MONTANA DEPARTMENT OF TRANSPORTATION

ROAD DESIGN MANUAL

Chapter 8

Urban Design Considerations

January 2026

Contents

Chapter 8

Urban Design Considerations

8.1 INTRODUCTION

Chapter 8 is intended to provide design guidance for urban facilities including local streets, collectors and arterials. The design approach described in this chapter considers various transportation modes and addresses how to integrate motorized vehicles, pedestrians, and bicycles into the urban environment in an effective manner. This chapter will:

- Refer to the tools and multimodal design considerations described in Chapter 7,
- Provide additional information on urban intersections to expand on Chapter 6,
- Apply the basic roadway design principles documented in Chapters 3 (Horizontal Alignment), 4 (Vertical Alignment), and 5 (Cross Section Elements), and
- Introduce drainage topics that are further discussed in Chapter 11 (Drainage and Irrigation Design).

MDT urban design standards are presented in the *MDT Baseline Criteria Practitioner's Guide*, which are referenced throughout this chapter *(1)*.

8.2 DESIGN PRINCIPLES AND APPROACH

The urban design environment is faced with a variety of design considerations that are typically not found in a rural area. Intersections are often spaced relatively close together, are designed to accommodate various modes, and a wide range of traffic speeds and volumes. Therefore, the horizontal and vertical alignment must be designed to appropriately accommodate these intersections and modes. Additional challenges that are often encountered in an urban design environment include *(2)*:

- Limited right-of-way for cross section elements;
- Constrained horizontal and vertical alignments;

- Limited sight distance;
- Offset intersection alignments;
- Multiple driveway approaches to access adjacent properties;
- Increased presence of pedestrians, bicycles, and transit;
- Accommodation of utilities;
- Reduced speeds in specific areas (i.e., traffic calming); and
- Local policies, plans and ordinances.

Design of urban streets typically consists of either designing a new facility, where new right-of-way can be acquired to accommodate the desired cross section elements, capacity, and modes; or upgrading an existing facility to improve safety, provide more capacity, integrate various modes, or meet other project objectives. In either design approach, the following factors should be considered *(2)*:

- Right-of-way acquisition procedures and needs;
- Permanent traffic control;
- Public involvement;
- Multidisciplinary coordination;
- Pedestrian, bicycle, transit, and motorized vehicle needs;
- Utility relocation and potential conflicts;
- Adjacent access, including building access;
- Drainage design;
- Guidance for consistent cross sections;
- Location and design of medians;
- Street lighting;
- Cross section trade-offs, such as the widths associated with travel lanes, turn lanes, on-street parking, and bicycle lanes;
- On-street parking;
- Design vehicles; and
- Landscaping.

8.3 PROJECT CONTEXT

Understanding the project context, purpose of the facility, and target facility users for a project is critical to making appropriate design decisions within an urban design environment. As described in the *MDT Context Sensitive Solutions Guide (CSS Guide)*, a successful CSS project seeks to understand the landscape, the community, valued resources, and the role of all appropriate modes of transportation in each unique context before developing engineering solutions *(3)*. This also includes public involvement that is tailored to the community and project needs to help guide design decisions, and occurs early and frequently throughout the project. The approach outlined in the *CSS Guide* is consistent with applying a performance-based design approach (Chapter 1, Section 1.2.2), which can also provide a framework for initiating projects in urban areas.

Urban design environments may be particularly constrained due to adjacent land use and are often faced with balancing the needs of motorized vehicles, pedestrians, bicycles, and transit. The design team should be prepared to apply criteria for differing types of design features as a roadway transitions through various types of land uses that often exist along corridors in urban settings.

Urban design projects on existing roads are sometimes triggered by adjacent redevelopment and may require the design to provide street frontage improvements. The majority of the major transportation improvement projects are developed through capital improvement programs consistent with long-range transportation plans.

Understanding the primary purpose of the facility and targeted users can help guide the design decisions and priorities for balancing the needs of each user. Urban arterials may have higher traffic volumes and focus on mobility for vehicles, as well as providing facilities for pedestrians, bicycles, and transit. In these cases, access to adjacent properties may be somewhat limited, using medians, and separate turn lanes. However, for urban facilities such as collectors or local streets, the design may focus on providing access to businesses, neighborhoods, or other land uses, for all types of users. In some cases, the roadway may be specifically designed for pedestrian, bicycle, and transit facilities, and design decisions may enhance facilities to encourage these types of users.

Designing roadway improvements for an existing urban roadway can be complex, particularly if right-of-way acquisition is not feasibly possible in highly developed areas. Design decisions may be impacted by coordination with utilities (water, sewer, storm water, electric, gas, and communication lines), potential for on-street parking, and multimodal facilities. Balancing the project needs and target users for the facilities in a constrained environment may result in design values that do not meet the *MDT Baseline Criteria Practitioner's Guide (1).* In these cases, consult the Practitioner's Guide to determine the level of documentation required for the non-standard design element(s).

A performance-based design approach, as described in Chapter 1, provides a clear framework for evaluating design decisions and documenting each decision.

8.4 APPLYING GEOMETRIC DESIGN IN URBAN ENVIRONMENTS

Designing in an urban context does not imply that the design team should not meet design values and criteria. Rather, the design team should apply the basic geometric design principles in an urban setting considering and evaluating trade-offs between design, safety, and operations. This section highlights key concepts the design team should consider when refining improvements within the urban environment.

The *MDT Urban Baseline Criteria* reflect flexibility for cross sectional dimensions and provide a great starting point.

8.4.1 **Urban Cross Sections**

The design team should use the *MDT Baseline Criteria Practitioner's Guide* to determine the cross sections for urban roadways *(1)*. Exhibit 8-1 illustrates an example of an urban cross section at an intersection.

College Street
Bozeman, MT

Exhibit 8-1
Urban Cross Section at an Intersection

In addition, cross sections in urban environments may include the following design features:

1. **Narrow Cross Section**. Due to right-of-way constraints, travel lanes in urban roadways may be narrower than in rural roadways. There are numerous factors related to lane width that influence operations and safety.

2. **Bicycle Facilities.** Bicycle facilities should be considered for roadway designs in urban environments, particularly in corridors with high motor vehicle volumes and on roadways where bicycle facilities are consistent with local plans. Bicycle facilities can have varying levels of separation and/or protection from motor vehicle traffic, ranging from separated cycle tracks, with the most separation from motor vehicles, to shared roadways, with no separation. Exhibit 8-2 illustrates an urban cross section with bicycle facilities. Additional information on bicycle facilities can be found in Chapter 7, Section 7.4.

   Exhibit 8-2
   Urban Cross Section with Bicycle Facilities

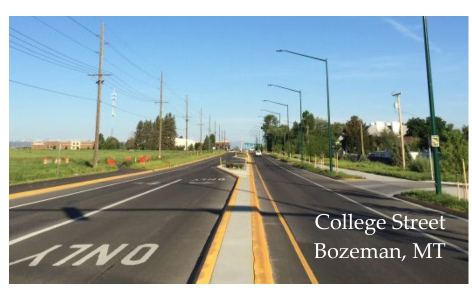
   Pedestrian Facilities. When pedestrian facilities are provided along roadways, buffered facilities are typically preferred. Intersections and driveway approaches introduce conflict areas between pedestrians and other modes. Appropriate pedestrian facility design should provide high visibility of pedestrians in these conflict areas. Chapter 7, Section 7.3 and Chapter 5, Section 5.2.9 provide additional cross sectional information on pedestrian facilities.

3. **Integrating Landscape Features.** Urban environments have opportunities to incorporate landscape features within the roadway design, particularly if there is a buffer area separating the pedestrian access route and the roadway, landscaped medians, and stormwater management areas such as detention ponds. Exhibit 8-3 illustrates an urban cross section with a landscaped median and Exhibit 8-4 illustrates a raised median. These landscape features may include grass, low vegetation, planting areas, rock, mulch, and street trees. These features may also be used as a stormwater management tool,

   Exhibit 8-3
   Urban Cross Section with a Landscaped Median

   Exhibit 8-4
   Urban Cross Section with a Raised Median

as described in Section 8.5. Adequate roadside clearance should be maintained for landscape features integrated into the design. Chapter 9, Section 9.2 provides additional information on roadside clearance.

Exhibit 8-5
On-Street Parking in a Downtown Setting

Exhibit 8-6
Parking with a Bicycle Facility

4. **Parking.** On-street parking is a consideration in urban environments, particularly in commercial areas with multiple businesses along a corridor. Exhibit 8-5 illustrates parking in a downtown setting and Exhibit 8-6 illustrates parking with a bicycle facility. There are several types of parking designs, such as parallel parking and angled parking (both forward-in and back-in). There are trade-offs with each design, in terms of the footprint, the number of spaces that can be accommodated, the potential safety impacts, and ease of use by drivers. Parking designs should also consider the interaction between parking maneuvers and bicycles. Parking spaces should be designed with consideration of the specific need and local context of each facility. In areas with potential for loading, parking lanes may be designed to be wider to accommodate these maneuvers.

5. **Crown/Cross Slope.** Urban roadways typically have a crown cross section with the crown at the center of the road with drainage to the outside. A crown that is offset from the center of the road may be used to avoid impacts along the corridor or to match an existing roadway cross section that differs in elevation from one side to the other. In addition to an offset crown, different cross slopes on each side of the crown point may be used. The drainage design should reflect the new flow patterns as a result of this offset crown. Pavement preservation projects should consider the impact of various methods of paving (e.g., overlay, mill-and-fill). An overlay will likely result in a steeper cross slope in the bicycle lane, parking, or shoulder area, which can impact user comfort and pedestrian crossing slopes.

8.4.2 Intersection Design

Intersection design in urban environments should consider the following design elements:

Exhibit 8-7
Example of a Design Vehicle

The Traffic and Safety Bureau is responsible for the overall intersection design, including accommodating design vehicles and traffic signal design.

1. **Design vehicles.** Urban intersections may be used by vehicles that are unique to the urban environment, such as delivery trucks or fire trucks. Exhibit 8-7 illustrates a Streamline Transit Bus. The design team should identify the design vehicle and a design approach for:
   - accommodating the design vehicle within the intersection area (pavement between curbs without encroaching into opposing lanes); or
   - designing for the vehicle to stay within specific lanes.

   The intersections should be designed for these vehicles to operate safely and efficiently.
2. **Various modes**. Intersections are a meeting point for multiple users of the roadway, particularly in urban environments. As such, they are potential conflict locations due to the various movements and modes. The right-of-way allocation for the various modes and movements must be clear to all users to minimize confusion and improve efficient operations and safety at the intersection.
3. **Adjacent approach access.** Commercial areas in urban environments are likely to have approach accesses near intersections, such as driveways to various retail land uses. The locations of the approach accesses must be determined in considering the proximity of the intersection and ensuring that it does not adversely impact the operations or safety of the intersection. Approach access may be limited if it is found to be too close to the intersection. Additional information on approach access is provided in the *MDT Approach Manual for Landowners and Developers*, located at the following link on the MDT Website.

   MDT Approach Manual for Landowners and Developers

8.4.3 Horizontal and Vertical Alignments

There are unique design characteristics that may be considered in an urban area. The design team should have a clear understanding of the urban roadway type, project context, and existing constraints to make appropriate design decisions. Horizontal and vertical alignment design in urban environments may consider the following design features:

1. **Driver Expectations**. Due to the complexities of designing within urban environments, the resulting roadways may not be what roadway users are accustomed to navigating. Roadways should be designed in such a

way that they meet driver expectations and establish consistency along the facility and/or within the transportation system.

2. **Horizontal Alignment.** Typically, circular curves will be used on roadways in urban conditions. In urban areas, it is acceptable to use compound curves to avoid obstructions, minimize right-of-way impacts and match existing topography. MDT has adopted the use of a maximum rate of superelevation (e_{max}) of 4 percent for the selection of minimum curve radius and superelevation rates for urban design. Typically, the axis of rotation is about the centerline of traveled way, but unique circumstances such as turn lanes and offset crowns may require a shift in the axis of rotation. Deflection angles of 1 degree or less without horizontal curvature may be appropriate for urban streets. At intersections, higher deflection angles may be acceptable depending on design speed, traffic volumes, and type of traffic control. Offsets through an intersection should be evaluated on a case-by-case and MDT may consider a transition across the intersection no greater than 6 feet (less preferred) based on the context.
3. **Vertical Alignment.** Developing profile grade lines in urban areas often is more challenging due to limited right-of-way, closely spaced intersections, the need to meet existing roadside development, and accommodating drainage on curbed streets. Long vertical curves and grades on urban streets are generally impractical because in most cases the profile grade line must allow the roadway cross section to match existing conditions. No minimum vertical curves lengths are provided for urban streets. Vertical curves are not required when the algebraic difference in grades is less than 1.0 percent. When practical, the vertical point of intersection (VPI) should be located at intersections. Fairly flat approach grades should be provided at intersections to accommodate vehicles pulling away from a stopped position and to provide accessible cross slopes at pedestrian crossings. Using K-values to determine if vertical curves meet minimum stopping sight distance (SSD) may not be reliable, because curve lengths are typically shorter than the minimum SSD in urban conditions. Therefore, curves should be checked graphically to determine if they meet minimum SSD requirements.

Chapter 7, Section 7.3.2 provides additional information on accessibility considerations.

8.4.4 Traffic Calming

There are areas within an urban environment in which lower speeds are more appropriate, such as collectors and local roads. To encourage lower speeds in these areas, vertical and horizontal traffic calming measures may be implemented as part of the roadway design.

- Vertical traffic calming measures may include: speed humps, speed tables, and/or raised intersections.
- Horizontal traffic calming measures may include curb extensions, mini roundabouts, and/or chicanes.

Additional information on traffic calming measures can be found on the ITE website on traffic calming measures (4), which can be accessed through the following link:

ITE Traffic Calming Measures

8.5 DRAINAGE DESIGN

Drainage design in urban environments has the following considerations.

Exhibit 8-8
Drainage example

Valley Center Road, Gallatin County, MT

1. **Low points.** All low points in curbed sections should have drainage inlets. Exhibit 8-8 illustrates a drainage example. Additional drainage inlets may be required between low points to keep drainage spread widths from encroaching into travel lanes. When feasible, the roadway should be designed to drain water away from pedestrian crossings. Where this is not possible, drainage inlets should be installed just upstream of pedestrian ramps.
2. **Crown.** When the roadway crown is offset to match roadside improvements or avoid conflicts, it may change drainage patterns by placing additional drainage on one side of the roadway. In such cases, the appropriate drainage features should be in place to handle the additional drainage. Existing drainage feature capacities should be checked to ensure sufficiency or to determine if an improvement is required.
3. **Drainage Inlets.** Drainage inlets should not be located in designated bicycle lanes, whenever possible and covers should have a bicycle-friendly design.
4. **Flat Grades.** When reconstructing a curbed roadway with existing drainage challenges caused by very flat grades, the new roadway grade line may need to be raised (rolled) between drainage inlets to provide sufficient flow line grades at the curb. In some cases, such as areas where the curb and adjacent sidewalk must match multiple existing building accesses, a separate curb grade may be used to roll the grade quickly between closely spaced drainage inlets.
5. **Stormwater**. Landscaping in urban environments provides opportunities for stormwater management. Drainage mechanisms can be incorporated in the roadway cross sections by using buffer areas and/or bioswales.

8.6 BALANCING TRADE-OFFS AND OBJECTIVES

Urban design projects often present unique challenges for making decisions within a constrained environment with multimodal needs, varying land use, and existing utilities. To make appropriate design decisions that meet the project objectives and serve the target users of the facility, the design team should have a clear understanding of the trade-offs of each decision. This includes balancing the project objectives for the design, operations, and safety of the facility. The design team should coordinate closely with the Traffic and Safety Bureau to understand the operational and safety trade-offs for each design decision.

Two key techniques to use in balancing competing objectives and understanding the trade-offs are (a) context-sensitive design, and (b) flexibility in design practices. While the two are related and complementary, they bring different aspects to the design process.

Local officials may have knowledge of approved plans and an understanding of the overall project "vision" that can help start a project off in the right direction.

8.6.1 **Context-Sensitive Design**

Context-sensitive design is a key aspect of designing in an urban environment to produce a successful project. One of the most effective methods to achieve successful projects in an urban setting is to engage the public and local officials early and often throughout the design project. In an urban environment, stakeholders are often adjacent to and familiar with the project and can easily see the impacts of each design improvement and the decisions associated with the project. Public involvement can help identify the needs of users and provide insight on the project constraints and overall objectives. Building relationships with the public during the project process and getting these insights can help the design team understand the trade-offs and make decisions that align with the public's priorities.

An effective public engagement process that results in community-based solutions typically reflects the following key elements:

- Identify a group of key stakeholders who are most directly affected by the project and represent a range of diverse interests. These can include, but are not limited to, residents, business owners, leaders of community organizations, transportation providers, elected officials, and affected public agencies. Key stakeholders are most effective if they are engaged throughout the project, they bring their perspective to the project but are also willing to listen and adapt to others' opinions, and they are willing to be a champion for the project in representing it to others.
- Provide the various stakeholders, local officials and general public a basic understanding of the components and implementation tools of a project.
- Integrate several educational sessions into the meetings and public workshops so that the stakeholders and general public gain a better understanding of the geometric, safety, operational, and environmental constraints and opportunities associated with a project.
- Engage the stakeholders and general public to develop formal concepts in a workshop environment. This approach makes them part of the

solution rather than merely commenting on concepts developed by others.

- Continue with public involvement throughout the project to keep the public informed and ensure that the design meets the original intent of project. It is particularly valuable to be able to demonstrate responsiveness to public input.

The *MDT CSS Guide* provides additional information on conducting a CSS Process that includes effective public involvement to achieve the project purpose *(3)*.

8.6.2 **Flexibility in Design Practices**

The guidelines in this RDM are intended to provide the design team with a set of preferred practices that will suffice the majority of the time, with the flexibility to use good engineering judgment where needed to deviate from these practices in a thoughtful and appropriate way. A context-sensitive design, as discussed in the previous section, may require flexibility around design values. When considering flexibility around the preferred practices, it is the responsibility of the design team and the engineer-in-responsible-charge to answer each of the following questions:

- Why does this specific value exist? Are there documented safety, operational, or other reasons for the value being what it is?
- What are the trade-offs associated with a variance from this value? Quantify these trade-offs wherever possible using evaluation tools.

A performance-based design approach integrated into the road design project development process enables design team to make informed decisions about the performance trade-offs. This is especially helpful when developing solutions in fiscally and physically constrained environments. Examples of performance-based tools that can be used as a resource for conducting a project with this approach are described in Chapter 1.

The MDT context specific and scope specific process is intended to be the primary method for documenting design decisions where variations from *MDT Baseline Criteria Practitioner's Guide* are being proposed *(1)*. These design decisions are not simply cases of not being able to meet design values; rather they represent an opportunity for the design team to use good engineering judgment to make the best decisions for a particular project. Additional information on design exceptions is available in Chapter 2, Section 2.9.

8.7 REFERENCES

1. Montana Department of Transportation (MDT). *Baseline Criteria Practitioner's Guide*. MDT, Helena, MT, 2021.
2. Institute of Transportation Engineers (ITE). *Urban Street Geometric Design Handbook.* ITE, Washington, D.C., 2008.
3. MDT. *MDT Context Sensitive Solutions Guide*. MDT, Helena, MT, 2015.
4. ITE. Traffic Calming Measures Website: https://www.ite.org/technical-resources/traffic-calming/traffic-calming-measures/