Chapter 4
Facility Type - Street

Legend

(solid box, purple)	Multimodal Application Example
(dotted box, green)	Context-Sensitive Solutions Application Example
(dashed box, orange)	Performance-Based Practical Design Application Example
(bicycle icon)	Multimodal (MM)
(mountain icon)	Context-Sensitive Solutions (CSS)
(light bulb icon)	Performance-Based Practical Design (PBPD)
(globe icon)	Web link for additional information
(AASHTO seal)	AASHTO-Specific Information

Chapter

4

4 Facility Type – Street

<u>Street</u>
Context Classifications: C3 Suburban Places, C4 Traditional Neighborhoods, C5 Downtown Places, C6 Urban Cores.
A facility generally characterized by the inclusion of curb and gutter, sidewalks, and storm sewers in more urban contexts that may include on-street parking, bike lanes, and transit stops.

4.1 Introduction

The guidelines in this chapter apply to facilities defined as Streets, consistent with the definitions in Chapter 1 of this Guide and Chapter 5 of the American Association of State Highway and Transportation Officials (AASHTO) *A Policy on Geometric Design of Highways and Streets* (the Green Book) (2018 AASHTO GDHS) (AASHTO, 2018). Guidelines for Roads and Freeways, Expressways, and Interstates are described in Chapters 3 and 5, respectively.

A Street facility type (Street) is typically found in higher-density areas, such as Suburban Places, Traditional Neighborhoods, Downtown Places, and Urban Cores context classifications. They are characterized by curb, gutter, storm sewers, bicycle and pedestrian accommodations, and transit uses; and have higher access frequency to the street. A Street can be any functional classification—Arterial, Collector Road and Street, or Local Road and Street.

Refer to Chapter 1 of this Guide for definitions of functional classifications, facility types, and context classifications that are used in this chapter.

Use this link to access CDOT's Roadway Functional Classification Guidance Manual (CDOT, 2019): *https://www.codot.gov/business/designsupport/bulletins_manuals/cdot-roadway-design-guide-2018/2018-rev-rdg/dg18-01-revs*

4.2 Highway Capacity (Transportation Facility Operations)

4.2.1 Highway Capacity Manual

When a Street is being scoped for improvements, the designer needs to know current and projected traffic volumes and level of service (LOS) for the future design year. A 20-year capacity design project for what is a Street in current year might need to be designed as a Road facility type with fewer lanes in the future year if there are projected traffic volume decreases and higher levels of service.

4.2.2 Factors Other Than Traffic Volume That Affect Operating Conditions

There are many factors that can affect the operating conditions of a Street. Some examples the designer should consider are:

- Design speed of the existing road.
- Weaving sections of the road.
- Intersection type or types.
- Number of side road accesses.
- Vertical and horizontal sight distances.
- Bicycle and pedestrian usage and crossings.
- Mixture of vehicle types using the road.

Refer to Chapter 2, Section 2.4.4, of the 2018 AASHTO GDHS for information on these factors.

4.2.3 Measures of Multimodal Connectivity

In the C3 through C6 context classifications, it is important to provide a variety of practical and efficient mobility options. In some cases, local agencies may choose to prioritize modes other than single-occupancy vehicles to achieve congestion reduction and environmental goals. Designers should consult local, regional, and state plans when working in these context classifications to understand transportation goals for an area and to include bicycle, pedestrian, and transit infrastructure where appropriate. A few references for how to include multimodal elements in a street facility are provided below.

Use this link to access the FHWA Bikeway Selection Guide:
https://safety.fhwa.dot.gov/ped_bike/tools_solve/docs/fhwasa18077.pd

Use this link to access the U.S. Access Board (Proposed) Public Rights-of-Way Accessibility Guidelines (PROWAG) for ADA and ABA accessibility:
https://www.access-board.gov/prowag

Use this link to access the NACTO design guides for pedestrian, bicycle, and transit street designs: https://nacto.org/publications/

4.2.4 Design Service Flow Rates

In general, the design service flow rate is defined as, the maximum hourly vehicular volume that can pass through a Street element at the selected level of service for the facility. Refer to Chapter 2, Section 2.4.3.1, of the 2018 AASHTO GDHS for information on design service flow rates.

4.3 General Design Considerations

Local agencies desiring to use federal funds must design projects to meet or exceed the design standards or the minimums presented in the 2018 AASHTO GDHS and in this Guide. The use of federal funds also requires that the National Environmental Policy Act (NEPA) process be followed. Historic districts also require special consideration that may require consultation with the State Historic Preservation office.

4.4 Design Speed

Design speeds ranging from 25 to 45 mph are typically considered for a Street, depending on available right of way, terrain, adjacent development, and other area controls. When a Street is also a Principal Arterial, the design speeds could be as high as 50 or 55 mph. For new and reconstructed facilities, the designer should strive to design the street segment to the appropriate standards to maintain the designated design speed. Refer to Table 5-1, Minimum Design Speeds for Roads in the 2018 AASHTO GDHS to determine appropriate design speeds while considering traffic volumes and terrain.

Designing a Street at a higher design speed may inadvertently become a barrier and/or increase crash potential for non-motorized uses, such as pedestrians and bicyclists. See Chapter 13 of this Guide for more information on pedestrian and bicycle design.

The surrounding natural and built environment can directly influence the design considerations for a specific Street segment. The designer needs to recognize how the physical setting will influence the design speed and consider what measures can be used to influence driver expectations to maintain appropriate speeds. For example, a Major Collector Street in a C3 context classification may have single family housing on one side and a small strip mall on the other side. It may have different design speed requirements than a Major Collector Street in a C5 context classification adjacent to store fronts and on-street parking.

The designer may use the current posted speed as a logical governing design criterion, but a better practice is to use performance-based practical design (PBPD). The designer can drive the street and observe driver behaviors to influence their design decisions. It may also be appropriate to request a traffic and safety analysis to determine the 85th percentile speed and safety performance to determine if there are crash patterns to potentially mitigate.

4.5 Design Traffic Volume

Current and future traffic volumes are important design considerations. The basis of traffic design is to calculate the anticipated Design Hour Volume (DHV) of traffic projected to a future design year. During the planning stage of a project, the Region Traffic Engineer can provide current traffic volumes, predict future traffic volumes, and determine the future design year that is appropriate for the project. Design traffic volume should be estimated for at least 10 years, and preferably 20 years, from the date of completion of construction. A simple resurfacing project may only need a future DHV of 10 years, while a major rehabilitation or reconstruction project may require a DHV of 20 years.

In determining the design traffic volume, it is important to understand the perceptions of the local community regarding traffic growth and congestion. In rural parts of Colorado, three cars stopped at a street intersection may be perceived as congestion, while in a more urban area, it would be expected and not questioned. The designer must consider the local context of the traffic impacts and determine if something can be done differently. Understanding the perception of traffic volumes and their impacts, no matter how large or small, helps to make the design context-sensitive and appreciated by the local users.

4.6 Level of Service

Understanding level of service (LOS) and how it impacts design must take several factors into consideration. Consider that a stop-controlled intersection on a street may target a LOS C rather than an LOS D or E for a signalized intersection. Discussions with the local traffic engineer and individuals who have a good working knowledge of the roadways and conditions at the project location can determine what an acceptable LOS target should be for the design. Refer to the *Highway Capacity Manual* (TRB, 2022) for further information on LOS.

4.7 Multimodal Accommodations

Street facility types are more commonly found in higher-density areas where alternative modes of travel are more prevalent in the transportation system and where local agencies may have bicycle, pedestrian, and/or transit plans and goals. The designer should consider these multimodal visions and how they may influence the design of a Street.

4.7.1 Transit

While transit systems most commonly operate on Street facility types in medium to large cities, such as Grand Junction, Pueblo, Boulder, and Denver, they can also operate on a Road in more rural contexts. For example, the VelociRFTA Bus Rapid Transit, serving the Roaring Fork Valley, is the first rural bus rapid transit system in the nation. While most of the VelociRFTA route operates on Roads in a Rural Places (C2) context, it passes through several Downtown Places (C5) areas with Streets. The designer needs to coordinate with the local and regional agencies, such as school districts, cities, counties, and Metropolitan Planning Organizations, to identify where transit systems exist and where they may be planned in the future. This will help determine what accommodations need to be incorporated into the Road design.

4.7.2 Bicycles

In Colorado, bicycles are considered a vehicle and are allowed on most roadways but generally not on interstates unless there is no alternate route available. The designer should investigate the level of bicycle activity and consult with local agencies to understand policies and plans related to current and proposed bicycle infrastructure and accommodations. Furthermore, bicycles may play a role in reducing greenhouse gas emissions, reducing congestion, and improving public health; and the right design can eliminate barriers making bicycling a preferred mode choice for a greater number of travelers.

Bicycle facility design is largely dependent on the physical surroundings (context classification) and functional classification, namely speed and motorized traffic volume; and preferred facilities vary by local or regional agencies. Often, agencies have plans and recommendations for facility types, but, if none exist, the CSS process can help determine the appropriate facility, using Chapter 13 of this Guide as a reference.

“Sharrow” markings can be used on Streets with restricted streetway width and posted speeds of 35mph or less. Sharrows should be only used where no other alternative is possible to accommodate the bicycle activity. The use of sharrows could be appropriate where the Street is making its final transition from a Rural Places context to more urban environment. The appropriate use of a sharrow markings should be discussed with the Region Traffic Program.

4.7.3 Pedestrians

A differentiating characteristic of a Street facility type is that it is located in areas where there is higher residential and business density, so pedestrian activity is expected. Because crash histories show that pedestrians are most vulnerable at crossings, designers should consider street design elements that reduce pedestrian exposure at these locations.

Refer to Chapter 2, Section 2.6.1, of the 2018 AASHTO GDHS for more information. Refer to Section 4.8 for information on accessible design.

4.7.4 Motorized Vehicles

Knowing the type of vehicles that commonly use a Street and the land uses they access impacts decisions regarding lane widths, shoulder widths, turning radii, and stopping sight distance. Typical land uses adjacent to a Street, such as an industrial park, maintenance facility, or waste transfer facility, indicate the type of vehicles that use the Street. Typically, passenger and transit vehicles and box trucks should be the starting point for vehicle design considerations on a Street. Larger vehicle design standards may be required based upon the local business needs and the types of vehicles that use the Street.

PBPD principles can be used to consider trade-offs in the design process. For example, a design solution might be a tighter radius to reduce pedestrian crossing distances and conflicts by allowing vehicle tracking to encroach into an adjacent lane, or it might be a wider right turn lane to allow off tracking from the curb to avoid jumping the curb. Knowing the frequency of use and size of vehicle using an intersection helps the designer to optimize the curb radius for all users.

4.8 Accessible Design

When designing improvements to a Street, the designer should determine if current Americans with Disabilities Act (ADA) accommodations are to standard or if they need to be added or upgraded. ADA elements are unique to each location and require a level of design detail that cannot be short-cut. CDOT follows design and construction guidance and standards found in the U.S. Department of Transportation ADA Standards for Transportation Facilities (USDOT, 2006), the U.S. Department of Justice 2020 ADA Standards for Accessible Design (U.S. Department of Justice, 2020), Americans with Disabilities Act Architectural Guidelines for Buildings and Facilities (ADAAG) (U.S. Access Board, 2002), and the *Manual on Uniform Traffic Control Devices for Streets and Highways* (FHWA, [2009] 2022). In addition, CDOT adopted the Proposed Right-of-Way Accessibility Guidelines (PROWAG) for curb ramps, which also provides design guidance for sign heights and pedestrian pushbuttons for traffic signals (U.S. Access Board, 2011). The designer should evaluate innovative ways to shorten pedestrian crossings at intersections to provide the greatest safety to the pedestrian. If the intersection is signalized, PROWAG guidance is highly recommended to provide the highest level of ADA accommodations.

Refer to Chapter 12 of this Guide for information on CDOT's design standards for ADA accessibility and PROWAG related to curb ramps.

Refer to Chapter 2, Section 2.6.7 of the 2018 AASHTO GDHS for more information.

Use this link to access CDOT's ADA resources for engineers:
https://www.codot.gov/business/civilrights/ada/resources-engineers

4.9 Access Control and Access Management

Access control and management is critical to maintaining a safe facility. When access is managed and controlled, there is a safer environment for the public. Refer to Chapter 2, Section 2.5.1, of the 2018 AASHTO GDHS, the State Highway Access Code (2 CCR 601-1) (State of Colorado, 2002), and Chapter 11 of this Guide for further information on access control and management.

4.10 Horizontal and Vertical Geometry

The horizontal and vertical design elements for a Street are determined by the surrounding environment and context classification. A Street in C4 context classification may have bike lanes and on street parking to consider. In a C6 context classification, there may be tall buildings that cast shadows, exacerbating roadway icing in the winter.

Intersections on a Street may need special design considerations for safety as many modes may be present, each having unique considerations. Minor improvements can provide major safety benefits. Considerations should include:

- Avoid locating intersections on steep profile grades.
- Avoid locating intersections just before or after a crest vertical curve.
- Avoid locating intersections within horizontal curves.
- Try to minimize access openings that are too close to the intersection and within any auxiliary lanes.
- Designing intersection approaches to be as close to perpendicular with the major roadway as possible.
- Design with adequate corner radii and intersection sight distance.

4.11 Alignments

Street alignments should fit closely with the existing topography to minimize the need for cuts or fills. The alignment should not reduce safety but may be altered to serve a special purpose if desired by the local planning officials.

Street alignments in commercial and industrial areas (in C3, C4, C5, and C6) should consider the topography but should be as direct as possible. The choice of alignment, cross section, and right of way width may be based on avoiding and minimizing construction impacts to adjacent properties and properties associated with hazardous waste or petroleum product contamination.

Refer to Chapter 6 of this Guide and Chapter 3, Section 3.3.4, in the 2018 AASHTO GDHS for additional information on superelevation considerations.

4.12 Grades

Maximum grades for a Street are a function of terrain and design speed. Refer to Table 5-2 in the 2018 AASHTO GDHS.

There are locations where grades cannot meet the 2018 AASHTO GDHS standards, and a PBPD analysis of the current roadway operations, crashes, etc. may reveal that the current condition is acceptable. The analysis could also indicate hot spots where a problem exists. Using PBPD may help the designer to better determine where necessary improvements are needed and to better maximize the project budget to improve those hot spots.

The grade for a residential Street should be as flat as the surrounding terrain and topography permit. When grades are 4% or steeper, drainage design may become critical. Steep grades can create elevated runoff velocities. Faster-moving runoff requires larger storm water inlets to capture the water. In curves or at curb cuts, the water can leave the curb pan and scour or flood properties adjacent to the Street. For a Street in an industrial area (with truck traffic) (C3, C4, C5, or C6), grades should be less than 8% and desirably less than 5%. The designer should carefully consider descent grades where trucks will be commonly using a Street. Refer to Table 6-4 in Chapter 6 of this Guide for maximum grades.

To provide for drainage, the minimum preferred cross-slope grade used for a Street with curbs is generally 0.30%, but can be as flat as 0.20% when sufficient drainage can be provided. Where bikeways are present, there may be specific grade requirements to accommodate bicycles.

Approach grades to intersections should be reduced to less than 8% to accommodate improved stopping distances and to improve vehicle starts to efficiently cross the intersection quickly and safely. This is also beneficial in areas where winter conditions are common.

4.13 Vertical Curves

Design control for vertical sag and crest curves are provided in Table 5-3 (stopping sight distance) and Table 5-4 (passing sight distance) of the 2018 AASHTO GDHS. Criteria for measuring stopping sight distance include an eye height of 3.5 feet and an object height of 2.0 feet. Passing sight distance criteria include an eye height of 3.5 feet and the object height of 3.5 feet.

4.14 Cross Slope and Superelevation

The cross-slope for a Street is dependent on the Street's surface type, posted speed, and whether it has curb and gutter or shoulders and ditches. Typically, a cross-slope of 2% may be appropriate for a Street with a paved surface, but for a gravel Street, a steeper cross-slope may be necessary. Cross-slope can also be affected by topographic features. Adding superelevation to streets maybe necessary as the design speed increases. Using PDPB principles may help to determine if superelevation is necessary. Pavement cross slope should be adequate to provide proper drainage.

Although superelevation is advantageous for traffic operations, such factors as wide pavements, abutting properties, drainage, intersections, and access points may make it impractical in more developed environments. Therefore, superelevation is not usually provided on low-speed Streets in residential and commercial areas. It should be considered in industrial areas or Streets where operating speeds are above 40 mph. A maximum superelevation of 4% to 6% is commonly used. A detailed discussion of superelevation is found in Chapter 6 of this Guide.

4.15 Cross Section Elements

Cross section elements of a Street (lane, shoulder, median, topographic impacts, parking, multimodal amenities, etc.) are varied and can be quite simple or complex. PBPD plays a key role in developing cross sections. Using good data analysis for the roadway helps define the cross section elements and the widths that are appropriate to accommodate all users. Refer to Chapter 7 of this Guide for cross section elements.

When bicycle and/or pedestrian facilities are included as part of the design, refer to Chapter 13 of this Guide for bicycle facilities design, and refer to Chapter 12 of this Guide for accessible pedestrian design considerations.

4.16 Median Type

Medians on a low-speed Street are either raised or painted. Median widths can vary from 4 feet to 20 or more feet depending upon the specific Street. Raised median widths should be designed to accommodate required signing widths. On a Street, median areas of 1 to 3 feet in width are considered" separators" or "dividers" and not medians, and they may not accommodate required sign widths. A sign may extend beyond the raised median and be a striking hazard to large vehicles. Raised medians can be used for access control on a Street.

CSS Application Example

Medians of sufficient width will provide refuge at pedestrian crossings allowing the pedestrian to focus on traffic from one direction to reach the median refuge and to safely prepare for the other direction of travel before completing the crossing. An appropriately sized median can provide safe refuge for pedestrians and bicyclists on large crossings along busy corridors.

4.17 Drainage

Proper drainage design minimizes high runoff and flooding potential. Drainage facilities, such as bridges, culverts, channels, curbs, gutter, and storm sewer systems, are designed to carry water across the right of way and are designed so that stormwater is removed from a Street surface.

The principal objective in drainage design is to control the presence and flow of water on a Street surface such that pedestrians, bicyclists, and vehicles are not placed in an unsafe situation during storm events.

It is desirable to use a minimum crown slope of 2.0% (0.02 foot/foot), particularly where the surrounding terrain is relatively flat. This reduces ponding areas that can contribute to deterioration of pavements and create safety problems. For additional information, refer to the CDOT *Drainage Design Manual* (CDOT, 2019).

4.18 Pedestrian Facilities

Pedestrian facility design is largely dependent on the physical surroundings (context) and functional classification, namely speed and motorized traffic volume, and preferred facilities vary by local agency. Often, local agencies have plans and recommendations for facility types. If none exist, the CSS process can help determine the appropriate facility, using Chapter 13 of this Guide.

Pedestrian facilities must be compliant with PROWAG (U.S. Access Board, 2011). Refer to Chapter 12 of this Guide for accessible pedestrian design.

4.19 Bicycle Facilities

Bicycle facility design is largely dependent on the physical surroundings (context) and functional classification, namely speed and motorized traffic volume, and preferred facilities vary by local agency. Often, local agencies have plans and recommendations for facility types. If none exist, the CSS process can help determine the appropriate facility using Chapter 13 of this Guide.

When bicycle facilities are also pedestrian facilities, such as shared-use paths, they must be compliant with PROWAG (U.S. Access Board, 2011). Refer to Chapter 12 of this Guide for accessible pedestrian design.

4.20 Transit Facilities

Transit facilities, such as bus stops, mobility hubs (bus, parking, and train hubs), and bus rapid transit lanes are common in urban areas where Street systems are prominent. The designer should communicate early in the scoping development with the local transit agencies to identify if there are transit routes, bus stops, or multimodal hubs within or near the project limits. When present or planned, the designer should consider if improvements or additional accommodations are needed to facilitate safer pedestrian, bike, bus, and vehicle access to the facilities and incorporate them into the design.

4.21 Sidewalks

Sidewalks should be provided along both sides of a Street in commercial areas and when they are used for pedestrian access to schools, parks, shopping areas, and transit stops. In residential areas, it is desirable to have sidewalks on both sides of a Street, but can be provided on at least one side. Sidewalks may be considered as an addition to a Street in rural areas, and should be separated from the Street. The preferred cross slope for sidewalks should be 2% or less, be gentle enough to accommodate ADA accessibility, and slope toward the Street.

Where practical, the sidewalk should be separated from the edge of traveled way. The principal reasons for doing this are:

- Greater separation of pedestrians from moving traffic provides a more comfortable pedestrian experience.
- An area for placement of street hardware and traffic signs that does not interfere with pedestrian traffic.
- A location for landscaping.
- A location for placing removed snow.

Maintenance of the area between curb and sidewalk can be difficult, and some jurisdictions may desire to eliminate the area in favor of additional sidewalk width. The designer should coordinate with local agencies for maintenance outside of the back of curb.

Clear sidewalk width should be an absolute minimum of 4 feet; 5 feet is desirable. If a continuous sidewalk has a width of 4 feet, a minimum 5-foot by 5-foot passing space needs to be provided at 200-foot intervals for ADA accessibility. Sidewalk widths of 8 feet or greater may be needed in commercial areas. If roadside appurtenances are situated on the sidewalk adjacent to the curb, additional width is required to secure a minimum clear width of 4 feet.