MONTANA DEPARTMENT OF TRANSPORTATION

ROAD DESIGN MANUAL

Chapter 1

Road Design Guidelines and Procedures

January 2026

Contents

Chapter 1

Road Design Guidelines and Procedures

1.1 INTRODUCTION

Chapter 1 introduces the Montana Department of Transportation (MDT) *Road Design Manual (RDM)* by describing the manual's purpose, scope, and primary definitions. This chapter presents the nationally recognized perspective of the project development process and introduces topics such as performance-based road design and multimodal design considerations. Chapter 1 includes an overview of MDT road design activities, process, and project coordination. This chapter sets the basis for the entire manual by outlining key concepts and providing a fundamental understanding of the design policies and procedures for executing a design project within MDT.

1.1.1 Purpose of the Manual

The *RDM* has been developed to provide uniform design practices for MDT design teams and consultant personnel preparing contract plans for projects involving MDT facilities. While the design team should use the guidance and criteria presented in the *RDM* to execute the design project, the *RDM* should not be considered a standard which must be met regardless of impacts.

Engineering judgment is the evaluation of available pertinent information and the application of appropriate principles for the purpose of making design decisions.

The *RDM* presents a majority of the information that is typically required throughout the course of a roadway design project. However, the design team must exercise engineering judgment when making decisions to execute a design approach that meets the desired outcomes of a project within the context of that project. This may require innovative design approaches, consulting with other departments and staff, and even additional research into highway literature to reflect the most recent best practices.

1.1.2 Scope of the Manual

The *RDM* outlines the design process, design team coordination, and design principles and approaches for various types of projects. Design controls and considerations are presented for horizontal alignment, vertical alignment, and cross sections for the range of roadway facility types. Design elements, such as drainage, roadside safety, and traffic control during construction are presented, with references to detailed plans and additional resources within MDT. The *RDM* presents design considerations for various modes of travel in both rural and urban design environments. Geometric design criteria that are referenced throughout the *RDM* are provided in the *Baseline Criteria Practitioners Guide* *(1).*

An overview of the process of preparing detailed plans, specifications and special provisions are provided within the manual, while actual example plans and specifications are provided in a separate document that is referenced and linked within the *RDM*. The *RDM* contains appendices that provide a comprehensive glossary of definitions for the terminology used throughout the chapters, as well as additional design calculation examples.

Information in this manual is cross-referenced between chapters to provide a clear understanding of the design process and coordination between disciplines.

While the *RDM* contains a large amount of detailed design information, this manual also provides links to other MDT manuals and resources that will be important to the design team throughout the project. The *RDM* was developed in coordination with various MDT bureaus and units to illustrate the interactive relationships among those bureaus and units. Information related to these topics is cross-referenced to provide the design team a clear understanding of the overall design process and close coordination with the multidisciplinary engineering project team. For example, the traffic engineering elements, in particular, will serve as important resources for the design team when projects include coordinating the geometric design of intersections, interchanges, and other traffic engineering elements.

All numerical values presented within the text and exhibits are presented in United States (U.S.) Customary Units.

1.1.3 Definitions

This section presents the specific qualifying words used throughout the *RDM* and provides definitions for overarching key terminology. Appendix A provides a comprehensive glossary of terminology for the entire *RDM* and cross references appropriate chapter content.

1.1.3.1 Qualifying Words

Many qualifying words are used throughout design projects and within the *RDM*. For consistency and uniformity in the application of various design criteria, the following definitions apply:

1. **Shall, require, will, must.** A mandatory condition. The design team is obligated to adhere to the criteria and applications presented in this context or to perform the evaluation indicated. For the application of geometric design criteria, the *RDM* limits the use of these words.
2. **Standard.** Indicating a design value which cannot be changed without formal documentation, such as a design exception. Therefore,

"standard" is not used in the *RDM* to apply to geometric design criteria, except for the design exception discussion in Chapter 2, Section 2.9.

3. **Criteria.** A term typically used to apply to design values, usually with no suggestion on the criticality of the design value. Because of its basically neutral implication, the *RDM* frequently uses "criteria" to refer to the design values presented.
4. **Should, recommend.** An advisory condition. The design team is strongly encouraged to follow the criteria and guidance presented in this context, unless there is reasonable justification not to do so.
5. **Guideline.** Indicating a design value which establishes an approximate threshold which should be met if considered practical.
6. **Target.** Selected criteria that the design team is striving to achieve. However, not meeting these criteria will typically not require a justification.
7. **Policy.** Indicating MDT practice which MDT generally expects the design team to follow, unless otherwise justified.
8. **May, could, can, suggest, consider.** A permissive condition. The design team is allowed to apply individual judgment and discretion to the criteria when presented in this context. The decision will be based on a case-by-case assessment.
9. **Desirable, preferred.** An indication that the design team should make every reasonable effort to meet the criteria and that they should only use a less desirable or less preferred design after due consideration of the desirable or preferred design.
10. **Ideal.** Indicating a condition that may not exist in reality or be achievable under practical constraints (e.g., traffic capacity under "ideal" conditions).
11. **Minimum, maximum, lower, upper, (limits).** Representative of generally accepted limits within the design community but not necessarily suggesting that these limits are inflexible.
12. **Practical, feasible, cost-effective, reasonable.** Advising the design team that the decision to apply the design criteria should be based on a subjective analysis of the anticipated benefits and costs associated with the impacts of the decision. No formal analysis (e.g., cost-effectiveness analysis) is intended, unless otherwise stated.
13. **Possible.** Indicating that which can be accomplished. Because of its rather restrictive implication, this word will not be used in the *RDM* for the application of geometric design criteria.
14. **Significant, major.** Indicating that the consequences from a given action are obvious to most observers and, in many cases, can be readily measured.
15. **Insignificant, minor.** Indicating that the consequences from a given action are relatively small and not an important factor in the decision-making for geometric design.

Additional information regarding design standards and design decisions is discussed in Chapter 2, Section 2.9.

16. **Typical.** Indicating a design practice that is most often used in application. However, this practice does not necessarily represent the "best" treatment at a given site.
17. **Acceptable.** Design criteria which do not meet desirable values, but yet is considered to be reasonable and safe for design purposes.

1.1.3.2 Key Terminology

While some chapters include key terminology as part of the introduction to the chapter, a comprehensive list of definitions and acronyms are provided in Appendix A. The definitions provided in Appendix A are cross-referenced with relevant chapter material to allow design teams to reference appropriate terms and design concepts throughout the *RDM.*

1.2 PROJECT DEVELOPMENT PROCESS

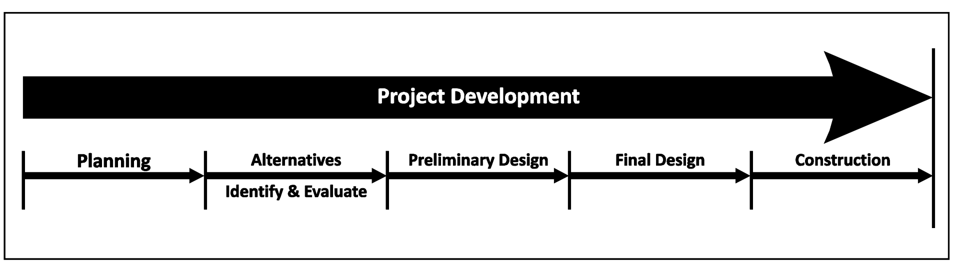
The project development process outlines the primary stages that occur within a transportation project. The following sections provide an overview of the project development process stages, an overview of performance-based road design and describe the MDT-specific activities and project development stages.

1.2.1 National Perspective

A clear understanding of each stage of the process and design team coordination can help align design decisions with the desired outcomes.

Exhibit 1-1 provides an overview of a representative project development process. Road design may have limited roles in the planning stage of project development and may become most relevant during the alternatives identification and evaluation stage and the preliminary design stage. A clear understanding of each stage of the process and design team coordination throughout the entire project can help align design decisions with the overall desired outcomes of the project. Descriptions for each stage of the project development process are provided below.

Exhibit 1-1
Representative Project Development Process *(2)*



1.2.1.1 Planning

Planning often includes exercises such as problem identification and other similar steps to establish a connection between the project purpose, and the geometric concepts being considered. Planning studies could include limited geometric concepts on the general type or magnitude of project solutions to support programming *(2).*

1.2.1.2 Alternatives Identification and Evaluation

The project needs identified in prior planning studies inform concept identification, development, and evaluation. At this stage, understanding and documenting the project context and intended outcomes are needed so potential solutions may be tailored to meet project needs within the opportunities and constraints of a given effort. This stage continues the meaningful and continuous stakeholder engagement to be carried throughout the project development process *(2)*.

1.2.1.3 Preliminary Design

Concepts advancing from the previous stage are further refined and screened during preliminary design. In complex or detailed projects that may impact sensitive areas, the preliminary design and subsequent documentation is used to support complex state or federal environmental clearance activities. Preliminary design builds upon the work and geometric evaluations conducted during alternatives identification and evaluation. Some of the common components of preliminary design are the following *(2)*:

- Horizontal and vertical alignment,
- Typical sections,
- Grading,
- Structures,
- Traffic Operations,
- Signing and pavement markings,
- Illumination,
- Utilities,
- Right-of-Way,
- Environmental Impacts,
- Drainage, and
- Geotechnical considerations.

1.2.1.4 Final Design

The design elements are advanced and refined in final design. The project plans undergo various review periods before completing the final set of plans, specifications, and estimates. During this stage, there is relatively little variation in design decisions as the project advances to the final plan. Functionally, in this stage of the project development process there are few ways of modifying the design plans in a way to substantially affect or attain targeted performance measures *(2)*.

1.2.1.5 Construction

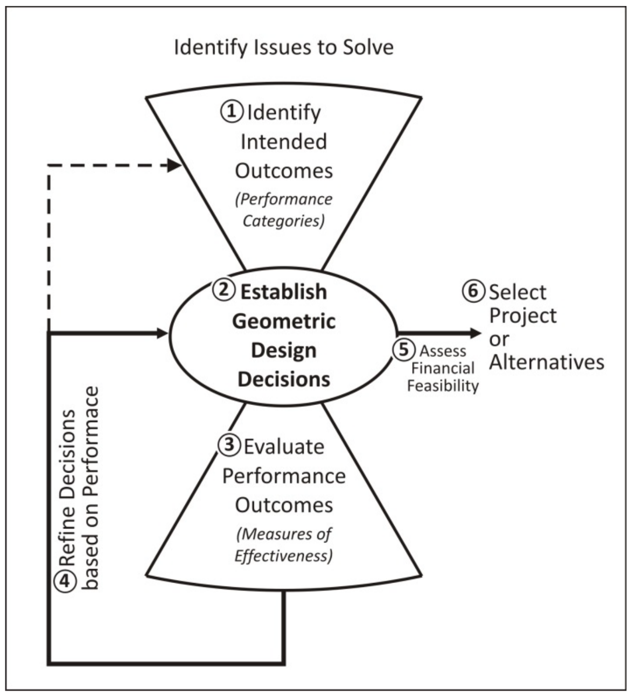
In addition to the final product, construction activities could include geometric design decisions related to temporary roadways, connections, or conditions that facilitate construction activities *(2)*.

1.2.2 Performance-Based Road Design

Incorporating a performance-based road design approach into the road design project development process enables design teams to make informed decisions about the performance tradeoffs. This is especially helpful when developing solutions in fiscally and physically constrained environments. National activities and associated publications, such as Federal Highway Administration's (FHWA) Performance-Based Practical Design initiatives and *NCHRP Report 785, Performance-Based Analysis of Geometric Design of Highways and Streets, (NCHRP Report 785)* have resulted in a framework for how this approach can be executed within a design project *(2, 3)*. While design teams may have been using similar practical design approaches in the past, clear documentation of a performance-based approach can encourage effective problem-solving, collaborative decision-making, and an overall greater return on infrastructure investments.

A fundamental model for this approach documented in *NCHRP Report 785* is shown in Exhibit 1-2 *(2)*.

Exhibit 1-2 Fundamental Model for Performance-Based Analysis for Geometric Design of Highways and Streets ***(2)***



Source: *NCHRP Report 785*

Exhibit 1-2 illustrates the following basic steps in performance-based analysis to inform geometric design. Each step of this approach is further described below *(2)*.

1. **Identify intended outcomes** (desired project performance) and project purpose and need. This may include any number of project context-driven categories helping to identify project objectives. Identifying project purpose and need early in the project development process, such as the planning stage, can help guide the project team as decisions are made in the subsequent stages of the project.
2. **Establish geometric design decisions.** This could include establishing design criteria and developing preliminary designs. Design criteria identified for use may be Baseline Criteria or Context Specific Criteria.

Additionally, scope specific exceptions for meeting select criteria should be identified. A preliminary review of potential design exceptions required for the project may be identified at this stage. Documenting design decisions and the considerations supporting those choices that result in flexible design solutions is a key component in managing project risk. Additional information on documentation for design exceptions is provided in Chapter 2, Section 2.9.

3. **Evaluate performance outcomes.** This is the point at which the performance outcomes of the geometric design choices are evaluated. Establishing the geometric performance allows an assessment of the effectiveness of the design decision in relation to the project purpose.

4. **Refine decisions based on performance.** Depending on the results of the evaluation of the design performance, there can be an iterative process to refine design decisions to bring resulting performance in line with project purpose. This type of approach can be used as a problem-solving tool throughout a project and a framework for maintaining a consistent project scope throughout each stage of the process.

5. **Assess financial feasibility.** In this step the benefits associated with design choices are assessed to establish the monetary value of the geometric solution compared to the intended project outcomes. Cost estimates and project funding information will be used at this stage to help make project decisions. Additional information on cost estimating is described in Section 1.3.3.

6. **Select project(s) or alternatives.** As project alternatives are deemed viable within the project context, they may be advanced for more detailed evaluations and/or environmental reviews. At this stage of the project, a selected alternative may be carried forward to a final design stage where additional road design details are reviewed and design plans are prepared.

The fundamental model provides a decision making approach that can help the design team to develop and evaluate design choices within each unique contextual design environment. The focus is on performance improvements that benefit the project and system needs and allows decisions to be made based on performance analysis.

The fundamental model provides a decision making approach that can help the design team to develop and evaluate design choices.

Executing this approach involves using relevant, objective data to support the design decisions and developing an analytical approach tailored to the project purpose and need. This will require an awareness of the resources available to quantify specific performance measures or qualitatively describe the anticipated effect of a given roadway, intersection, or interchange design. Examples of performance-based tools that can be used as a resource for conducting a project with this approach are described below:

- American Association of State Highway and Transportation Officials (AASHTO) *Highway Safety Manual (HSM)* provides factual information and proven analysis tools for crash frequency prediction *(4).* The *HSM* helps users integrate quantitative crash frequency and severity performance measures into roadway planning, design, operations, and maintenance decisions. *HSM* analytical tools allow users to assess the safety impacts of transportation project and program decisions *(2).*

- The *HSM* predictive tools have been integrated into FHWA's *Interactive Highway Safety Design Model (IHSDM)*. *IHSDM* is a suite of software analysis tools developed by FHWA that are used to evaluate the safety and operational effects of geometric design decisions on highways *(5). IHSDM* applies *HSM* methodologies to estimate safety performance. It can be used to provide estimates of a highway design's expected safety and operational performance and checks existing or proposed highway designs against relevant design policy values *(2).*
- The *Highway Capacity Manual (HCM)*, published by the Transportation Research Board (TRB), presents the operational performance measures and evaluation procedures for various modes and types of facilities. The *HCM* includes methodologies for evaluating the operations of freeways, weaving areas, freeway/ramp junctions, two-way two-lane facilities, and intersections *(6)*.
- MDT's *Safety Information Management System (SIMS)* is a database and analysis system that allows users to screen the roadway network and complete reviews of specific locations using *HSM* tools and methodologies. This system provides increased access to crash data and advanced crash data query capabilities. *SIMS* incorporates many roadway elements into the database which allows for comparisons of crashes versus roadway characteristics. In addition, this system allows tracking of safety projects for before and after evaluations. Additional information on using this system should be coordinated with the Traffic and Safety Bureau.

In addition, *NCHRP Report 785* (Section 4.4.1) contains table summaries to help identify the available resources for evaluating the performance of roadway segments and nodes (intersections and interchanges) as it relates to various project priorities. Other performance-based resources available are supplemented with spreadsheet or software tools to help expedite their application, and some include graphical representations or table summaries of the relationships to provide guidance early in a project's development *(2)*.

Performance-based road design provides a clear way to document decisions and the justification for these choices.

A performance-based road design approach can be beneficial to executing design decision documentation. The steps taken within this approach help identify the need for design exceptions early in project development. It provides a clear way to document design decisions and the considerations supporting those choices that result in a flexible design solution. Documenting design decisions helps manage tort liability risk. Chapter 2, Section 2.9 provides additional information on MDT's design exception process and considerations.

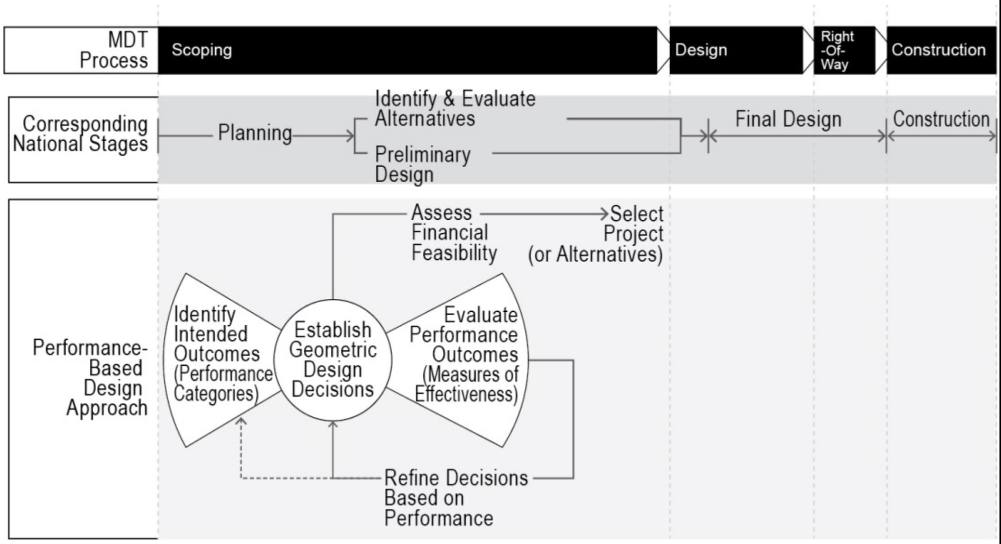
The information in this section is consistent with the ideas and values presented in the MDT Context Sensitive Solutions Guide *(MDT CSS Guide)*. The *MDT CSS Guide* and the performance-based road design approach emphasize agency and community values and considers tradeoffs in decision making based on available funding. The *MDT CSS Guide* can be a valuable resource for gathering additional information about public involvment, balancing tradeoffs, and methods for reaching desired project outcomes *(7)*.

1.2.3 MDT Project Development Process

The MDT project development process is similar to the project development process described in Section 1.2.1. However, the design activities within each stage may differ from other State agencies and the nomenclature used is specific to MDT. The majority of MDT projects are developed from the planning stage to the construction stage by the same design team. The typical activities within a MDT project are executed through four primary stages: *Scoping, Design, Right-of-Way, and Construction*. Exhibit 1-3 illustrates where MDT's project development process, the nationally recognized project development process, and performance-based road design approach coincide with each other.

The typical design activities within a MDT project are executed through three primary stages: *Scoping, Design and Right-of-Way*.

Exhibit 1-3
Relationship between Project Development Processes



The following sections describe the MDT-specific stages, design activities that occur within each stage, and how these activities relate to the representative national project development process. Some of the activities shown below may only occur on capital improvement projects designed by MDT. Projects with a reduced scope may have different or fewer design activities. There are some projects that may include a planning stage prior to the scoping stage. Design projects will require coordination between multiple disciplines and departments internal and external to MDT. The discussion below provides an overview of the road design activities. There are other activities that occur within each project stage for various other disciplines.

Additional information on internal and external MDT coordination is described in Section 1.3.

1.2.3.1 MDT Scoping Stage

The design team tasks within the MDT Scoping Stage are described below. Project initiation activities occur prior to the Preliminary Field Review (PFR) and may include identifying the project catalyst and funding source, initiation of stakeholder engagement, and identifying the project purpose and need. Upon project nomination, the following tasks within this stage are completed:

- Conduct Preliminary Field Review (PFR)
    - Continue Stakeholder Engagement

  - Identify Project Context
  - Clarify Intended Outcomes
  - Refine Purpose and Need
  - Prepare PFR Report
- Obtain Public Input
- Conduct Survey
- Gather Design Input
- Conduct Preliminary Plan Preparation
- Establish/Review Alignment and Grade
- Prepare Scope of Work (SOW) Report
- Approve Scope of Work

The MDT Scoping Stage corresponds to the Planning, Alternatives Identification and Evaluation, and Preliminary Design Stages of the representative national project development process.

Corresponding National Planning Stage

The portion of the MDT Scoping Stage that corresponds to the national Planning Stage is not as extensive as other stages throughout the project and relies on other bureaus and units to provide operational and safety analyses. The Planning Stage corresponds to the Preliminary Field Review (PFR). Prior to the PFR, there are other planning activities that occur including considerations for project catalyst, initial stakeholder engagement, and project context. A clear understanding of these considerations helps frame the basis for outlining the project desired outcomes and project purpose and need.

As described previously in Section 1.2.2, establishing the project purpose and need early in the project development can help the design team make decisions throughout the project and is a key component of executing performance-based design approach. The purpose and need identification is followed by determining the preliminary scope and budget, and prioritizing the project for inclusion in the construction program. Once a project becomes a priority, funding is programmed and a design team is assigned that will complete the project. The Preliminary Field Review, and subsequent PFR Report, typically completes the Planning Stage and begins the next stages for the design.

Corresponding National Alternatives Identification & Evaluation, and Preliminary Design Stages

NEPA documentation may be completed within the Planning Stage and will be completed by the end of the Scoping Stage.

Within the MDT Scoping Stage, the two stages of the national project development process, Alternatives Identification and Evaluation and Preliminary Design, are generally executed concurrently. The Scoping Stage provides the greatest opportunity for evaluating design alternatives and understanding the tradeoffs for each design alternative. In this part of the Scoping Stage, the design team gathers all data and project information, such as surveys, public input, and anticipated future conditions, that are necessary to advance the project into final design. At this stage of the process, a performance-based road design analysis approach may help provide a clear framework for making design decisions and selecting alternatives consistent with the intended project outcomes. Performance-based analysis tools, such as the *HSM* and *IHSDM* can help provide quantitative data for supporting design decisions *(4, 5)*.

During the Scoping Stage, the design team completes the necessary documentation for the National Environmental Policy Act (NEPA) and Montana Environmental Policy Act (MEPA), and the design is advanced to allow for the Scope of Work to be finalized and approved. Design plans are advanced to an approximate 30-percent level of detail, including proposed lines and grades, mainline grading and surfacing design and preliminary design of major drainage structures. In addition, avoidance measures for impacts to sensitive areas have been taken into account and documented.

Proposed horizontal and vertical alignments are developed and approved through the Alignment and Grade Review process during the Scoping Stage.

1.2.3.2 MDT Design Stage

The MDT Design Stage includes the following design team tasks:

- Prepare Plans for Plan-in-Hand
- Conduct Plan-in-Hand Inspection
- Determine Construction Limits

Final construction limits are provided to all units where mitigation of impacts are required, which is typically the Right-of-Way, Utilities, and Environmental Design Units.

Corresponding National Final Design Stages

The beginning of the MDT Design Stage will typically include some activities that may correspond to the end of the corresponding national stages of Alternatives Identification and Evaluation and Preliminary Design, as shown in Exhibit 1-3.

The remainder of the MDT Design Stage corresponds to the Final Design Stage of the representative national project development process. The MDT Design Stage involves refining the design to the point where final construction limits and impacts are known. The design is advanced to an approximate 80-percent level of detail, including designing features that have the potential to impact construction limits, such as irrigation, approaches, or widening for turn lanes and guardrail. Final construction limits are provided to all units where mitigation of impacts are required, which is typically the Right-of-Way, Utilities, and Environmental Design Units. During this stage, minimizing impacts to known sensitive areas occurs and those that could not be avoided are documented. MDT's corresponding Final Design Stage continues to the next MDT design stage, *Right-of-Way*, shown below.

1.2.3.3 MDT Right-of-Way Stage

The MDT Right-of-Way Stage includes the following design team tasks:

- Design Miscellaneous Features
- Conduct Final Plan Review
- Prepare Final Plan Updates and Revisions
- Check Plans
- Complete Final Plans, Specifications- & Estimate (PS&E)

Changes to plans due to right-of-way negotiations or contractor/construction proposals should be checked to ensure the overall purpose and need of the project is still being met.

- Submit final PS&E package to Engineering Construction Contracting Section (ECCS) Coordinating with:
    - Right-of-Way Acquisition
    - Utility Agreements and Relocation
    - Environmental Permits

Corresponding National Final Design and Construction Stages

The MDT Right-of-Way Stage also occurs within the Final Design Stage of the project development process. During the Right-of-Way Stage, plans are completed, all impacts are mitigated and permitted, and the right-of-way required for the project is acquired.

1.2.3.4 MDT Construction Stage

Once the project reaches the MDT Construction Stage, the Construction Bureau executes the project construction. The road design team has limited involvement in the Construction Stage, other than to provide support to the Construction Bureau by answering design-related questions and assisting with change orders.

1.3 MDT ROAD DESIGN PROCESS AND COORDINATION

Section 1.2 provided an overview of the nationally recognized project development process stages, an overview of performance-based road design and described the MDT-specific activities and project development stages. The purpose of Section 1.3 is to provide additional details on the MDT road design process and coordination that occurs on projects. The following information will introduce the MDT internal and external units and provide an overview of engineering management, cost estimating and project reports.

1.3.1 Road Design Coordination

The design team must coordinate with many units internal and external to MDT.

During the development of a road design project, the design team must coordinate with many units internal and external to MDT. This section provides additional resources for understanding how the various units within MDT coordinate during various stages of the project. The design team works with representatives from many other groups and disciplines.

1.3.1.1 Internal

Throughout the various stages of a project, the design team will communicate and work with many other MDT internal units outside of the Engineering Division. The following link on the MDT Website provides the organizational chart for all divisions and departments within MDT to provide an overview of the various groups the design team may coordinate with throughout a project.

[MDT Organizational Chart]

The following links provide the design team activities within the Engineering Project Scheduler (EPS):

MDT EPS Design Team Activities (consultant projects)

MDT Road Design Activities (for internal design only)

Additional information regarding internal MDT coordination, organizational structure, and group interaction is described in Appendix D.

An overview of the Engineering Division is described below, which includes information about the Preconstruction and Construction programs. Environmental Services is located within the Rail, Transit and Planning Division. Within the Districts, there are parallel coordination activities.

Preconstruction

Preconstruction involves planning and developing the details of construction projects. This includes determining the project location and design features, gathering public input and working with local officials, acquiring property for right-of-way and relocating utilities. Preconstruction functions include:

- Bridge
- Consultant Design
- District Staff
- Engineering Information Services/CADD
- Highways
- Hydraulics
- Survey
- Right-of-Way
- Traffic and Safety

Construction

Construction includes Construction Engineering, Construction Administration, Engineering Construction Contracting, Materials, Pavement Analysis, and Geotechnical. Construction is responsible for processing construction contracts for award to private contractors and managing all construction activities on all State-administered projects. The design team also coordinates with construction staff during project design.

Environmental Services

The Environmental Services Bureau is responsible for identifying cultural and environmental resources; estimating potential impacts; recommending avoidance, minimization, and mitigation features and obtaining permits associated with the location, design, construction, operation and maintenance of transportation projects within Montana. Bureau staff members are an essential part of the project development team. Their work addresses a variety of applicable state, federal, and tribal laws that require consideration of social, economic, and environmental impacts and protection of important resources *(7)*.

Specific individuals and departments that the design team will coordinate with to submit project materials and obtain review comments are further described in the Distribution Section of the MDT Project Reports. A link to the MDT Project Reports is provided in Section 1.3.4.

1.3.1.2 External Partners

There are various partners external to MDT that may be involved in planning, developing, and implementing the transportation system. Federal Highway Administration (FHWA) is the primary federal partner, which provides a majority of the funding for transportation projects in Montana. Additional information on the external resource, regulatory, and local agencies that MDT may coordinate with on a project are described below, and can also be found in the *MDT CSS Guide (7)*.

1. **Federal Highway Administration (U.S. Department of Transportation).** The Federal-aid highway program is administered by FHWA, providing financial and technical assistance to the States and metropolitan planning organizations to plan, construct, and improve the National Highway System and other roads and bridges eligible for federal aid. The program also addresses economic and social factors affected by transportation systems and infrastructure development. Assistance is available for communities through State-administered, federally-assisted planning, development, safety and operational funding. The program fosters the development of a safe, efficient, and effective highway and intermodal system nationwide. FHWA has primary responsibility for compliance with the National Environmental Policy Act and the Uniform Relocation Assistance Act, as examples, and other statutory and regulatory requirements.
2. **U.S. Fish and Wildlife Service (U.S. Department of the Interior).** The U.S. Fish and Wildlife Service work to protect threatened and endangered species, migratory birds, freshwater fish and wildlife habitats. They administer provisions of the Endangered Species Act, Bald and Golden Eagle Protection Act, Migratory Bird Treaty Act, and other wildlife laws.
3. **U.S. Forest Service (U.S. Department of Agriculture).** The U.S. Department of Agriculture Forest Service's fundamental responsibility is focused on stewardship and sustainability of the National Forests and the associated resources.
4. **Bureau of Land Management (U.S. Department of Interior).** It is the mission of the Bureau of Land Management (BLM) to sustain the health, diversity and productivity of the public lands for the use and enjoyment of present and future generations. The BLM's task is to recognize the demands of public land users while addressing the needs of traditional user groups.
5. **U.S. Army Corps of Engineers (U.S. Department of Defense).** The United States Army Corps of Engineers is primarily responsible for

regulating the placement of fill material into waters of the U.S. by authority of the Clean Water Act.

6. **U.S. Environmental Protection Agency (EPA).** The mission of the EPA is to protect human health and the environment. In Montana, the EPA has delegated much of the regulatory authority to the State but maintains oversight responsibility for a variety of programs, such as the Clean Water Act and the Resource Conservation and Recovery Act (Superfund sites). The EPA has oversight for environmental regulation on sovereign Indian lands.
7. **Montana Department of Environmental Quality (DEQ).** The DEQ is responsible for ensuring clean air, water, and land in the state and for protecting Montana citizens' constitutional rights for a clean and healthful environment. As a regulatory agency, the DEQ is responsible for enforcing various state environmental regulations and administering a number of federal environmental protection laws, including the Clean Air Act, the Clean Water Act, and the Resource Conservation and Recovery Act. The Montana DEQ reviews MDT projects to ensure that they have the necessary environmental permits and clearances.
8. **Montana Department of Fish, Wildlife & Parks (FWP).** The Montana FWP's primary role is advising and providing technical information regarding wildlife and fish. The FWP administers the Montana Stream Protection Act and oversee properties acquired or improved with funds from the land and water conservation fund (Section 6(f)). MDT has agreements in place with the FWP to provide consultation services, and the FWP is also a participant in interagency coordination for transportation projects under development.
9. **Montana Department of Natural Resources & Conservation (DNRC).** The Montana DNRC deals with water resource issues. Their programs include groundwater protection, floodplain management, stream channel protection, water allocations/water rights, and water planning.
10. **Montana State Historic Preservation Office (SHPO).** The Montana State Historic Preservation Office is a division of the Montana Historical Society. The mission of SHPO is to preserve Montana's historic, archaeological and cultural places. The role of the State Historic Preservation Office in federal project review is to reflect the interests of the State and its citizens in the preservation of Montana's rich cultural heritage through the State Antiquities Act, Section 106 of the National Historic Preservation Act, Section 4(f) of the Department of Transportation Act.
11. **Tribal Governments.** The Montana Department of Transportation regularly works with several tribal governments. This would include a project that impacts land owned by a tribe or provides access to tribal land. In these cases, MDT coordinates with the tribe and tribal government to execute the design project based on established agreements.

12. **Local Government Agencies.** MDT coordinates with local cities and counties on MDT projects that include both State and non-State facilities. These agencies will work collaboratively to ensure that appropriate design processes and objectives are accomplished by the collective design team.
13. **Consultants.** MDT may use a consultant for a road design project. When a consultant is used, the Consultant Design Bureau is the primary contact with the consultant. The Highways Bureau will provide technical support on the project and review the plans prepared by the consultant.
14. **Railroads.** Railroad departments and authorities may be involved in a project that involves a roadway facility that crosses through or is adjacent to an existing railroad.

1.3.2 Engineering Management

The Preconstruction Engineer is ultimately responsible for managing the delivery of project plan packages to construction as an overall program. District Administrators, through District Preconstruction and Headquarters design managers, are responsible for project delivery. The MDT EPS Support team monitors, maintains and updates the EPS (Engineering Project Scheduler) program which is used to schedule project tasks and monitor preconstruction manpower needs. The following sections provide an overview of the types of managers, correspondence, meetings, project work type codes, and quality assurance and quality control.

1.3.2.1 Types of Managers

Project Design Managers (PDMs) are assigned the responsibility to monitor the design of roadway projects from project inception to when they are delivered to contract. Functional Managers (FMs) are assigned the everyday responsibility of completing the project tasks set forth in the EPS.

PDMs reside primarily in the Highways Bureau, Bridge Bureau, Consultant Design Bureau, Traffic and Safety Bureau, and District offices. The Project Design Manager may act as both PDM and FM, with other FMs residing throughout the Department. The Right of Way Bureau, Environmental Services Bureau, and Construction Engineering Bureau, all have FMs assigned to project activities.

1.3.2.2 Correspondence

As described in Section 1.3.1, the design team will correspond with many people internal and external to MDT. In-house memoranda (electronic) are used by MDT to provide written, interdepartmental information between the various Bureaus, Sections, and Districts. They are used to distribute project reports, process approval requests, request project information, submit project information, distribute policies and for informational purposes.

The design team will likely have correspondence with groups outside of MDT, such as federal, state or local agencies. The design team should work with the project manager to determine the appropriate signatures and policies for out-going correspondence.

Specific individuals and departments that the design team will coordinate with to submit project materials and obtain review comments are further described in the Distribution Section of the MDT Project Reports. A link to the MDT Project Reports is provided in Section 1.3.4.

1.3.2.3 Meetings

Design projects will include multiple meetings to provide information, obtain information and coordinate with other disciplines or teams. It is imperative that all meetings be well planned, attended by the proper individuals, and the information well documented and disseminated to the affected people in a timely manner.

Project Review Meetings are conducted throughout the course of a project to allow others to review the project design and make design decisions. Formal review meetings include the Preliminary Field Review, the Alignment & Grade Review, the Plan-in-Hand Review and the Final Plan Review. In addition, informal meetings are often initiated to gather or disseminate information between the affected parties.

1.3.2.4 Project Work Type Codes

All project documents are required to provide the project work type number in the subject portion of a memorandum. A listing of the standardized project work type codes and definitions used by MDT can be found at the following links on the MDT Website.

Project Work Type Codes

Project Work Type Definitions

The applicable project work type number will be determined when the project is nominated and is verified during the PFR process. It may be revised for the Scope of Work Report.

Changes to the project work type after the Scope of Work Report has been approved require developing a Scope of Work amendment.

1.3.2.5 Quality Assurance/Quality Control (QA/QC)

Establishing an effective and consistent Quality Assurance/Quality Control (QA/QC) process can help ensure each design meets the appropriate level of detail and quality necessary to complete the objectives of the project. This process may include multidisciplinary reviews, peer reviews, performance-based analysis, Value Analysis, and establishing standardized reports. Following the established process and active participation in the QA/QC process can lead to effective and timely projects that accomplish the desired outcomes and meet the quality expected from MDT. If project issues arise, there should be an emphasis on collaborative problem-solving to identify an approach to resolve the issues to allow the project to continue forward.

1.3.3 Cost Estimating

The following information provides a summary of the various pre-construction cost estimates required during project development and the procedures for developing these estimates. Additional cost estimating information and procedures is provided on the MDT Website at the following location:

Cost Estimating Information

Project estimates are used by Fiscal Programming and the Districts to develop the 5-year Tentative Construction Plan (TCP, also known as the *Red Book*) to ensure that sufficient funds are available for construction. The TCP is MDT's best estimate of when projects will be let and what the costs will be. The Highways and Engineering Division and the Districts use the TCP to prioritize project design. Accurate cost estimates ensure that the design team is working on the appropriate projects. If cost estimates are too low, there may not be sufficient funds to complete the designed projects. As a consequence, resources will be focused on projects that may not be let to contract until the next fiscal year. If cost estimates are too high, the TCP will under-estimate the number of projects designed for the fiscal year. This could result in inadequate time to complete designs or even the loss of federal funding.

During project development, several cost estimates are prepared to determine and refine the expected project construction costs. Cost estimates are typically developed at the following project stages:

In addition to the Core Program, there are other program managers including Safety, Bridge, Urban Pavement Preservation, etc. that follow a similar process.

1. **Project Programming/Preliminary Field Review.** The District Office is responsible for nominating projects to be included on MDT's Core Program of Projects. When the District Office submits these nominations, they are also required to submit a conceptual cost estimate for each project. This estimate should be reviewed and revised, if necessary, during the PFR and documented in the PFR Report.
2. **Alignment and Grade Review/Report**. The design team is responsible for determining the first detailed construction cost estimate at this stage of project development.
3. **Scope of Work Report.** If a project does not have an Alignment and Grade Review, the design team will develop the first construction cost estimate which will be included in the Scope of Work Report.
4. **Plan-in-Hand Report.** The design team is responsible for updating the construction cost estimate for the Plan-in-Hand. At this stage of project development, the majority of the project quantities should be available.
5. **Project Scope Changes**. Whenever the scope of the project changes, the design team will be responsible for determining a new construction cost estimate.
6. **Final Plan Review Report.** The cost estimate will be reviewed during the review of the final plans.
7. **PS&E Submittal.** The final cost estimate is provided as part of the PS&E submittal.
8. **Annual Updated Estimates.** Estimates are updated annually to support *Red Book* preparation, as needed.

9. **Engineer's Estimate.** The Engineer's Estimate is developed by the Engineering Construction Contracting Section (ECCS) for programming Construction and Construction Engineering funds, and for comparative purposes for bid letting.

Additional details regarding quantity summaries are provided in Chapter 13.

1.3.4 Project Reports

Project reports are developed to identify potential project-related issues, document alignment determinations, provide an overview of the design features, and outline an in-depth review of all items contained in the project plans and special provisions. MDT road design projects typically develop the following types of project reports throughout the course of the project:

- Preliminary Field Review Report
- Combined Preliminary Field Review Report and Scope of Work Report
- Alignment and Grade Review Report
- Scope of Work Report
- Plan-in-Hand Report
- Final Plan Review Report

Additional information regarding the format, content, and how to prepare the project reports to provide consistent, accurate and appropriate project information can be found at the following link on the MDT Website.

Project Report Templates

In some cases, a project may require special reports to document unique project development approaches and project characteristics. For these instances, the design team should consult with the project manager to identify an appropriate format and content for the report.

1.4 MULTIMODAL DESIGN

Roadway facilities should be designed and operated to enable safe access for all users, including pedestrians, bicycles, motorists, and transit riders of all ages and abilities. The design team should understand the difference between "accommodating" versus "designing for" a given mode and apply consistent principles within the project context. The multimodal design considerations depend on the intended function of the corridor. For example, if a roadway is intended to be designed primarily for mobility for motorized vehicles, the design may "accommodate" other users, such as pedestrians and bicycles. However, if a roadway is intended to primarily serve non-auto users, with mobility for motorized vehicles as a lower priority, the corridor should be "designed for" multimodal users.

Understand the difference between "accommodating" versus "designing for" a given mode and applying consistent principles within the project context.

Pedestrian facilities should be designed to be accessible to all users, regardless of ability. The United States Access Board provides additional resources on accessibility and specific requirements for Accessible Public Rights of Way *(19).*

Chapter 7 of this manual describes the integration of multimodal design in the overall design process. This chapter includes the design principles and approach for a multimodal design, including pedestrians, bicycles, shared use paths, and transit. It also addresses accessibility as it relates to special consideration given to pedestrians with disabilities including accommodating pedestrians with vision or mobility impairments.

1.5 COORDINATION WITH OTHER PUBLICATIONS

The *RDM* is not intended to present all information which may be needed by the design team on a specific project. While the *RDM* does include the majority of the road design information for the vast majority of projects, there may be specific projects or project elements that require referencing other publications to perform a fully comprehensive analysis of the project. The following section provides a summary of the national publications and MDT department publications that can provide additional resources for the design team throughout the design project. Refer to the most recent version of the publications listed below.

1.5.1 National Publications

There are many national publications that can provide resources for the design team throughout a project. Below is a brief description of some relevant national publications, and its application on MDT road design projects. There may be other AASHTO and FHWA documents that the design team may consider to gain additional design information and guidance.

1.5.1.1 American Association of State Highway and Transportation Officials (AASHTO) A Policy on Geometric Design of Highways and Streets (Green Book)

The AASHTO *A Policy on Geometric Design of Highways and Streets*, more commonly known as the *Green Book*, discusses the nationwide policies, practices, and guidance for the geometric design of highways and streets. It is intended to present a consensus view on the most widely accepted approach to the design of a variety of geometric design elements, including design speed, horizontal and vertical alignment, cross-section widths, intersections, and interchanges *(9)*.

Several of the chapters within the *RDM* address geometric design elements. The *RDM*'s geometric design controls and criteria have been based on the *Green Book* but tailored to the prevailing climate, topography and practices within Montana. Also, the *RDM* is intended to clarify, where needed, specific presentations in the *Green Book* and to discuss geometric design information not presently included in the *Green Book*. Where conflicts may exist between the *RDM* and the *Green Book*, the *RDM* will govern.

1.5.1.2 AASHTO Roadside Design Guide

The AASHTO *Roadside Design Guide* presents the nationwide policies, practices and guidance for roadside safety along highways and streets. It is intended to present a consensus view on the most widely accepted approach to providing a reasonably safe roadside for run-off-the-road vehicles. The *Roadside Design Guide* discusses clear zones, drainage appurtenances, sign and luminaire supports, roadside barriers, median barriers, bridge rails, crash cushions and roadside safety within construction work zones. The overall objective of the *Roadside Design Guide* is to recommend an appropriate roadside safety treatment for specific sites considering the consequences of run-off-the-road accidents, specific roadway features (e.g., traffic volumes, design speed, and roadside topography) and construction and maintenance costs *(10)*.

Chapters in the *RDM* that address roadside safety include:

- Chapter 9: Roadside Safety; and
- Chapter 10: Work Zone Traffic Control.

The roadside safety criteria in these chapters are based on the criteria presented in the *Roadside Design Guide* but tailored to the prevailing practices and conditions in Montana. Also, the *RDM* is intended to clarify, where needed, the presentations in the *Roadside Design Guide* and to discuss roadside safety information not included in the Roadside Design Guide. Where conflicts may exist between the *RDM* and the *Roadside Design Guide*, the *RDM* will govern.

1.5.1.3 AASHTO Model Drainage Manual

The AASHTO *Model Drainage Manual (MDM)* presents the nationwide criteria for the hydrologic and hydraulic design of drainage appurtenances for highway projects. The *MDM* discusses the most commonly used hydrologic methods (such as the Rational Method), and it discusses the hydraulic design of open channels, culverts, bridges, closed drainage systems, energy and dissipaters. The *MDM* supersedes, incorporates or references FHWA Hydraulic Engineering Circulars and Hydraulic Design Series publications. The overall objective of the *MDM* is to present hydraulic design criteria for highway drainage features which properly consider the probability of an extreme hydraulic event, the consequences of that event and the costs of providing a drainage system which will accommodate the event *(11)*.

The Hydraulics Section is typically responsible for the hydraulic design of drainage appurtenances for all roadway projects under the jurisdiction of the Department. The design is based on criteria in the AASHTO *Model Drainage Manual*, *MDT Hydraulics Manual* and general MDT practices in hydrology and hydraulics *(12).* Where conflicts exist between the *MDM* and MDT practices, the Hydraulics Section will determine the proper application.

Chapter 11 primarily discusses structural requirements for drainage appurtenances (e.g., maximum heights of fill and wall thicknesses for pipe culverts). It does not address hydrology and hydraulics.

1.5.1.4 AASHTO Policy on Design Standards – Interstate Highways

AASHTO's *Policy on Design Standards – Interstate Highways* provides design guidance for designing the nation's highways with an importance on safety, permanence, utility, and flexibility to provide for predicted growth in traffic *(13)*. This document provides the minimum standards for interstate highway segments constructed on new right-of-way and segments undergoing complete reconstruction along existing right-of-way. The current editions of *AASHTO's A*

Policy on Geometric Design of Highways and Streets shall be used as design guides where they do not conflict with these standards.

1.5.1.5 AASHTO Practical Guide to Cost Estimating

AASHTO's *Practical Guide to Cost Estimating* provides State Departments of Transportations (DOTs) guidance on developing realistic estimates of project cost. This document provides information anticipating cost impacts that may occur due to changes in project scope, available resources, and national and global market conditions. This publication provides "practical" guidance that serves those charged with the development of DOT cost estimates and with the management of the estimating process. This guidebook has two parts. Part I focuses on key cost-estimate techniques and Part II focuses on cost management activities *(14)*.

1.5.1.6 Highway Capacity Manual (HCM)

The *Highway Capacity Manual (HCM)*, published by the Transportation Research Board (TRB), presents the nationwide criteria for performing capacity analyses for highway projects. The *HCM* includes methodologies for freeways, weaving areas, freeway/ramp junctions, two-way two-lane facilities, and intersections. The basic objective of the capacity methodologies in the *HCM* is to determine the necessary configuration and dimensions of a specific highway element to accommodate the projected traffic volumes at a given level of service *(6)*.

The Traffic and Safety Bureau performs all needed capacity analyses for MDT road design projects. The *HCM* is used for all analyses with some adjustments for local highway capacity factors.

1.5.1.7 Highway Safety Manual (HSM)

The *Highway Safety Manual (HSM)*, published by AASHTO, presents a variety of methods for quantitatively estimating crash frequency or severity at a variety of locations. This manual provides tools to conduct quantitative safety analyses, allowing for safety to be quantitatively evaluated alongside other transportation performance measures such as traffic operations, environmental impacts, and construction costs *(4)*.

The *HSM* may be used by the design team to identify quantitative data for supportive design decisions when executing a performance-based approach and can help provide documentation for design decisions that require design exceptions.

1.5.1.8 AASHTO Guide for the Development of Bicycle Facilities

The AASHTO *Guide for the Development of Bicycle Facilities* provides information and guidelines for designing bicycle facilities in various design environments. The intent is to provide sound guidelines that result in facilities that meet the needs of bicyclists and other roadway users. While suggested minimum dimensions are provided, there is also sufficient flexibility permitted to encourage designs that are sensitive to local context and incorporate the needs of bicyclists, pedestrians, and motorists *(15)*.

Chapter 7 and Chapter 8 provide design principles and considerations for designing facilities for all users. The AASHTO *Guide for the Development of Bicycle Facilities* was used to develop the material described in the *RDM* and can be used as an additional resource when designing bicycle facilities.

1.5.1.9 AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities

The AASHTO *Guide for the Planning, Design, and Operation of Pedestrian Facilities* provides design guidance for pedestrian facilities and helps identify effective measures for accommodating pedestrians on public rights-of-way *(16)*.

Chapter 7 and Chapter 8 provide design principles and considerations for designing facilities for all users. The AASHTO *Guide for the Planning, Design, and Operation of Pedestrian Facilities* was used to develop the material described in the *RDM* and can be used as an additional resource when designing pedestrian facilities.

1.5.1.10 Transportation Research Board Access Management Manual

TRB's *Access Management Manual* provides technical information on access management techniques for the systematic control of the location, spacing, design, and operation of driveways, median openings, street connections, and interchanges to a roadway. This manual integrates planning and engineering practices with the transportation and land use decisions that contribute to access outcomes *(17)*.

Access control on MDT facilities is described in Chapter 2, Section 2.7. TRB's *Access Management Manual* can serve as a resource, in addition to the *MDT Approach Manual for Landowners and Developers (18).*

1.5.1.11 Guidance on the 2010 Americans with Disabilities Act (ADA) Standards for Accessible Design

The Department of Justice's revised regulations for Titles II and III of the Americans with Disabilities Act of 1990 (ADA) were published in the Federal Register on September 15, 2010. These regulations adopted revised, enforceable accessibility standards called the 2010 ADA Standards for Accessible Design, "2010 Standards." On March 15, 2012, compliance with the 2010 Standards was required for new construction and alterations under Titles II and III. March 15, 2012, is also the compliance date for using the 2010 Standards for program accessibility and barrier removal *(8)*.

Guidance on the 2010 Americans with Disabilities Act (ADA) Standards for Accessible Design can be used as a resource for the design team to address accessibility considerations and ensure the design meets the needs of all users.

1.5.1.12 United States Access Board Public Rights-of-Way Accessibility Guidelines (PROWAG)

The *U.S. Access Board PROWAG Guidelines* should be used by the design team to design sidewalks, street crossings, and other elements in the public right-of-way, such as curb ramps. The guidelines 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. The guidelines include pedestrian access to sidewalks and streets, including crosswalks, curb ramps, street furnishings, pedestrian signals, parking, and other components of public rights-of-way *(19)*.

The *U.S. Access Board PROWAG Guidelines* can be used as a resource for the design team to address accessibility considerations and ensure the design meets the needs of all users.

1.5.1.13 Manual on Uniform Traffic Control Devices (MUTCD)

The *Manual on Uniform Traffic Control Devices (MUTCD)*, published by FHWA in coordination with the National Committee on Uniform Traffic Control Devices, presents nationwide criteria for the selection, design and placement of all traffic control devices. This includes highway signs, pavement markings and traffic signals. The basic objective of the *MUTCD* is to establish an effective means to convey traffic control information to the driver for uniform application nationwide. The *MUTCD* information is divided into four categories — standard, guidance, option and support. These categories are used to establish the proper application of *MUTCD* criteria for all public roads and streets within the U.S. *(20)*.

The Traffic and Safety Bureau is responsible for the use of traffic control devices on all projects under the jurisdiction of MDT. MDT has adopted the use of the *MUTCD* in its entirety, including the context of its presentation. The *RDM Detailed Drawings* present additional information on traffic control devices which supplements the criteria in the *MUTCD*.

1.5.2 MDT Publications

MDT has prepared many publications in addition to the *RDM* which may apply to a road design project. MDT Publications can be accessed through the following link on the MDT Website.

Montana Department of Transportation Publications

In addition, the design team should identify if there are applicable design memoranda that should also be referenced for additional updated design information. MDT design memoranda are provided at the following link on the MDT website:

MDT Design Memoranda

1.6 REFERENCES

1. Montana Department of Transportation (MDT). *Baseline Criteria Practitioners Guide*. MDT, Helena, MT, 2021.
2. Ray, B., Ferguson, E., Knudsen, J., and Porter, R.J. *NCHRP Report 785: Performance-Based Analysis of Geometric Design of Highways and Streets.*

Transportation Research Board of the National Academies, Washington, D.C., 2014.

3. Federal Highway Administration (FHWA). Performance-Based Practical Design Website: http://www.fhwa.dot.gov/design/pbpd/

4. American Association of State Highway Transportation Officials (AASHTO). *Highway Safety Manual 2nd Edition (HSM)*. AASHTO, Washington, D.C., 2024.

5. FHWA. *Interactive Highway Safety and Design Model (IHSDM)*. FHWA, Washington, D.C., 2003.

6. Transportation Research Board (TRB). *Highway Capacity Manual (HCM).* Transportation Research Board of the National Academies, Washington, D.C., 2010.

7. MDT. *MDT Context Sensitive Solutions Guide*. MDT, Helena, MT, 2015.

8. Department of Justice. *Guidance on the 2010 Americans with Disabilities Act (ADA) Standards for Accessible Design.* Department of Justice, 2010.

9. AASHTO. *A Policy on Geometric Design of Highways and Streets.* AASHTO, Washington, D.C., 2018.

10. AASHTO. *Roadside Design Guide.* AASHTO, Washington, D.C., 2011.

11. AASHTO. *Model Drainage Manual*. AASHTO, Washington, D.C., 2005.

12. MDT. *MDT Hydraulics Manual.* Helena, MT: MDT, 2015.

13. AASHTO. *Policy on Design Standards – Interstate System.* AASHTO, Washington, D.C., 2005.

14. AASHTO. *Practical Guide to Cost Estimating, 1st Edition.* AASHTO, Washington, D.C., 2013.

15. AASHTO. *Guide for the Development of Bicycle Facilities.* AASHTO, Washington, D.C., 2012.

16. AASHTO. *Guide for the Planning, Design, and Operation of Pedestrian Facilities.* AASHTO, Washington, D.C., 2004.

17. TRB. *Access Management Manual.* Transportation Research Board of the National Academies, Washington, D.C., 2003.

18. MDT. *Approach Manual for Landowners and Developers.* MDT, Helena, MT, 2013.

19. United States Access Board. *Public Right-of-Way Accessibility Guidelines (PROWAG).* Website: https://www.access-board.gov/prowag/

20. FHWA. *Manual on Uniform Traffic Control Devices (MUTCD).* FHWA, Washington, D.C., 2023.