://maps2.tucsonaz.gov/Html5Viewer/?viewer=maptucson for pavement condition)?

☐ Yes ☐ No

Will the project improve pavement conditions?

☐ Yes ☐ No

Transit

Is the project on the Frequent Transit Network?

☐ Yes ☐ No

If yes, does the project include elements that will improve transit performance (queue jumps, transit signal priority, dedicated transit lanes)?

☐ Yes ☐ No

If yes, please describe transit-supportive elements.

Does the project area include existing bus shelters?

☐ Yes ☐ No

Will new bus shelters be installed as part of the project?

☐ Yes ☐ No

Are bus stops being relocated as part of the project?

☐ Yes ☐ No

If yes, are any bus stops located more than 100 feet from the nearest signalized intersection or enhanced pedestrian crossings? Explain why.

Intersection Design

Does the project present an opportunity to redesign intersection curb geometry?

☐ Yes ☐ No

What is the design vehicle of the intersections (design vehicle should be the least maneuverable vehicle representing at least 3% of turning vehicles)?

Are both the curb radii and turn radii being considered in the intersection design?

☐ Yes ☐ No

If curb radii are being redesigned, is the design of the curb radii consistent with the guidance provided in Tables 5.1 and 5.2 of the Street Design Guide?

☐ Yes ☐ No

For any intersections with curb radii that deviate significantly from the guidance in the tables mentioned above, please describe why (for example: classification counts indicate a high share of heavy vehicles, the intersection is near a trauma center, intersection is skewed, etc.)

Are dedicated right-turn lanes being installed at any intersections or driveways in the project area (see Figures 7 and 8 in the Street Design Guide for Guidance on when to install dedicated right-turn lanes)?

☐ Yes ☐ No

If yes, what is the approach volume and right-turn volume at right turn lane locations?

Intelligent Transportation Systems and Traffic Signals

Will the project upgrade traffic signal elements?

☐ Yes ☐ No

Will fiber optics cables be installed as part of the project?

☐ Yes ☐ No

Is the project on an ITS Key Corridors network?

☐ Yes ☐ No

If yes, what ITS features are being installed as part of the project?

Are there any dual left-turn lanes at intersections in the project area?

☐ Yes ☐ No

If yes, will they be converted to flashing yellow arrow or protected-only left-turn phasing?

☐ Yes ☐ No

Green Streets and Drainage

Does the project intersect with a Green Infrastructure Priority Area? (see https://gismaps.pagnet.org/PAG-GIMap/Map.aspx)

☐ Yes ☐ No

Will green infrastructure features be installed as part of the project?

☐ Yes ☐ No

Does this project meet the performance goals of the City of Tucson Green Streets Policy (see https://www.tucsonaz.gov/files/transportation/Green_Streets_APG_Signed_by_Director.pdf)?

☐ Yes ☐ No

If not, why not?

Does the project incorporate Design Best Practices from Part 3 the Green Infrastructure Resource Library from American Rivers? https://www.americanrivers.org/conservation-resource/sonoran-desert-green-infrastructure-resource-library/

☐ Yes ☐ No

If not, why not?

Will street trees and other landscaping improvements be included as part of the project?

☐ Yes ☐ No

If not, why not?

Is the project within a floodplain?

☐ Yes ☐ No

Does the project upgrade drainage structures to reduce flood risk?

☐ Yes ☐ No

Historical Preservation

Does the project take place within or adjacent to any historically zoned properties (Historic Preservation Zones or Historic Landmarks)?

☐ Yes ☐ No

If yes, list:

-NOTE: Changes to the appearance of the historic streetscape within an HPZ require review by the respective Historic Zone Advisory Board and the Tucson-Pima County Historical Commission, Plans Review Subcommittee.

Does the project take place within a National Register Historic District or is it an individually listed National Register property?

☐ Yes ☐ No

If yes, list:

Has the City of Tucson Historic Preservation Officer been consulted on preservation-sensitive design for this location?

☐ Yes ☐ No

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DRAFT STREET DESIGN GUIDE
CITY OF TUCSON
2021

DEPARTMENT OF TRANSPORTATION AND MOBILITY